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An Exploratory Study of Trust Dynamics in Work-Oriented Virtual Teams

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This study explores trust development and maintenance in temporary, work-oriented virtual teams, and examines the effect of trust on communication and cohesiveness. Results suggest that for work-oriented virtual teams formed on a temporary basis, members swiftly develop calculus-based trust in order to assess the outcomes and costs of maintaining team relationships. Members also rely on prior knowledge to determine other members' competence so that they can make predictions about one another's behaviors. Thus, both calculus-based and knowledge-based trust play accentuating roles in the initial development of work-oriented virtual teams. Identification-based trust also develops swiftly initially, but is relatively insignificant compared to the other two types of trust. Finally, initial trust may correlate to both later communication and later cohesiveness.

Key words: work-oriented virtual teams, trust development

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Introduction

Computer-mediated communication (CMC) technology, such as the Internet, has the potential to overcome spatial and temporal barriers in human communication. CMC systems are sociotechnical systems for supporting such activities as knowledge learning and sharing free from constraints of time and place. Work-oriented virtual teams, composed of parties that have not worked together previously, are becoming the norm in organizations for completing temporary team tasks or project engagements (Jarvenpaa & Leidner, 1998; Jarvenpaa, Shaw, & Staples; 2004; McKnight, Cummings, & Chervany, 1998). Unlike the traditional teams that are allowed to develop slowly, these teams are required to be effective in completing tasks and meeting various demands from the beginning to the end of the group life. This is especially visible as companies rely more and more on outsourcing in their business operations. In this pursuit, many researchers have focused on understanding the role of trust in influencing the performance of work-oriented virtual teams (Tyler

& Kramer, 1996). Trust is "a state involving confident positive expectations about another's motives with respect to oneself in situations entailing risk" (Boon & Holmes, 1991, p. 194). For teams in traditionally physical settings, trust has been seen as an essential part of a healthy personality (Erikson, 1997; McKing, Choudhury, & Kacmar, 2002; Shaver & Hazan, 1994), as a foundation for interpersonal relations (Ba & Pavou, 2002; Brown, Poole, & Rodgers, 2004), as a foundation for cooperation (McKnight et al., 1998), and as the basis for stability in social institutions (Aubert & Kelsey, 2003; Larsen & McInerney, 2002; Paul & McDaniel, 2004; Piccoli & Ives, 2003; Jarvenpaa et al., 2004).

Yet, for temporary, work-oriented virtual teams consisting of members that are geographically dispersed and accountable to different stakeholders, responses often are not synchronized and information exchange can become decoupled from events (Jarvenpaa & Leidner 1998). Hence, there exists much difficulty in monitoring and managing team performance (Chidambaram, 1996; Kollock & Smith, 1996; Paul & McDaniel, 2004; Piccoli & Ives, 2003; Walther, 1995). Still, because high performance requires a high level of trust, members of work-oriented teams are required to build a trusting disposition toward other members quickly. That is, from the very beginning of team life, the members are expected to meet specific demands placed upon them immediately; and the team must uphold their productivity to the end of the team's life. Because trust is necessary for team members to work together to meet various outcome expectations, an important question arises for both researchers and practitioners of information systems: "How does trust develop and how is trust sustained in work-oriented virtual teams that are formed on a temporary basis?"

According to Jarvenpaa & Leidner (1998), there exist two streams of theoretical reasoning in the IS literature to address this question (see Table 1). The traditional view is that trust development is based strongly on interpersonal relationships, while recent researchers have focused on swift formation of category-based trust that plays down the interpersonal dimensions (Jarvenpaa & Leidner 1998, Jarvenpaa et al., 2004). For the former, Lewicki and Bunker (1996) have theorized that different types of trust emerge in different stages of group development. Initially, there emerges calculus-based trust, based on a member's assessment of the outcomes and costs of maintaining a group relationship. Subsequently, for teams that continue to work productively, this calculus-based trust is transformed into knowledge-based trust, which is based on members' knowledge of other members' competencies so that they can make predictions about one another's behaviors. Finally, for teams that work together effectively throughout their existence, members transform knowledge-based trust into identity-based trust, which is grounded in members' mutual identity and willingness to act for each other (Lewicki, McAllister, & Bies, 1998; Rousseau, Sitkin, Burt, & Camerer, 1998; Sheppard & Tuchinsky, 1996). These three types of trust are linked in a sequential iteration over time.

On the other hand, researchers who have recently studied trust development in temporary project teams and work-oriented virtual teams have stressed the importance of high levels of initial trust in establishing an organizational relationship

Table 1 Summary of two streams of theorization concerning trust development and effects

Trust Issues	Primary Conclusion	Source
Swift Trust		
1.	High swift trust within groups has a positive effect on establishing an organizational relationship.	(McKnight et al., 1998; Jarvenpaa et al. 1998,2004)
2.	Swift trust has a positive effect on group collaboration.	(McKnight et al., 1998)
3.	Swift trust is formed based on three types of categorization: unit grouping, reputation categorization, and stereotyping (McKnight et al. 1998). Viewing trust development as an attribution process, researchers theorize that people may employ preexisting dispositions, institutional expectations, and social categorization to make attributions about the other person's initial trustworthiness (Jarvenpaa et al., 2004). . . For temporary, work-oriented virtual teams, because there is insufficient time to build trust on first-hand information, categories.	
4.	Swift trust has an effect on calculus-based, knowledge-based, and identity-based trust.	(McKnight et al., 1998; Jarvenpaa et al., 1998; 2004)
5.	Swift trust is based on team goals and members' stereotypical impressions	(Meyerson et al., 1996; Jarvenpaa & Leidner,1999; Jarvenpaa et al. 2004; McKnight et al., 1998)
Trust Issues	Primary Conclusion	Source
Sequential Development of Trust		
1.	Different types of trust emerge in different stages of group development.	(Lewicki & Bunker , 1996)
2.	Trust moves from calculus-based trust, to knowledge-based trust, to identification-based trust.	(Lewicki & Bunker , 1996)
3.	Early trust has a positive effect on late trust.	(Lewicki & Bunker, 1996; Sheppard & Tuchinsky, 1996)
4.	Calculus-based trust increases rapidly in the beginning.	(Shapiro et al., 1992)
5.	Knowledge-based trust increases the more a trustee's behavior becomes predictable.	(Lewicki & Bunker, 1996)
6.	Identification-based trust grows in the last stage.	(Lewicki & Bunker, 1996)
Trust Issues	Primary Conclusion	Source
Effect of Trust on Communication and Cohesiveness		
1.	Communication facilitates and maintains trust.	(Rafaeli, 1988; Davidow & Malone, 1992; Jarvenpaa & Ives, 1994; Jarvenpaa & Leidner, 1999; Dirks & Ferrin, 2001).
2.	Trust and communication have a positive correlation.	(Jarvenpaa et al., 1998).
3.	Trust and cohesiveness have a positive correlation.	(Roark & Hussen, 1989).
4.	Cohesiveness has a positive effect on group trust.	(Shaw, 1980).
5.	Initial trust has a positive effect on cohesiveness.	(Jarvenpaa et al., 2004)
6.	Trust has an effect on the learning performance of virtual teams.	(Tyler & Kramer, 1996; Jarvenpaa & Leidner , 1998; Jarvenpaa et al., 2004).
7.	Trust has an effect on interpersonal relationships.	(Shaver & Hazan, 1994; Erikson, 1997; McKing et al., 2002).
8.	Interpersonal traits have an effect on the individual's disposition to trust.	(Ba & Pavlou, 2002; Brown et al., 2004).
9.	Trust can reduce transaction risks.	(Ba & Pavlou, 2002; McKing et al., 2002; Piccoli & Ives, 2003; Aubert & Kelsey, 2003; Jarvenpaa et al., 2004; Paul & McDaniel, 2004)
10.	Trust helps to monitor and manage team performance.	(Kollock & Smith, 1996; Piccoli & Ives, 2003; Paul & McDaniel, 2004).

(Jarvenpaa & Leidner 1998, Jarvenpaa et al., 2004). Swift trust is formed on the basis of three types of categorization: unit grouping, reputation categorization, and stereotyping (McKnight et al., 1998). Viewing trust development as an attribution process, researchers theorize that people may employ pre-existing dispositions, institutional expectations, and social categorization to make attributions about the other person's initial trustworthiness. For temporary, work-oriented virtual teams, because there is insufficient time to build trust on first-hand information, categories governing some previously experienced settings are imported quickly to serve this purpose. For example, Jarvenpaa et al. (2004) have found that work-oriented virtual teams may experience a form of swift trust that directly affects early trust development, which, in turn, affects the team's later trust, communication, cohesiveness, and performance. Note that while this line of research differs from the theorization of Lewicki and Bunker (1996) in the swift forming of trust in the initial stages of team life, both emphasize that in the later periods, trust may improve or deteriorate depending upon interpersonal interactions. In the study by Jarvenpaa & Leidner (1998), for instance, interactions may strengthen or weaken trust, raising or lowering the team's capability of managing uncertainty, risk, and points of vulnerability in a self-fulfilling fashion.

Thus, the present study investigates the patterns of trust development for temporary, work-oriented virtual teams. Specifically, we attempt to clarify whether calculus-based trust, knowledge-based trust, and identity-based trust develop sequentially, as suggested by Lewicki and Bunker, or swiftly in the initiation of team formation, as proposed by McKnight et al. Note that while Lewicki and Bunker's theorization is grounded in face-to-face teams, our study focuses on work-oriented virtual teams by examining the evolvement of the three types of trust, and the way they may influence group communication and cohesiveness throughout the entire life of the group. In this pursuit, we hope to contribute to the integration of the traditional and current streams of theorization regarding the maintenance of trust for work-oriented virtual teams.

