

# Technology, Trust and Effectiveness in Virtual Teams

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## Abstract

Business and government organizations today need to compete and interoperate globally to survive. Effective virtual team management through technology is a key factor. Virtual teams present advantages for cost control and access to global expertise. Previous research suggests a variety of factors for effective functioning of virtual teams. This study explored technology and relationships between team leader personalities, team trust, and team perceived effectiveness by surveying 873 engineers. The findings suggest that a virtual team leader's personality has a significant impact on the team's perceived effectiveness but this effect is mediated through cognitive and personality based trust. Implications for managers and further research are discussed.

**Keywords:** Cognitive Trust, Leader personality, Personality based Trust, Virtual Teaming, Big Five personality model, Structural equation modelling

## Introduction

In the most contemporary work environments, it is increasingly likely that workers will be called upon to participate on virtual teams at several points throughout their careers. Whether working on a project, contributing to a task force, or managing the global operations of an organization, modern professionals are frequently required to collaborate with individuals who they have never met face-to-face or who live and work thousands of miles away. The emergence of advanced information and communications technologies (ICTs), such as email, video conferencing, and online collaborative environments, has enabled the development of a wide variety of such distributed work arrangements and novel organizational forms (Fulk & DeSanctis, 1995). As a result, commercial activity on an expanded geographic scale and continuous timeline has become a prevailing reality.

Virtual teaming presents organizations with a range of potential benefits, including improved access to high-level talent, increased flexibility for knowledge professionals, enhanced ability to serve markets on a global scale, and reduction in travel costs and other expenses associated with traditional meeting arrangements (Lipnack & Stamps, 1997; Majchrzak, Rice, Malhotra King, 2000; Mowshowitz, 1997). Yet significant challenges remain. While technology has created new horizons for communication and interaction over time and space, these novel work arrangements demand a set of interpersonal competencies, coordination processes, and leadership

skills that are markedly distinct from those required in co-located team environments (Jarvenpaa & Leidner, 1999). To achieve the envisioned benefits of virtual teaming, organizations must bring the right people together at the right time and do so quickly (Townsend, DeMarie, & Hendrickson, 1998). As working virtually becomes increasingly commonplace it is important to understand what factors influence the effectiveness of a virtual team.

The current study explores the factors that drive team effectiveness within a virtual teaming arrangement. A number of such factors have been proposed within the research community, including the technologies employed and their adaptation by team members (King & Majchrzak, 2003; Majchrzak et al., 2000), patterns of communication (Pauleen, 2003), the frequency of face-to-face interaction (Handy, 1995), and incentive structures for team members (Lawler III, 2003). Perhaps no facet of virtual team dynamics has received more attention than the question of trust among team members. Drawing upon the centrality of trust in traditional group dynamics research, several researchers have considered the degree to which various forms of trust are established and nurtured in virtual team environments (Iacono & Weisband, 1997; Jarvenpaa & Leidner, 1999; Kanawattanachai & Yoo, 2002; Meyerson, Weick, & Kramer, 1996). Another area of significant interest in the management of virtual teams is the role of team leadership (Bell & Kozlowski, 2002; Kayworth & Leidner, 2001; Pauleen, 2003; Poole & Zhang, 2005; Yoo & Alavi, 2004; Zigurs, 2003). Many of these studies have focused on the emergence of leaders in ad hoc virtual teams, and as a result, others have called for greater research into the nature of virtual team leadership (Zigurs, 2003).

### **Research Problem, Objectives and Plan**

In the present study, we seek to combine a consideration of leadership qualities with the dynamics of trust in virtual teams and their effects on team effectiveness. Specifically, we seek to assess the degree to which personality characteristics of virtual team leaders impact the emergence of various forms of trust within virtual teams and in turn the effective of the team's processes as perceived by its members. In this effort, we focus on the following research questions:

*What is the effect of a team leader's personality on the existence of trust within virtual teams? Which personality factors have the greatest influence?*

*What is the effect of a team leader's personality on the perceived effectiveness of a virtual team? Which personality factors are most relevant in this regard?*

*What forms of trust have the greatest influence on the perceived effectiveness of a virtual team?*

*What forms of technology best support virtual team projects?*

To address these questions we completed a large scale study of existing virtual teams within a large organization that is actively experimenting with, and expanding its use of, distributed work arrangements, namely the U.S. Department of Defense. With this focus on actual virtual teams and their experiences, we hope to advance research on the dynamics of virtual teams as they occur in situ.

In developing our analysis, we first provide a brief overview of the research on virtual teams with an emphasis on the roles of team leadership and trust in the management of such groups. We then present the theoretical model that grounds our study and the research methodology employed.