Theoretical Background and Hypotheses

Initial Trust

As mentioned previously, there are two streams of theorization concerning initial trust development. First, in Lewicki and Bunker's (1996) theorization of trust development, if a team goes through its full development into maturation, trust moves from calculus-based trust (CBT), through knowledge-based trust (KBT), to identification-based trust (IBT) (see Figure 1). Relationship building begins with the development of calculus-based trust activities. If these activities develop in a manner that confirms the validity of the trust, the parties will also begin developing a knowledge base about each other's needs, preferences, and priorities. This information about the other creates the foundation for a transition to knowledge-based trust, which occurs at point J_1 in Figure 1. The transition from knowledge-based trust to

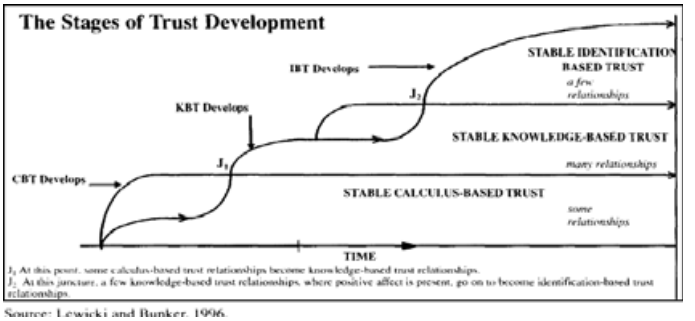

Figure 1 The stages of trust development proposed by Lewicki and Bunker (1996, pp.124).

identification-based trust occurs in a similar manner and begins at point J_2 in the figure. As the parties come to learn more about each other, they may also begin to identify strongly with the others' needs, preferences, and priorities, and come to see them as their own. Identification leads to a search for more information, which creates a broader maintenance for knowledge-based trust and more dimensions on which the parties may identify with each other.

Thus, according to Lewicki and Bunker (1996), only calculus-based trust will develop initially (see Hypothesis 1a). The following hypothesis may therefore be contemplated:

Work-oriented virtual teams' calculus-based trust develops in the early weeks of the relationship.

However, in contrast to Lewicki and Bunker (1996), the Social Identification/ De-individuation theory (SIDE) suggests that in the virtual context, individuals in temporary groups make initial use of a category-driven information process to form stereotypical impressions of others (Spears & Lea, 1992). This activation of category information in turn helps to identify embedded social relationships that are seen to be more personal and collaborative. Subsequently, members may form social, informal contracts and share private, situated information awe well as tacit knowledge. Extending from SIDE, McKnight et al. (1998) and Jarvenpaa, Knoll, and Leidne (1998) have theorized that, for teams of participants with diverse skills who are assembled temporarily, trust is not based on first-hand knowledge of the other party; rather, it is based on category information. The members of work-oriented virtual teams have a limited history of working together, have a limited prospect of working together in the future, and their assigned tasks are neither routine nor well understood (Meyerson, Weick, & Kramer, 1996). So these teams often encounter uncertainty, and seem to lack normative structures. Moreover, there is no time to engage in the usual forms of confidence-building activities that contribute to the development and maintenance of trust in more traditional, enduring teams. In these situations, categories are invoked to speed perception: role reflection, cultural cues, and occupational and other stereotypes.

Thus, according to Jarvenpaa et al. (1998; 2004), McKnight et al. (1998), Meyerson et al. (1996), and Spears & Lea, (1992) not only calculus-based trust, but also knowledge- and identity-based trust may develop swiftly based on the initial category-driven information of the members of the work-oriented virtual team. Thus, we formulate the following hypotheses (note that the word "weeks" in our hypotheses refers to the duration of our study teams' relationships, which was 18 weeks):

H1: Work-oriented virtual teams' trust develops in the early weeks of the relationship.

H1a: Work-oriented virtual teams' calculus-based trust develops swiftly in the early weeks of the relationship.

H1b: Work-oriented virtual teams' knowledge-based trust develops swiftly in the early weeks of the relationship.

H1c: Work-oriented virtual teams' identification-based trust develops swiftly in the early weeks of the relationship.

Maintenance of Trust

Calculus-based trust. CBT is the trust that exists in the early weeks of a relationship. In this stage, teams appear to be very harmonious on the surface. Participants look for guidelines that may alleviate their concerns and anxiety. To foster members' relationships, cohesiveness, cooperation, and agreement are strongly encouraged, and differences among members resulting from factors such as race, gender, or occupation tend to be denied or ignored. Accordingly, calculus-based trust is driven by members' assessments of the outcomes of creating and sustaining that relationship relative to the costs of severing it. Lewicki and Bunker (1996) argue that this form of trust peaks quickly in the initial period of team development and remains stable later (see Figure 1). The fast development of calculus-based trust allows a member to be assured that the other members will do what they say because the positive results are greater than the negative and they might benefit more by keeping their promises. This is important because trust is low in the initial stages of team development, when members tend to refrain from freely exchanging knowledge and information.

To develop sufficient information about one's partners in the context of shallow interdependence and weak trust, one must quickly engage in active discovery through interaction. As members of the virtual teams have the time or resources to engage in interaction and extensive information processing, they can better assess their gain from cooperation and predicate the other members' behaviors or intentions. Thus, for teams that succeed in managing the tension experienced by members during the first phase of the group, calculus-based trust increases rapidly initially (Lewicki & Bunker, 1996; Sheppard & Tuchinsky, 1996). In later weeks, as the parties feel more secure that they will not be harmed or put at a risk by the actions of other team members, calculus-based trust will stabilize and remain constant to the end. Thus, we propose the second hypothesis:

H2: Work-oriented virtual teams' calculus-based trust increases in the early weeks and remains stable thereafter.

Knowledge-based trust. KBT is the form of trust grounded in others' predictability (Jarvenpaa et al., 2004; McKing et al., 2002). According to Lewicki and Bunker (1996), knowledge-based trust peaks in the middle period of group development and remains stable afterward. Building knowledge-based trust via a prediction process requires information about a trustee's past actions. In this stage, conflicts emerge among members. Conflict has been described as essential to the development of cohesion (Gersick, 1988; Gersick & Hackman, 1990; Kollock & Smith, 1996). The motivation behind the struggle is to reduce anxiety by clarifying the goals and structure of the group. As the depth of interaction and interdependence increases, partners' imperfections are gradually revealed and members become motivated to learn about the drive for success of other team members and the prospects for a successful working relationship. The greater the variety of shared experiences and the generated knowledge base, the more a trustee's behavior becomes predictable (Jarvenpaa et al., 2004; Shapiro, Sheppard, & Cheraskin, 1992). Gradually, as parties interact and accumulate a rich tapestry of cooperative experience over time, they may learn to function together. The growing interdependent relationships will provide a powerful signal of success in building knowledge-based trust, which grows steadily and peaks when the group reaches the middle period of group development. Thus, we formulate the following hypothesis:

H3: Work-oriented virtual teams' knowledge-based trust reaches its peak in the middle weeks, and remains stable in the final weeks.

Identification-based trust. IBT is the trust that exists due to the parties' mutual understanding and appreciation of one another's wants. Assuming that conflicts have been resolved successfully, members feel secure with, and trusting of, one another and the leader. They feel no need to question their partners' motives and commitment, and their attention to structures and roles during this stage significantly increases the team's capacity to work effectively and productively (Duphorne & Gunawardena, 2005; Newhagen & Rafaeli, 1996; Poole, 1983; Gunawardena, Jennings, Ortegano-Layne, Frechette, Carabajal, Lindemann, & Mummert, 2004). The consequence of this is further development of identification-based trust. This form of trust depends on members' shared values and norms of obligation and enables members to effectively act for the others. As Lewicki and Bunker (1996) argue, common values and norms of obligation can develop into a long-standing relationship for which trust was originally created in an incremental manner. The essential construct in this argument is time. Sufficient identification-based trust for deep interdependence can only be built over time. During early weeks, the members of the virtual teams may cooperate continually and share information and assets but still view the other party as "them" instead of "us." However, repeated interactions tend to create expanded resources, including shared information, status, and concern. These expanded resources can, in turn, give rise to psychological identity. Therefore, Lewicki and Bunker (1996)

theorize that identification-based trust grows in the last period. Accordingly, we formulate the following hypothesis:

H4: Work-oriented virtual teams' identification-based trust reaches its peak in the final weeks.

Trust Dependence

According to Lewicki and Bunker (1996), McKnight et al. (1998), and Jarvenpaa et al. (2004), a direct, positive relationship exists between early and later trust. In any given situation, people are likely to rely on initial trust to determine their willingness to trust others. At first, each member observes the others' behaviors. If a member repeatedly fulfills his or her promises and acts positively, the others will view those behaviors as predictable. Next, after people see other members behaving predictably, they begin to consider them as reliable or dependable. Finally, members grow confident that their relationship will last. Thus, trust in the early weeks will influence trust in later weeks directly and positively. Accordingly, we propose the following hypotheses:

H5: Work-oriented virtual teams' trust in the early weeks has a positive correlation to this trust in the later weeks.

H5a: Work-oriented virtual teams' calculus-based trust in the early weeks has a positive correlation to their calculus-based trust in the later weeks.

H5b: Work-oriented virtual teams' knowledge-based trust in the early weeks has a positive correlation to their knowledge-based trust in the later weeks.

H5c: Work-oriented virtual teams' identification-based trust in the early weeks has a positive correlation to their identification-base trust in the later weeks.

Moreover, Lewicki and Bunker (1996) propose that if a relationship reaches full maturity, it moves from calculus-based trust, to knowledge-based trust, and finally to identification-based trust. Relationship building, therefore, begins with the development of calculus-based trust activities. As team members' behaviors become predictable, their mutual trust changes from calculus-based trust to knowledge-based trust (Shapiro et al., 1992), as shown by the transition to knowledge-based trust, which occurs at point J_1 in Figure 1. At point J_2 in the figure, the movement from knowledge-based trust to identification-based trust occurs in a similar manner. Thus, we propose an additional hypothesis:

H5d: Work-oriented virtual teams' calculus-based trust in the early weeks has a positive correlation to their knowledge-based trust in the later weeks; and work-oriented virtual teams' knowledge-based trust in the early weeks has a positive correlation to their identification-based trust in the later weeks.

Effect of Trust on Communication

Communication occurs as team members encourage and support one another in order to reach the team's goal (Dirks & Ferrin, 2001; Rafaeli, 1988). According

to the study by Jarvenpaa and Leider (1998), a high level of trust in the team's early life allows the team effectively to solve problems, resolve conflicts, and have positive communications when they are faced with technical or task uncertainty. Conversely, teams of low initial trust are characterized by irregular and unpredictable communication, and exchange little information. Several other studies (Davidow & Malone, 1992; Jarvenpaa & Ives, 1994; Jarvenpaa et al., 2004) have also shown that virtual teams rely on predictable, clear, and timely communication to reduce uncertainty and increase team effectiveness. The extensive level of communication appears to be fostered by the high level of trust initially. Finally, Jarvenpaa et al. (1998) have discovered that for high-trust teams, frequent communication allows team members to better understand a new environment and evaluate their options, thereby enabling successful adaptation to various communication technologies. Therefore, we formulate the following hypothesis:

H6: A positive correlation exists between the level of trust in the first half of the relationship and the level of communication in the second half.

Effect of Trust on Cohesiveness

Cohesiveness is a key theoretical construct to describe the "group-ness" of individuals constituting an interactive small team (Hogg, 1992; Shaw, 1980). As individuals extend their trust to others, they create a work environment that is characterized by mutual empathy, a willingness to accept others, and a high level of cohesiveness (Roark & Hussen, 1989). This high level of cohesiveness, in turn, leads to the members' deep identification with a team (Roark & Hussen 1989). Thus, members of cohesive teams are more likely both to remain team members throughout the duration of a task, and to perform effectively.

For work-oriented virtual teams, however, cohesiveness may not necessarily develop well due to the physical separation of the team members as well as the limited opportunity for members to interact. Jarvenpaa et al. (2004) have discovered that a high level of initial trust leads to a subsequent high level of cohesiveness for work-oriented virtual teams. Hence, we formulate the following hypothesis:

H7: A positive correlation exists between the level of trust in the first half and the level of cohesiveness in the second half of the relationship.

Research Methodology

Data

In this study, we observed the work-oriented virtual teams of an 18-week class offered by a cyber university in Taiwan. According to Cooper and Emory (1995) and Maxwell (1996), four criteria come into play in securing a sample: relevance, frame, size, and cost. "Relevance" means that the population must be apparent for the research objective, which here is to explore the work-oriented group's development process in the CMC-environment. Because the teams observed in this study had well-defined goals, and members had to coordinate their work through an electronic bulletin

board system (BBS) on the Internet, we considered these teams appropriate for our research objects. ''Frame'' means that the chosen sample must be representative of the population, and ''size'' means that the sample bears some proportional relationship to the size of the population from which it is drawn. The teams chosen for our study were from course C in the cyber university. Of the 311 members registered in the cyber university, 158 attended course C. Thus, the sample satisfied the criteria of both frame and size. Finally, ''cost'' means that both budget and time can influence the size and type of the sample chosen for study. In our research, the computer system of the cyber university automatically collected team members' discussions without disturbing team activities, and recorded data continuously. The cost criteria were, therefore, satisfied.

Among the 158 participants, 35 were female. One-third of the participants had previous experience in taking courses offered by the same cyber university. The majority of participants came from diverse areas, with various occupations, including teachers, programmers, managers, journalists, project leaders, doctors, and company workers. They were assigned to 25 different teams that were required to meet face-to-face in the first week of the semester. There were six to eight persons per team.

In the virtual classes, students and the teacher had online cyber-office hours every week. The grade received for the team project accounted for 60 percent of the students' final grades. Students were evaluated based on the quantity and quality of their contribution to discussions and to the final report. In addition, each student was required to complete four homework assignments in the semester. Each team had its own electronic BBS for electronic collaboration. Note that each team also held two face-to-face meetings with the teacher, one in the middle and the other at the end of the semester. This was comparable to Jarvenpaa et al.'s study (1998), which allowed students to meet face to face if they so wished.

Task

Temporary, work-oriented virtual teams are characterized by the need to engage in task completion both immediately at the beginning and throughout the team's life, whereas the aim of this research is to investigate the development and maintenance of trust during the team's lifespan. In previous studies of groups, researchers have employed a variety of tasks ranging from simple (e.g. brainstorming) to complex (e.g. command and control). In this study, we followed McGrath and Hollingshead's (1994) task design for group development and asked students to accomplish a complex project consisting of four subtasks arranged sequentially: (1) to generate ideas; (2) to choose a preferred solution; (3) to negotiate; and (4) to execute. McGrath has suggested that new teams have to devote time to mutual support so that they can progress through all four production phases. In the study by Jarvenpaa & Leidner (1998), the findings also show that work-oriented virtual teams with high levels of trust, when faced with technical/task uncertainty early in the group's life, were able to solve problems and resolve conflicts. The four tasks used in our experiment were

designed in light of the findings above. The weekly experimental tasks were described in the following way:

Week1∼Week4:
Task Type: Generate and select ideas
All teams were asked to determine the subject that they wished to pursue for the semester. Participants were explicitly instructed to list as many ideas as possible. Teams were scored based on the quality and quantity of their ideas they listed on their discussion board systems.

Week5∼Week8:
Task Type: Choose a preferred solution
Each team was obliged to submit a project proposal and set up the coordination mechanism necessary to keep the work running smoothly. The proposal had to include details of each subtask such as goal, tasks, procedure, assessment, and schedule. In addition, the meeting records on the discussion board system were to be tracked as a part of scoring. Each team was scored according to the proposal and their discussion about how they completed the team project.

Week9∼Week14:
Task Type: Negotiation
In this phase, members were expected to search for and exchange information, clarify any task ambiguity, and monitor each other's performance. Each team had to have regular meetings to discuss different opinions and resolve the conflicts among members. The teams were scored based on the progress of negotiation and conflict resolution.

Week15∼Week16:
Task Type: Execute
Teams were required to complete their project and submit a written report accompanied by relevant documents. Each team had to report how they collected and analyzed data, showed their findings and drew conclusions about the important measurement indexes of the project quality. A formal, face-to-face presentation at the end of the semester was conducted. The teams were scored based on activities relating to the execution of the project. Teams collecting and analyzing data, elaborating the project questions, and identifying and validating their findings clearly would gain high scores.

Content Analysis

Content analysis can reflect team interaction patterns, reveal the focus of individual, team, institutional, or societal attention, and disclose the relationship between intent and content (Krippendorff, 1980; Strauss & Corbin, 1998). The comments of members of virtual teams are rich in description of other members' traits and states (Newhagen & Rafaeli, 1996) and provide useful data for content analysis to reveal individuals' trust-related beliefs (Neuendorf, 2002). Therefore, we rely on content

Table 2 The example sentence and keyword of each category

Trust Category		
Category	Example	Keywords
Calculus-based trust	we should fulfill the requirement. . ..	Performance, Efficiency, Easy, Quick, . . .
Knowledge-based trust	according. . .. we have to focus on. . .	Base on, According. . .
Identification-based trust	We don't give up. . . our team is. . .	Our Team, tradition
Cohesiveness	Our team is great one. . .. We solve this problem together. . .	Support, Warm
Communication	Re: I could finish it.	Reply

analysis to discern expressed trust when studying how trust may affect the acts of communicators.

Harrison, Dibben and Maso (1997) have summarized how trust concepts can be operationalized for the purpose of analyzing trust development. Our study has adopted the categories proposed by Harrison et al. (1997), which are: (1) Calculus-based trust, reflecting each member's assessment of what they individually can gain from the relationship; (2) knowledge-based trust, reflecting knowledge of others' competencies, the group norm, and the past actions of others; (3) identification-based trust, reflecting a high degree of identification with the team; (4) cohesiveness, reflecting expressions of warmth, friendship, support, or intimacy with others; (5) communication, which is the number of messages related to previous messages, while the statements that repeat the words of an author or passage are not coded. According to Rafaeli (1988), fully interactive communication requires that later messages in any sequence take into account not just the messages preceding them, but also the manner in which previous messages are reactive. Thus, in this study, a sentence may refer to one of the three trust coding categories. The example sentences and keywords of each category are shown in Table 2.

Reliability and Validity

Content analysis includes several steps: (1) defining the recording units; (2) defining the categories; (3) testing the coding on the text sample; (4) assessing accuracy and reliability; (5) revising the coding rules; (6) returning to step (3) until the reliability is acceptable; (7) coding all the text; and (8) assessing the achieved reliability/accuracy. The training data were collected from another course in the same cyber university. Several rounds of training practices were conducted until the reproducibility reliability of the results from the two coders exceeded 90 percent (Strauss & Corbin, 1998). The two coders were Ph.D. students who were trained to ensure appropriate coding skill and reliability. In the fifth training round, this reliability index reached 90.02 percent. The training was then stopped and formal coding (Step (7)) began.

To test the reliability of this study, we evaluated stability and reproducibility. Stability refers to the extent to which the results of content classification by a certain coder are invariant over time (Weber, 1990). Reproducibility refers to the extent to which content classification produces the same results when the same text is coded by more than one coder. In this study, each coder was asked to code a set of data at two different times. The degrees of stability by the two respective coders were more than 90 percent, satisfying the stability criteria (Krippendroff, 1980). Comparison of these two researchers' coding results also reveals that the reproducibility between the two coders was 88.73 percent, indicating an acceptable level of reliability (Neuendorf, 2002).