The methodology is followed by a thorough discussion of our research findings. We then turn to a discussion of the significant implications of the research before offering some concluding thoughts.

## **Literature review**

### **Virtual Teams**

While the term itself has been defined in a wide variety of ways by different authors (Bell & Kozlowski, 2002; Knoll & Jarvenpaa, 1998; Majchrzak et al., 2000), the basic features of a virtual team are geographic and temporal distribution of team members with limited face-to-face communication and interactions mediated by ICTs (Poole & Zhang, 2005). In their description, Jarvenpaa and Leidner (1999) add that virtual teams are generally temporary in nature, being rapidly formed (and disbanded) in an effort to address the emergent demands of a changing marketplace. Consistent with this fundamental picture of virtual teams, Henry and Hartzler (1997) offer a more detailed delineation of a team marked by the following: 1) relatively small size (i.e., usually consisting of less than 20 individuals), 2) geographical distribution, 3) working apart more frequently than in the same location, 4) making decisions based on a stratification of work, and 5) shared accountability for team results.

The emergence of virtual teams over the past two decades has been driven by several factors. Perhaps foremost among these is the tremendous advancement in computing and communications media in the latter half of the 20<sup>th</sup> Century, including the development of such resources as email, instant messaging, video conferencing, electronic information exchange, shared data repositories, and other online collaborative systems (Fulk & DeSanctis, 1995; Majchrzak et al., 2000). In addition to these technological enablers, virtual teaming has been encouraged by the development of global markets for goods and services, the expansion of the network organizational form, and the creation of flexible work arrangements in many industries (Poole & Zhang, 2005).

### **Trust in Virtual Teams**

The significant interpersonal impediments posed by virtual teaming help to explain why the subject of trust has been a popular topic in research surrounding virtual teams. For the present discussion, *trust* is understood to mean "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer, Davis, & Schoorman, 1995, 712). The expectation that a positive outcome will result from someone else's action has an element of risk for the trusting party. The ability to trust is, as Panteli (2005) stated, "a dynamic and emergent social relationship that develops as participants interact with each other over time and depending on the situation" (p. 2). Researchers have consistently found that trust among virtual team members is one of the most critical success factors in regard to overall team success (Kostner, 1996; Nilles, 1998).

Trust has been well-established as a bellwether of team performance among traditional, face-to-face teams (Bromiley & Cummings, 1995; Butler Jr., 1991; McAllister, 1995). High levels of trust have been reported to reduce interpersonal transaction costs (Handy, 1995), increase security in relationships (Stinnett & Walters, 1977), promote open information exchange (Larzelere & Huston, 1980), enable risk taking (McAllister, 1995), and contribute to the well being of individuals and the stability of organizations (Cook & Wall, 1980). Morgan and Hunt (1994) found that trusting work relationships influenced cooperation, reduced conflicts, increased commitment to the organization, and reduced the tendency to leave. These findings are supported by Hinds and

Bailey (2003), who reinforce the link between trust and both the emergence and management of conflict on distributed teams.

Thus, the importance of trust to effective team dynamics is clear. Yet, if face-to-face interaction is considered the *sine qua non* for the development of interpersonal trust (Nohria & Eccles, 1992), how can trust be created and maintained in distributed work arrangements? Iacono and Weisband (1997) found that high levels of trust were achieved by virtual teams who remained focused on the work content of their group, moved efficiently between work tasks, and engaged in regular and frequent communication.

### **Leadership in Virtual Teams**

Another key theme in the research on virtual teams is the role of leadership and the management of conflict. In a review of the virtual teams literature, Poole and Zhang (2005) observe that “it appears that in comparison to traditional teams, virtual team leaders play a more important role in scheduling and structuring the communication practices as well as the work process” (p. 377). This finding is somewhat intuitive as the reduced salience of interpersonal commitments in virtual teams might well be expected to result in diffusion of responsibility among members. The necessity of a leader to structure the group’s activities thus takes on greater relevance (Bell & Kozlowski, 2002; Kayworth & Leidner, 2001). In many work groups, the role of leader may be determined a priori (e.g., a project manager). At other times, the leader emerges from within the group. In distributed teams, Yoo and Alavi (2004) found that leader emergence was tied to one’s degree of effort in communication. Communications from the individuals that became leaders of their groups were more extensive, more frequent, and pulled together the ideas expressed by other participants. In addition to coordinating the efforts of the team, distributed group leaders can play a crucial role in resolved intragroup conflict. Armstrong and Cole (2002) have suggested that a virtual team leader can address conflict through multiple means, including polling of participants outside of group discussions, promoting appropriate dialogue when disagreements emerge, and fostering the input of the more introverted members of a group.