Furthermore, both face validity and semantic validity were employed by this study. Face validity is the extent to which the measure, ''on the face of things,'' appears to tap the desired concept (Neuendorf, 2002). To assess face validity in our study, the researchers were asked to take a step back and examine each concept objectively. We considered validity to be reached when the researchers all agreed that the data tapped the desired concepts. For example, in this study, both coders agreed that only the set of key terms (benefits, dis/advantages, cost, interests, gain, and profit) could be used to represent the concept of calculus-based trust. For the classification to have semantic validity, it is necessary for coding units such as words that are classified together to possess similar connotations (Weber, 1990). In this study, the two coders had 2 years' experience participating in studying work-oriented virtual teams, and were familiar with the communication content. Semantic validity was achieved when these two coders examined the list of words placed in the same category and agreed that these words had similar meanings or connotations (Krippendorff, 1980).

Results

We collected conversations taking place on the cyber forum, including discussions between students, shared lectures and notes, and project reports. A total of 6,453 sentences were obtained across 20 weeks from 25 teams in the spring semester 2000. Of these, 1,759 units (27.10% of the total) could be classified into one of the three categories: calculus-based trust, knowledge-based trust, and identification-based trust. Three hundred eighty-four units were also classified into the cohesiveness category, and 2,413 units were classified as communication. Table 3 shows the numbers for each of the three types of trust during early, middle, and late weeks, respectively. Data were condensed into 18 weeks to analyze their respective characteristics through several statistical techniques: time-series regression, correlation analysis, auto-correlation function (ACF), cross-correlation function (CCF), and curve estimation.

Time-series regression is useful in exploring the relationship of an independent variable that marks the passage of time to a dependent variable. To test Hypothesis 1, we adopt time-series regression to estimate the intercept and slope of the three types of trust over time. Curve estimation using nonparametric smoothing techniques is an

Table 3 The number of each types of trust in the three periods

	CB-trust	KB-trust	IB-trust	Total
Early weeks	368	143	53	564
Middle weeks	369	227	87	683
Late weeks	282	148	67	497
Total	1019	518	207	1744

Key: CB: calculus-based trust, KB: knowledge-based trust, IB: identification-based trust.

elective tool for unmasking important structures from noisy data (Simonoff, 1996). Curve estimation offers the right setup for consistent, nonparametric inference of time-changing expected return, volatility, and covariance among the experimental data (Simonoff, 1996). In this study, the curve estimation is employed in testing the sequential development of trust (Hypotheses 2 through 4).

To test Hypothesis 5, the auto-correlation function and cross-correlation function allow us to observe the correlations between time-shifted variables. ACF is a function between two values of the same variable at times X_i and X_{i+k} (Box & Jenkins, 1976). Informally, it is the cross-correlation of a signal with itself, often used to measure how well a signal matches a time-shifted version of itself, as a function of the amount of time shift. ACF is, therefore, useful for finding repeating patterns in a signal, such as determining the presence of a periodic signal that has been buried under noise, or identifying the missing fundamental frequency in a signal implied by its harmonic frequencies. In this study, ACF is applied to discover the correlated patterns between different periods within the same type of trust.

CCF is a standard method for estimating the degree to which two series are correlated (Box & Jenkins, 1976). CCF is sometimes used to refer to the covariance [cov(X,Y)] between two random vectors X and Y, to distinguish that concept from the ''covariance'' of a random vector X. For example, consider two real-valued functions f and g that differ only by a shift along the x-axis. One can calculate the cross-correlation to ascertain how much g must be shifted along the x-axis to make it identical to f. CCF is applied here to discover patterns across different types of trust.

Finally, for Hypotheses 6 and 7, correlation analysis is employed to analyze the interrelationships of variables and indicate the strength of the association between two metric variables.

Initial Trust

To determine whether trust develops swiftly in the early weeks (i.e., Hypothesis 1), we employ a time-series regression to test whether the frequency of each type of trust is higher than zero and whether these frequencies fluctuate between weeks. The results of the time-series regression (see Table 4) show that the intercept for total trust is 4.272, which is significantly higher than zero, meaning that the initial total trust is high. Hypothesis 1 is therefore supported. In addition, Table 4 shows that the intercepts of calculus-based trust, knowledge-based trust, and identification-based

Table 4 The result of time series analysis-regression

	Equation	Sig. p-value
Total Trust	$Trust_t = 4.272 - 0.042 * t$	p-value = 0.0002
Calculus-based Trust	$CBTrust_t = 2.747 - 0.051 * t$	p-value = 0.0001
Knowledge-based Trust	$KBTrust_t = 1.089 + 0.006 * t$	p-value = 0.0006
Identification-based Trust	$IBTrust_t = 0.435 + 0.003 * t$	p-value = 0.0075

trust are 2.747, 1.089, and 0.435, respectively, and the p-values indicate that these three types of trust are significantly higher than zero, indicating that the initial level of calculus-based trust, knowledge-based trust, and identification-based trust are high for all work-oriented virtual teams in this study. Thus, Hypotheses 1a, 1b, and 1c are supported.

Maintenance of Trust

To analyze whether trust develops sequentially, we observe the development patterns of the three types of trust (see Figure 2) and use curve estimation (Table 5) to test the slope of each type of trust at each period. The CB-line in Figure 2 shows that the calculus-based trust is high and stable in the beginning, but decreases during the final weeks. In Figure 2, x-axis is the time stamp and y-axis is the percentage of trust sentences. Furthermore, Table 5 shows that the slope of the calculus-based trust line is 0.005 in the beginning, −0.18 in the middle period, and −0.1 in the final. This confirms that the frequency of calculus-based trust increases initially but decreases gradually during the final periods. Hence, Hypothesis 2 is not supported.

Next, the KB-line in Figure 2 shows that knowledge-based trust peaks in the middle and decreases during the later weeks. Table 5 shows that the slopes of the knowledge-based trust are 0.006, −0.002, and −0.002 at each period, respectively. The constant of the knowledge-based trust line in the beginning is 0.483. Therefore,

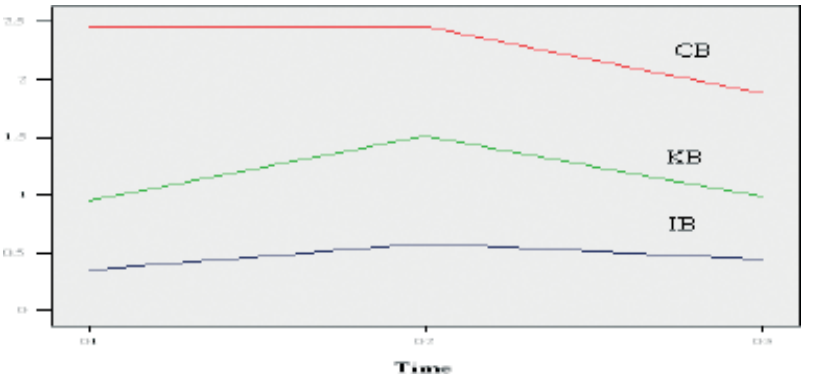

Figure 2 The pattern of three types of trust in our study.

Table 5 The result of curve estimation

Trust	Constant	Slope	Trust	Constant	Slope	Trust	Constant	Slope
CB1	2.079	.005	KB1	.483	.006	IB1	.508	−.002
CB2	3.840	−.018	KB2	1.652	−.002	IB2	.866	−.004
CB3	2.635	−.010	KB3	1.120	−.002	IB3	.371	.001

Key: CB:calculus-based trust, KB: knowledge-based trust, IB: identification-based trust

knowledge-based trust is higher than zero initially and peaks in the middle, a finding that partially supports Hypothesis 3.

Finally, the IB-line in Figure 2 shows that identification-based trust remains almost constant throughout the three periods. Table 5 shows that the slopes of identification-based trust at each period are −0.002, −0.004, and 0.001, respectively. The constants of the identification-based trust line during the first periods are 0.508 and 0.866. Our data show the identification-based trust is high during the first two periods and is stable throughout all weeks. This indicates that Hypothesis 4 is not supported.

Figure 3 compares the trust development curves resulting from this study (solid lines) to the curves theorized by Lewicki and Bunker (1996) (dotted lines). Figure 3a shows that the solid line (calculus-based trust from our study) increases in the beginning, in similar vein to the pattern of the dotted line (i.e., the curve as predicted by Lewicki & Bunker). However, the solid line peaks rapidly and decreases afterward, as opposed to the dotted line, which is theorized to increase initially but stabilize after its peak. Thus, Hypothesis 2 is partially supported.

Next, the solid line in Figure 3b (knowledge-based trust from our study) starts high (significantly higher than zero in Table 4), peaks in the middle, and decreases in the final two weeks, whereas the dotted line is theorized to peak in the middle but stabilize afterward. Thus, Hypothesis 3 is partially supported.

Finally, the solid line in Figure 3c remains low throughout the 18 weeks, differing substantially from the dotted line that is theorized to peak at the end. This indicates that Hypothesis 4 is not supported.

Trust Interdependence

We employ the auto-correlation function to examine the interdependence of trust throughout the period. Figure 4 shows the ACF coefficients for (a) total trust (aggregating all three types of trust); (b) calculus-based trust; (c) knowledge-based trust, and (d) identification-based trust in the different weeks. The ACF for the total trust (Figure 4a) indicates that the auto-correlations of trust are significant in 1-, 2-, 3-, and 5-week lags. The most significant auto-correlation coefficient appears in the five-week lag, meaning the trust in a certain week exhibits the highest auto-correlation with the trust five weeks later. Thus, Hypothesis 5 (i.e., there is a significant correlation between early total trust and later total trust) is supported.

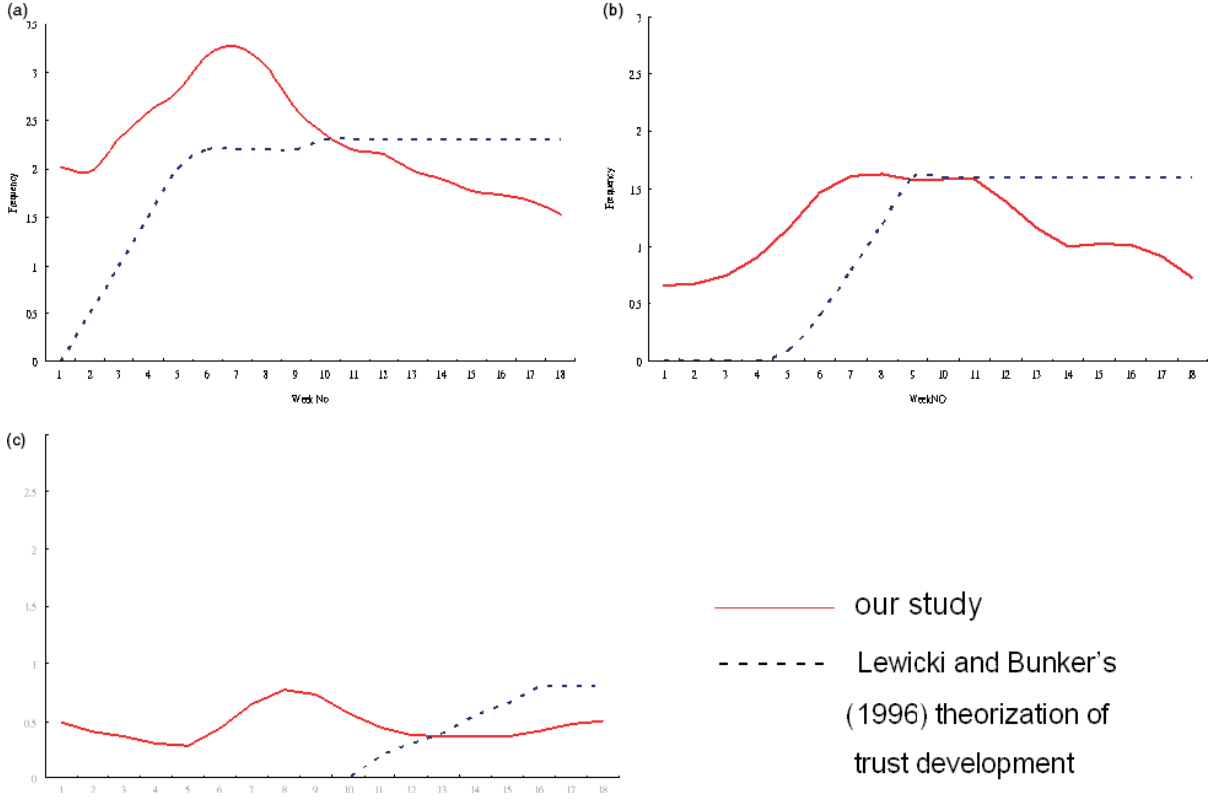

Figure 3 The patterns of three types of trust.

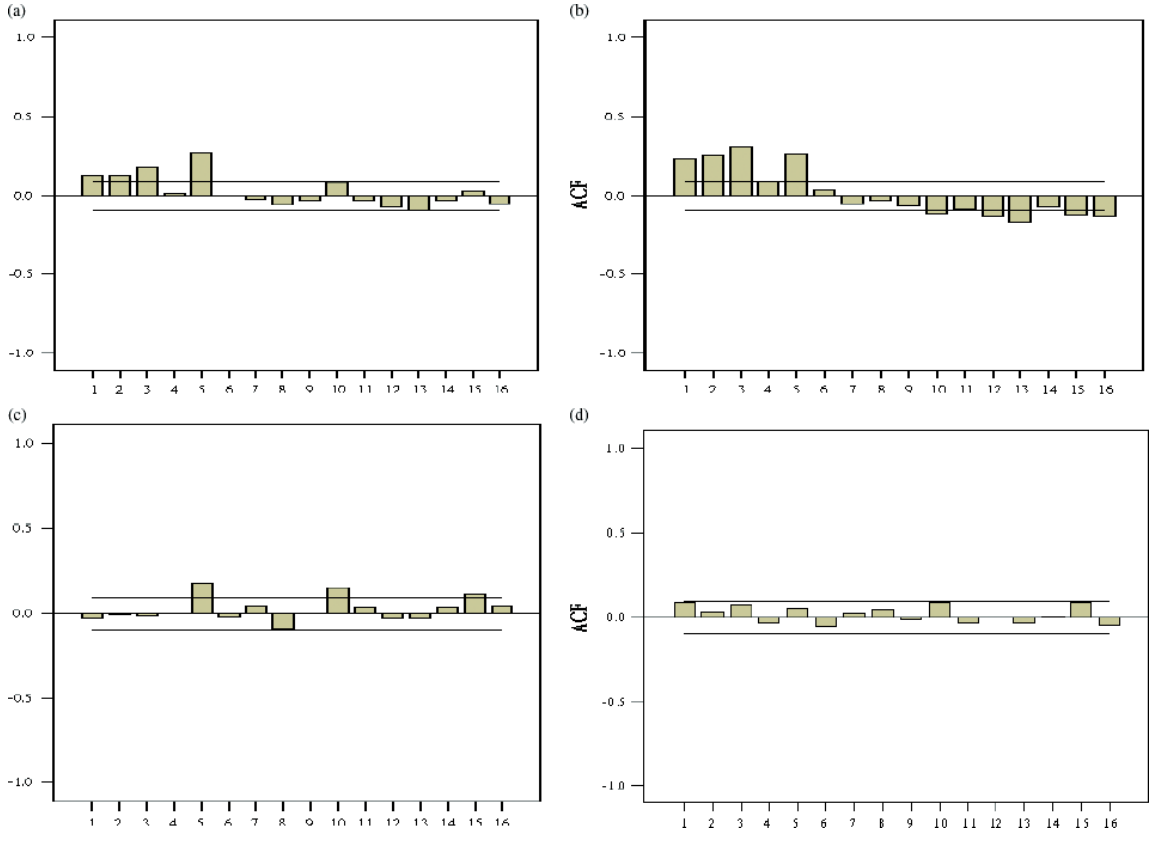

Figure 4 The autocorrelation coefficient of each type of trust: (a) total trust, (b) calculus-based trust, (c) knowledge-based trust, (d) identification-based trust.

For calculus-based trust, Figure 4b shows that there exist significant positive auto-correlation coefficients in the 1-, 2-, 3- and 5-week lags, the most significant being in the third week (ACF = 0.4). This means that the calculus-based trust in the t week may tend to affect that in the t + 3 week. Similarly, in Figure 4c, for knowledge-based trust, there exist significant positive auto-correlation coefficients in the 5-week lags (ACF = 0.25), indicating maximal knowledge-based trust correlation between weeks with a 5-week lag. Hypotheses 5a and 5b are, therefore, supported. However, for identification-based trust, no significant auto-correlation coefficient exists between the weeks (Figure 4d). Hypothesis 5c is, thus, not supported.

Finally, we use the cross-correlation function to test Hypothesis 5d. As shown in Figure 5a, the CCF coefficients are significantly positive between calculus-based trust and knowledge-based trust in both zero-week and 3-week lags, supporting the part of Hypothesis 5d that states that calculus-based trust in the early weeks has a positive correlation with knowledge-based trust in the later weeks. However, Figure 5b shows no significant CCF coefficient between knowledge-based trust and identification-based trust in any time lag, indicating that the early knowledge-based trust may not be correlated to later identification-based trust. Hence, Hypothesis 5d is only partially supported.

Effect of Trust on Communication and Cohesiveness

To analyze the impact of early trust on later communication and cohesiveness, we rely on correlation analysis of the interrelationships of these variables. Table 6 shows that the correlation between total trust in the first half of the period and communication in the second half is 0.368 (p-value = 0.000). This indicates that trust initially is positively correlated with communication later, supporting Hypothesis 6. Similarly, Table 6 shows a significant positive correlation between the initial trust and cohesiveness in the second half of the period (correlation coefficient = 0.391, p-value = 0.000). Hypothesis 7 is, therefore, supported.

Discussion

The previous sections have analyzed the patterns of trust development and maintenance for work-oriented virtual teams as well as the effect of trust on communication and cohesiveness. Our results are consistent with the theorization of McKnight et al. (1998) and Meyerson et al. (1996), and confirm the findings of Jarvenpaa et al. (1998; 2004), who found that swift trust emerges quickly initially for work-oriented virtual teams. This swift trust, based on beliefs imported from previous experience, is important to support a work-oriented virtual team's initial development. It serves as a proxy for members of the work-oriented virtual team to assess others' reliability and competence in completing their work. Swift trust, therefore, may lead members to work as a team and facilitate members continually to cooperate and share information. It also helps to create a swift identity so that members may believe that their virtual team is ''us.''