Finally, the interplay of trust and leadership behavior is a critical consideration which has received limited empirical analysis. Piccoli and Ives (2000) suggest that the open exchange of information, which provides a key basis for the development of trust (especially trust of the cognitive variety) within a group is critically tied to the leadership behavior within the team. Team members who share mutually valuable information with others establish a core for success within their teams. Team leaders are essential in fostering this sharing behavior (Cramton, 2001; Cramton & Orvis, 2003). Team members must be encouraged to help others and share what they know. In turn, they can expect the same behavior of other members. Thus, when team leaders promote this behavior by setting the example for others, trust among the members can be enhanced (Duarte & Snyder, 2000).

### **Effectiveness of Virtual Teams**

As with other technology-enabled innovations, the discussion of virtual teams must ultimately turn to the question of team performance or effectiveness. While our understanding of virtual team effectiveness in real work settings is still somewhat limited (Piccoli & Ives, 2000), a number of studies have shed some light on the subject. Building upon earlier group dynamics research (most notably, Hackman, 1990), Lurey and Raisinghani (2001) propose three criteria for assessing the effectiveness of virtual teams. First, team effectiveness can be assessed based on the group’s productivity and the degree to which the deliverables of the team address the requirements of the organization in which they are situated. Such measures of effectiveness are often determined

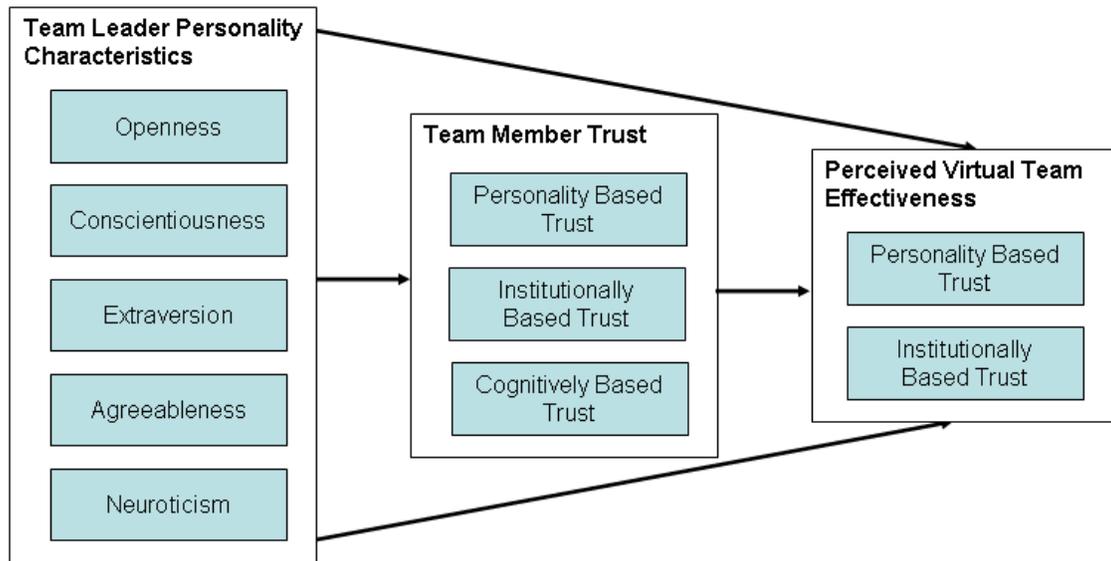
by an individual or group that is not a part of the team in question. Second, effectiveness can be assessed by the degree to which a virtual team's processes support the learning and maintenance of the team's function. Finally, the degree of satisfaction with team processes among members of the team provides a third approach to the measurement of virtual team effectiveness.

While acknowledging the challenges of using subjective measures of team performance, Lurey and Raisinghani (2001) note that those perceptual measures enable researchers to assess team effectiveness while a team is still in operation, in contrast to productivity measures which can often only be established after the fact. This point is reinforced by Campion, Papper and Medsker (1996), who argue that perceived measures of team effectiveness provide accurate predictions of a team's performance. In addition, Campion et al. (1996) call attention to the challenges posed by the relative dearth of clear-cut productivity measures in group work and limited comparability across teams.

### **Developing the Research Model and Hypotheses**

In the present study, we seek to build upon these varied streams of virtual team research to explore the dynamics of leadership and trust within existing virtual teams. While a significant amount of the research literature has focused on emergent leadership, we believe it is essential that researchers consider the influence of formal or assigned team leaders, since this is the prevailing condition in most organizations. Whether they are given the label of senior manager, project manager, systems architect, or some other formal title, virtual team leadership is often established before team members interact for the first time or even before the team composition is established. Thus, it is relevant to consider what characteristics of virtual team leaders engender trust amongst team members and lead to effective virtual team experiences. To address the range of questions surrounding this domain, we adopt multi-dimensional measures of team leader personality, team trust, and perceived virtual team effectiveness. Our theoretical model, shown in Figure 1, reflects the research questions that have been established for this study and the hypothesized relationships between the five facets of virtual team leader personality, three dimensions of virtual team trust, and two measures of perceived virtual team effectiveness. Fundamentally, we seek to determine how various dimensions of team leader personality influence personality based, institutional based, and cognitive based forms of trust, and in turn perceived virtual team performance and satisfaction.