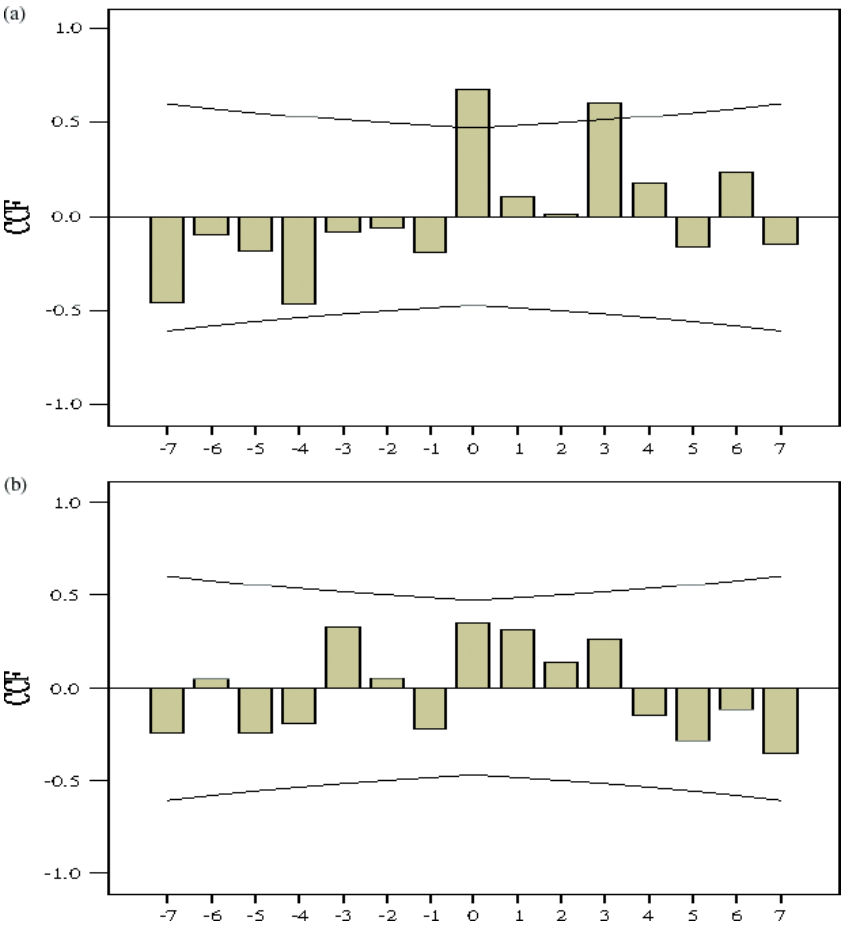

Figure 5 The cross-correlation coefficient of each type of trust: (a) calculus-based trust to knowledge-based trust, (b) knowledge-based trust to identification-based trust.

Furthermore, the cross-correlation functions in Figure 5 show that for teams in this study, both calculus- and knowledge-based trust are important to work-oriented virtual teams' trust maintenance. The calculus-based trust sentences in our study indicate that team members base their interactions mainly upon cost and benefit considerations. Initially, when most members face uncertainty, they often seek security and regard cooperative behaviors as a means to obtain a high grade. Thus, their efforts to cooperate with others are motivated by their judgments of how the team's success is linked to their ability to obtain valued and desired resources for completing their assignment. For example, sentences from members of work-oriented virtual teams often are similar to the following:

"*To better facilitate our discussions on . . ., I suggest we should list each question and then we can respond accordingly. . .* "

Table 6 Correlations

	Communication1	Cohesiveness1	Communication2	Coheiveness2	
Trust1	Corr	0.765	0.636	0.368	0.391
	p-value	0.000	0.000	0.000	0.000
	Communication1		Cohesiveness1	Communication2	Coheiveness2
Trust2	Corr	0.338	0.202	0.673	0.586
	p-value	0.000	0.000	0.000	0.000

In summary, Hypotheses 1, 1a, 1b, 1c, 5, 5a, 5b, 6, and 7 are supported; Hypotheses 2, 3, and 5d are partially supported; and Hypotheses 4 and 5c are not supported. These results are shown in Table 7.

Table 7 Results of hypotheses testing

Hypothesis	Result
Hypothesis 1: Work-oriented virtual teams' trust develops swiftly in the initial weeks of the relationship.	Supported
Hypothesis 1a: Work-oriented virtual teams' calculus-based trust develops swiftly in the initial weeks of the relationship.	Supported
Hypothesis 1b: Work-oriented virtual teams' knowledge-based trust develops swiftly in the initial weeks of the relationship.	Supported
Hypothesis 1c: Work-oriented virtual teams' identification-based trust develops swiftly in the initial weeks of the relationship.	Supported
Hypothesis 2: Work-oriented virtual teams' calculus-based trust increases in the early weeks and remains stable thereafter.	Partially Supported
Hypothesis 3: Work-oriented virtual teams' knowledge-based trust is low in the early weeks, increases to its peak in the middle weeks, and remains stable in the last weeks.	Partially Supported
Hypothesis 4: Work-oriented virtual teams' identification-based trust of is low in the early and middle weeks, and increases to its peak in the last weeks.	Not Supported
Hypothesis 5: Work-oriented virtual teams' trust in the early weeks has a positive correlation to this trust in the later weeks.	Supported
Hypothesis 5a: Work-oriented virtual teams' calculus-based trust in the early weeks has a positive correlation to their calculus-based trust in the later weeks.	Supported
Hypothesis 5b: Work-oriented virtual teams' knowledge-based trust in the early weeks has a positive correlation to their knowledge-based trust in the later weeks.	Supported
Hypothesis 5c: Work-oriented virtual teams' identification-based trust in the early weeks has a positive correlation to their identification-base trust in the later weeks.	Not Supported
Hypothesis 5d: Work-oriented virtual teams' calculus-based trust in the early weeks has a positive correlation to their knowledge-based trust in the later weeks; and work-oriented virtual teams' knowledge-based trust in the early weeks has a positive correlation to their identification-based trust in the later weeks	Partially Supported
Hypothesis 6: A positive correlation exists between the level of trust in the first half and the level of communication in the second half of the relationship	Supported
Hypothesis 7: A positive correlation exists between the level of trust in the first half and the level of cohesiveness in the second half of the relationship	Supported

"A good leader understands the core competencies of our team and knows how to harvest these competencies. . .. So, I think John will be a good leader" or

"This is a team project. . . We have to spend several weeks working together and sharing information. . . "

Note that the importance of calculus-based trust remains relatively high to the end in our study. We believe that this reflects not only a characteristic of virtual teams, but also the work orientation adopted by this study, as many exchanges

show that team members often focus on listening, watching, monitoring, and asking for feedback in their work conversations. For virtual team members, work-related conversations allow them to calculate their gains more accurately. For example, the following types of conversation are common:

"*I think you are on the right track with your above comments. In order to clarify our work, please expand on your thoughts with regards to how procedures. . .,* "

"*I would like to make sure that this topic fits into our fields. . . Maybe you could provide good information about. . .* " or

"*I'm sounding like a broken record, but I expect we could stress how to implement our system. . ..* "

Knowledge-based trust is also important to work-oriented virtual teams in this study in providing guidance to members on focusing on compartmentalizing dependence relationships. Often, members must rely on their prior knowledge to assess members' competencies and constraining factors so that they can determine what their partners will do next and decide whether their partners behave consistently. As members' knowledge-based trust grows, their relationships strengthen as well. For example, many members in this study initially elaborated on their professional backgrounds so that they could understand each other's competences for completing the project. In teams T01, T12, and T17, in order to define each team work assignment and assess each member's capacity during the first few weeks, members focused on structuring their communication initially, as shown in sentences such as:

"*Is this a better way to communicate with everyone rather than e-mailing? I want to make sure that messages are received in a timely manner. . .* "

"*I think ideally, we should try to have every discussion wrapped up in a friendly way, so each one can share their opinions with each other. . .* " or

"*By the way, Sandy, since we have reassigned everyone's task, it's your job. Please confirm that you will do it. . .*"

Conversely, if a certain member repeatedly fails to carry out his or her promises, knowledge-based trust deteriorates. For example, for team T08, Jack, who was a manager for an IT company, had volunteered to be the leader, and other members believed that they could rely on him in the beginning. In view of that category information (i.e., IT manager), no intensive exchanges concerning each others' backgrounds were conducted. However, members of team T08 were disappointed at their leader's lack of actions from the 4th week to the 7th week. One member said:

"*We did not get any response from you, Jack, regarding your leadership. . . Are you aware that you are going to have to write a summary of our discussion? . . .. It should not be difficult since only a couple of us posted responses.*"

In the meantime, Jack expressed his frustration over the lack of participation from members, and said:

"*I am the leader but I am pretty sure this is not an individual assignment. . . I think each of us should still answer all of the questions. . . you misunderstand my argument. . . You should follow my directive. . ..* "

Subsequently, as members failed to act as expected, a negative mood prevailed. Some members fought back, and said:

"It is unfair. . . . . I have done everything I could. . . "

In this case, members of team T08 seemed to believe that they had a competent leader initially but discovered later that this was not the case. As a result, they could not work together.

In brief, knowledge-based trust is sustained via a prediction process and requires information about a trustee's past actions, which indicate the variety of shared experiences. For work-oriented virtual teams, the greater the generated knowledge base, the stronger the trust that builds over time.

Moreover, our data show that for the maintenance of trust, early trust influences later trust. This result is consistent with the theorization of several researchers that early trust influences later trust or "deeper" levels of trust (e.g., Lewicki & Bunker, 1996; Jarvenpaa et al., 2004; Sheppard & Tuchinsky, 1996). Trust is a continuing process based on early trust. In addition, trust in the early weeks positively influences the level of communication and cohesion in later weeks. As observed by Jarvenpaa et al. (2004), team members who deliver their promises produce behavioral confirmation, which leads to the strengthening of early trust. The combination of perceptions of high initial trust and behavioral confirmation strengthens trust more quickly, speeding up the establishment of trust itself. It also appears that, in the same period, there exists a significant link between communication and trust. Table 6 shows that the growth trajectory for trust is dependent upon the nature of actual team communication, which enables members to stay together, engaged in the team project.

Note that in our study, all three kinds of trust appear in the early weeks, which contradicts the theorization of Lewicki and Bunker (1996). They propose that achievement of trust at one level enables the maintenance of trust at the next level and, accordingly, that the three types of trust are linked in a sequential iteration (see Figure 1). Our study shows that calculus-based trust peaks initially and decreases thereafter; knowledge-based trust peaks in the middle weeks; and identification-based trust remains low throughout the entire period. Lewicki and Bunker also propose that, at the J1 point in Figure 1, some calculus-based trust relationships become knowledge-based trust relationships and, likewise, at the J2 point, a few knowledge-based trust relationships become identification-based trust relationships. However, based on our CCF analysis, we are able only partially to support the existence of these transitional relationships (see Figures 5a and 5b).

Further analysis of the development patterns between teams with a high degree of communication (H) and those with a low degree of communication (L) (see Figure 6) reveals several interesting findings. As shown in Figure 6, the levels of trust for all three types for the H teams are significantly higher than those for the L teams, with their patterns of trust development also differing. In addition, for H teams, calculus-based trust is the most frequent type of trust and peaks in the middle period; knowledge-based trust, the second most frequent, exhibits a similar pattern; and

identification-based trust shows a slightly increasing trend from the initial stage to the end. This seems to confirm Lewicki and Bunker's (1996) predication that calculus-based trust and knowledge-based trust play more important roles in the early weeks of virtual group development, whereas identification-based trust emerges in the later weeks. More importantly, the high levels of all three types of trust throughout for H teams compared to L teams indicates that their members are quickly encouraged to join in the teamwork and remain committed to collaborating with other members to complete the work, thus improving group communication and member identification with the team (Shaver & Hazan, 1994; Mayer, Davis, & Schoorman, 1995; Tyler & Kramer, 1996; Jarvenpaa & Leidner, 1998). The implication here is that managers of temporary, work-oriented virtual teams should work intensely to generate a high level of swift trust at the beginning, which enables the team to remain productive as long as members deliver what they promise.

In contrast, a self-fulfilling process of trust deterioration may exist for L teams. Team members who are separated by physical distance and meet each other only infrequently may have great difficulty recovering from a bad start. The L teams in our study show that they have high calculus-based trust initially but their knowledge-based trust and identification-based trust are low and decreasing (Figure 6). This shows that although members of L teams may have positive attitudes toward their relationships with others, they do not apply their knowledge to define clearly collaborative relationships and members' competencies (Costigan, Ilter, & Berman,

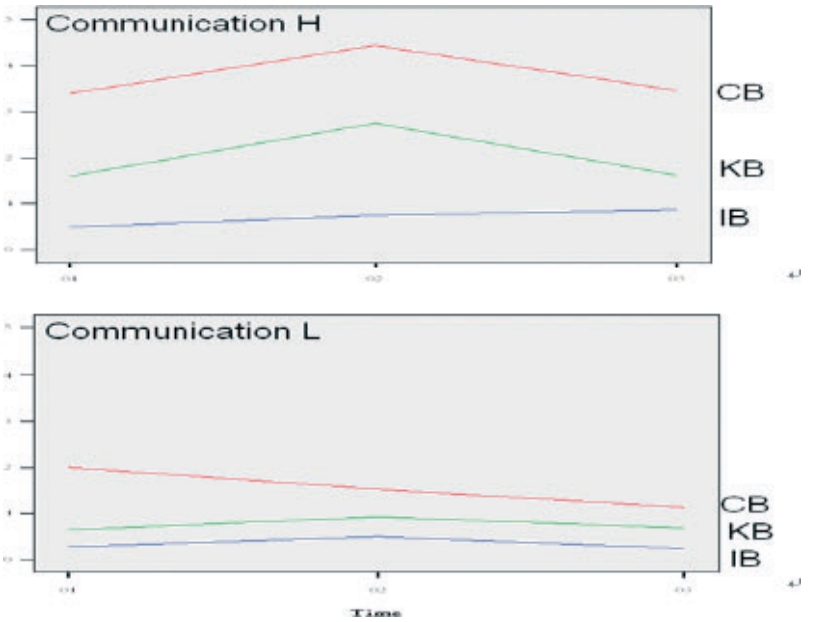

Figure 6 The trust development patterns between high-communication teams and low-communication teams.

1998). Conditions such as this make it extremely easy for members to devote significantly fewer resources to monitor others' behavior, and therefore they become vulnerable to possible exploitation by other members. Furthermore, as calculus-based trust deteriorates over time, members cannot appropriate their work according to their competence and do not identify with the group goal (Meyerson et al., 1996; Shapiro et al., 1992). For example, when members of teams T09 and T25 had problems with their work, they seemed to ignore their mistakes. Our data show that they never addressed the first failure and, worse still, their level of communication dwindled substantially afterward. Many members remained silent, to avoid negative feelings, when others failed to act as expected. Eventually, members seldom verbalized their commitment, excitement, and optimism. Thus, although members of teams T09 and T25 maintained a polite relationship on the surface, their level of calculus-based trust, knowledge-based trust, and identification-based trust dropped to almost zero toward the end of the semester.

Finally, a somewhat unexpected result is that different types of trust trail off near the end of the project. This differs from the prediction of Lewicki and Bunker (1996) (see Figure 2). It is possible that for virtual teams, members who are de-individuated and geographically dispersed rely principally upon category information to formulate trust. This formulation is swift and takes place in the early and middle weeks. In addition, near the end of the semester when the project is also coming to an end, members may not expend much effort in forging trust-relationships. Thus, the number of trust statements trails off in the later weeks. This is an area of interest for future research.

In summary, our research suggests that trust development and maintenance of temporary work-oriented virtual teams follow the pattern shown in Figure 7. Based on the SIDE (Social De-individualization) theory, when members of such teams lack a common history in the initial stage, they respond to favorable identity-relevant information to develop internal values that allow them to voluntarily engage in cooperative behaviors. Identity-relevant information allows team members to perceive similarities in goals and values. As such perception is confirmed, work-oriented virtual team members would expect others to act in accordance with these values and identify with goals that are good for all team members. Thus, for work-oriented virtual teams, all three types of trust develop swiftly in the early stage. Calculus-based trust peaks quickly, and contributes positively to the maintenance of knowledge-based trust at a later stage. Knowledge-based trust also peaks quickly, but identification-based trust remains low throughout the entire cycle. Among these three types of trust in the virtual environment, both calculus- and knowledge-based trust play a more critical role to the team's performance than identification-based trust. Note that while identification-based trust allows members to collaborate quickly, it runs the risk of losing touch with reality. When words are said but results are not delivered, members fail to accomplish their mission and become frustrated. Finally, as Jarvenpaa et al. (2004) have mentioned, total trust in the first half is correlated to

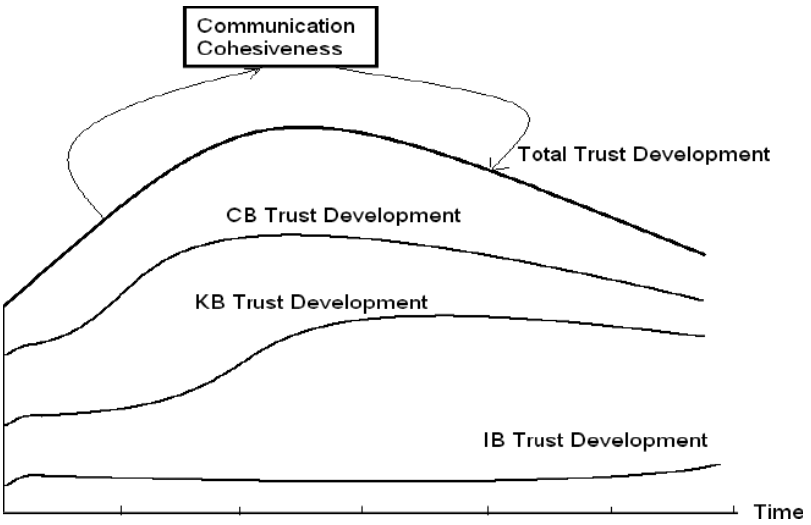

Figure 7 Trust development process of the work-oriented virtual team.

the group's communication and cohesion in the second half, while communication and cohesion in the first half is also correlated to total trust in the second.

Conclusion

This study has explored trust development and maintenance in temporary, work-oriented virtual teams and examined the effect of trust on communication and cohesiveness. The results suggest that, for such teams, members swiftly import their prior experience to assess the outcomes and costs of maintaining a team relationship. They also rely on their prior knowledge to determine other members' competencies so that they can make predictions about one another's behaviors. Thus, both calculus-based and knowledge-based trust play accentuating roles in trust development when members face uncertainty in the initial stage of team formation. Identification-based trust also develops swiftly initially based on members' past experiences, but the degree of such trust is relatively small compared to the other two types. Furthermore, this type of trust does not appear to play a significant role in trust maintenance for work-oriented virtual teams.

In addition, our study shows that initial calculus-based trust is correlated to late knowledge-based trust, although the early knowledge-based trust is not correlated to later identification-based trust. This deviates from the theorization presented in Lewicki and Bunker's (1996) model, namely, that the three types of trust are linked in a sequential manner. Note that for the H teams in our study, calculus-based trust allows members to effectively monitor others' performance, whereas knowledge-based trust enhances cooperation later on. Conversely, for the L teams, the lack of calculus-based trust may lead to a self-fulfilling process of trust deterioration.

Finally, our study shows that the early trust of work-oriented virtual team members provides reassurance that others are attending to the task, so that members' mutual communication and feelings of cohesiveness increase. Thus, trust may generate a high level of communication and cohesiveness.

Many issues in trust development and maintenance remain to be researched. For one, there is a need to further investigate the issue of managing trust development. Future research is needed to address how to create high levels of trust initially and how to maintain that high level to the end. There is also a need to study the self-fulfilling process of trust deterioration. Specifically, for work-oriented virtual team members who have low initial trust, there is a need to study what management tactics are available to ensure that the members would react in such a manner as to strengthen rather than enervate the team.

The issue of trust development in different cultures also awaits further exploration. The present study takes place in Taiwan, which has a collectivist culture as opposed to the Western individualist culture. The swift emergence of both calculus-based and knowledge-based trust could be influenced by the collectivism of Taiwanese culture because subjects might be inclined to base their behaviors on their assessment of collective benefits and competence. Thus, we expect that the results would be different if the study were to be conducted in the West or if the study employed teams consisting of members from the two different cultures.

Finally, the role of conflict in the context of work-oriented virtual teams' trust development is another important issue. Conflict is the medium through which problems can be aired and solutions found. Conflicts are of value and importance to work-oriented virtual team development. For work-oriented virtual teams, as for physical teams, members' conflicts are critical to the success or failure of team development. Conflicts provide important diagnostic evidence to each member seeking work-oriented virtual team development to assess and adjust his or her values, needs, and preferences in order to make a successful transition into the future. If work-oriented virtual teams avoid conflict or withdraw from problem solving, they lose opportunities to evaluate problems in teams. Therefore, the investigation of how conflicts can facilitate constructive engagement among members may provide important insights into the effective management of work-oriented virtual teams.

An important limitation of our study is that our analysis has relied solely on discussions conducted on the Internet; however, these discussions do not include all of the communications within each team because the members maintained contact not only through the Internet, but also in face-to-face meetings. Moreover, because the present study is situated in Taiwan, the results should not be generalized universally. Finally, we have relied on content analysis as our methodology, and therefore biases and preconceptions of the researchers might have entered into the interpretation of the data.

References

Aubert, B. A., & Kelsey, B. L. (2003). Further understanding of trust and performance in virtual teams. *Small Group Research*, **34**(5), 575–618.

Ba, S., & Pavlou, P. A. (2002). Evidence of the effect of trust building technology in electronic markets: Price premiums and buyer behavior. *MIS Quarterly*, **26**(3), 243–268.

Boon, S. D., & Holmes, J. G. (1991). The dynamics of interpersonal trust: Resolving uncertainty in the face of risk. In R. A. Hinde & J. Groebel (Eds.), *Cooperation and Prosocial Behavior* (pp. 190–211). Oxford, UK: Basil Blackwell.

Box, G.E.P., & Jenkins, G. (1976). *Time series analysis: forecasting and Control*, San Francisco: Holden-Day.

Brown, H. G., Poole, M. S., & Rodgers, T. (2004). Interpersonal traits, complementarity, and trust in virtual collaboration. *Journal of Management Information Systems*, **20**(4), 115–137.

Chidambaram, L. (1996). A study of relational development in computer supported groups. *MIS Quarterly*, **29**(2), 143–165.

Cooper, D. R., & Emory, C. W. (1995). *Business research methods*. (5th ed.). Burr Ridge, IL: Richard D. Irwin, Inc.

Costigan, R. D., Ilter, S. S., & Berman. J. J. (1998). A multi-dimensional study of trust in organizations. *Journal of Managerial Issues*, **10**(3), 303–317.

Davidow, W. H., & Malone, M. S. (1992). *The virtual corporation*. New York: Harper Collins.

Duphorne, P. L., & Gunawardena, C. N. (2005). The effect of three computer conferencing designs on critical thinking skills of nursing students. *The American Journal of Distance Education*, **19**(1), pp. 37–50.

Dirks, K. T., & Ferrin, D. L. (2001). The role of trust in organizational settings. *Organization Science*, **12**(4), 450–467.

Erikson, E. H. (1997). *The life completed*, New York: W.W. Norton.

Gersick, C. J. G. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, **31**(2), 9–41.

Gersick, C. J. G., & Hackman, J. R. (1990). Habitual routines in task-performing groups. *Organizational Behavior and Human Decision Processes*, **47**(1), 65–97.

Gunawardena, C. N., Jennings, B., Ortegano-Layne, L., Frechette, C., Carabajal, K., Lindemann, K., et al. (2004). Building an online wisdom community: A transformational design model. *Journal of Computing in Higher Education*, **15**(2), 40–62.

Harrison, R. T., Dibben, M. R., & Mason, C. M. (1997). The role of trust in the informal investor's investment decision: An exploratory analysis. *Entrepreneurship Theory and Practice*, Summer, 63–80.

Hogg, M. A. (1992). *The social psychology of group cohesiveness: From attraction to social identity*, New York: New York University Press.

Jarvenpaa, S. L., & Leidner, D. E. (1998). Communication and trust in global virtual teams. *Journal of Computer-Mediated Communication*, **3**(4), http://jcmc.indiana.edu/vol3/issue4/jarvenpaa.html.

Jarvenpaa, S. L., & Ives, B. (1994). The global network organization of the future: Information management opportunities and challenges. *Journal of Management Information Systems*, **10**, 25–57.

Jarvenpaa, S. L., Knoll, K., & Leidner, D. E. (1998). Is anybody out there? Antecedents of trust in global virtual teams. *Journal of Management Information Systems*, **14**(4), 29–64.

Jarvenpaa, S. L., Shaw, T. R., & Staples, D. S. (2004). Toward contextualized theories of trust: The role of trust in global virtual teams. *Information Systems Research*, **15**(3), 250–267.

Kollock, P., & Smith, M. (1996). Managing the virtual commons: Cooperation and conflict in computer communities. In S. Herring (Ed.), *Computer-mediated communication: Linguistic, social and cross-cultural perspectives* (pp. 109–128). Amsterdam: John Benjamins.

Krippendorff, K. (1980). *Content analysis: An introduction to its methodology*, London: Sage Publications.

Larsen, K.R.T., & McInerney, C. R. (2002). Preparing to work in virtual organization. *Information & Management*, **39**, 445–456.

Lewicki, R. J., & Bunker, B. B. (1996). Developing and maintaining trust in work relationships. In R. M. Kramer and T. R. Tyler (Eds.), *Trust in organizations: Frontiers of theory and research* (pp. 114–139). Thousand Oaks, CA: Sage Publications.

Lewicki, R. J., McAllister, D. J., & Bies, R. J. (1998). Trust and distrust: New relationships and realities. *Academy of Management Review*, **23**(3), 438–458.

Maxwell, J. A. (1996). *Qualitative research design: An interactive approach*, SAGE Publications, London. 63–85.

Mayer, R. C., Davis, J. H., & Schoorman, F. D. (1995). An integrative model of organizational trust. *Academy of Management Review*, **20**, 709–734.

Meyerson, D., Weick, K. E., & Kramer, R. M. (1996). Swift trust and temporary groups. In R. M. Kramer and T. R. Tyler (Eds.), *Trust in organizations: Frontiers of theory and research* (pp. 166–195). Thousand Oaks, CA: Sage Publications.

McGrath, J. E., & Hollingshead, A. B. (1994). *Group interacting with technology: Ideas, evidence, issues and an agenda*, London: Sage Publications.

McKing, D. H., Choudhury, V., & Kacmar, C. (2002). Developing and validating trust measures for e-commerce: An integrative typology. *Information Systems Research*, **13**(3), 334–359.

McKnight, D. H., Cummings, L. L., & Chervany, N. L. (1998). Initial trust formation in new organizational relationship. *Academy of Management Review*, **23**(3), 473–490.

Neuendorf, K. A. (2002). *The content analysis guidebook*. Thousand Oaks, CA: Sage Publications.

Newhagen, J. E., & Rafaeli, S. (1996). Why communication researchers should study the Internet: A dialogue. *Journal of Communication*, **46**, 4–13.

Paul, D. L., & McDaniel, Jr. R. R. (2004). A field study of the effect of interpersonal trust on virtual collaborative relationship performance. *MIS Quarterly*, **28**(2), 183–227.

Piccoli, G., & Ives, B. (2003). Trust and the unintended effects of behavior control in virtual teams. *MIS Quarterly*, **27**(3), 365–396.

Poole, M. S. (1983). Decision development in small groups: III. A multiple sequence model of group decision development. *Communication Monographs*, **50**(4), 321–341.
Rafaeli, S. (1988). Interactivity: From new media to communication. *Sage Annual Review of Communication Research: Advancing in Communication Science*, **16**, 110–134.
Roark, A. E., & Hussen, H. S. (1989). Factors related to group cohesiveness. *Small Group Behavior*, **20**, 62–69.
Rousseau, D. M., Sitkin, S. G., Burt, R. S. & Camerer, C. (1998). Not so different after all: A cross-disciplinary view of trust. *Academy Management Review*, **23**(3), 393–404.
Shapiro, D., B. H. Sheppard, L. Cheraskin. (1992). Business on a handshake. *Negotiation Journal*, **8**(4), 365–377.
Shaver, P. R., & Hazan, C. (1994). Attachment. In A. L. Weber & J. H. Harvey (Eds.), *Perspectives on Close Relationships* (pp. 110–130), Boston: Allyn and Bacon.
Shaw, M. E. (1980). *Group Dynamics*, New York: McGraw Hill.
Sheppard, B., & Tuchinsky, M. (1996). Micro-OB and the network organization. In R. M. Kramer and T. R. Tyler (Eds.), *Trust in organizations: Frontiers of theory and research* (pp. 140–165). Thousand Oaks, CA: Sage Publications.
Simonoff, J. S. (1996). *Smoothing Methods in Statistics*, New York: Springer Verlag.
Spears, R., & Lea, M. (1992). Panacea or panopticon? The hidden power in computer-mediated communication. *Management Science*, **21**(4), 427–459.
Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage Publications.
Tyler, T. R., & Kramer. R. M. (1996). Whither trust? In R. M. Kramer and T. R. Tyler (Eds.), *Trust in organizations: Frontiers of theory and research* (pp. 1–15). Thousand Oaks, CA: Sage Publications.
Walther, J. B. (1995). Relational aspects of computer-mediated communication: Experimental observations over time. *Organizational Science*, **6**, 186–203.
Weber, R. P. (1990). *Basic content analysis*. Thousand Oaks, CA: Sage Publications.

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