Figure 1 – Theoretical Model



Before we elaborate on the formal hypotheses reflected in our model, a more detailed discussion of construct definitions is in order.

### Operational Definitions

As noted above, we have employed multi-dimensional measures of virtual team leader personality, virtual team member trust, and virtual team performance. The operational definitions for each of these constructs are provided in the following discussion. A summary table of all constructs is provided in Appendix 1.

### Team Leader Personality Constructs

In this study, we assess the relevant characteristics of virtual team leaders using a widely-employed model of individual personality traits, often referred to as the *Big Five*. Consensus is emerging that a five-factor model can be used to describe the most salient aspects of individual personality (Goldberg, 1990). Building on work by Norman (1963) and Tupes and Christal (1992), the efficacy of the five-factor structure has been repeatedly reproduced in factor analytic studies of existing personality inventories, analyses of trait adjectives in various languages, and decisions regarding the dimensionality of existing measures made by expert judges (McCrae & John, 1992). In addition, the cross-cultural generalizability of the five-factor structure has been established through research in multiple countries (McCrae & Costa, 1997), and the evidence suggests that the *Big Five* model has been stable over time (Costa & McCrae, 1988; Digman, 1989).

The dimensions comprising the five-factor model are openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. *Extraversion* represents the tendency to be sociable, assertive, and active, and to experience positive affects, such as energy and zeal (Watson & Clark, 1997). *Agreeableness* refers to the tendency to be trusting, compliant, caring, and gentle (Digman, 1990). *Conscientiousness* is comprised of two related facets: a behavioral organizing or task-orientation element and an element of prudence or dependability (McCrae & John, 1992). *Neuroticism* refers to the tendency to exhibit poor emotional adjustment and

experience negative affects, such as anxiety, insecurity, and hostility.<sup>1</sup> Finally, *openness to experience* (hereafter, *openness*) refers to a disposition to be imaginative, nonconforming, open to ideas, and unconventional (McCrae & Costa Jr., 1997).

### **Team Member Trust**

As we have noted above, a recognition of the multi-dimensional nature of trust has been widely observed in the research on virtual teams (e.g., Jarvenpaa & Leidner, 1999; Kanawattanachai & Yoo, 2002). In one particularly insightful study, Sarker, Valachich and Sarker (2003) define virtual team trust as "the degree of reliance individuals have on their remotely located team members taken collectively (i.e., as a group)" (p. 37). They recognize three distinct dimensions of virtual team trust:

1. *Personality based trust* – Develops due to a person's propensity to trust.
2. *Institutional based trust* – A function of an individual's belief in institutional norms/procedures.
3. *Cognitive based trust* – Develops from social cues, impressions and interactive tasks that an individual receives/delivers to/from another.

In the present study, we adopt this three-faceted conception of trust, because we believe it incorporates and constructively extends the distinction between cognitive and affective trust established by Lewis and Weigert (1985).

### **Perceived Team Effectiveness**

Following Lurey and Raisinghani (2001) and Walters (2004), we adopt an operational definition of perceived team effectiveness as the sum of perceived satisfaction and perceived performance. We decided to employ perceptual measures of the virtual team effectiveness because such measures allow for assessment of effectiveness during the lifecycle of the team, i.e., while the team is still engaged in work. The virtual teams that we have studied were extant and in process; therefore, we approach perceived team effectiveness as a process measure, rather than an objective outcome measure. *Perceived performance* refers to team members' discernment of the team's ability to complete their work assignments. *Perceived satisfaction* refers to the levels of satisfaction with the team processes achieved by team members.

### **Hypotheses**

To reiterate, the primary focus of this study is to understand the relationships between team leader personality, team member trust, and perceived virtual team effectiveness. In general, we expect the "positive" measures of team leader personality to positively influence the levels of various forms of trust amongst team members.<sup>2</sup> Consistent with earlier research, enhanced team trust in turn is expected to result in higher measures of virtual team effectiveness. The detailed version of our hypothesized model is provided in Appendix 2.

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<sup>1</sup> Several authors have employed the more positive and inverse framing for the construct of *Neuroticism* as *Emotional Stability*. We have opted to maintain the label of neuroticism because it reflects the current prevailing approach to the five-factor model (McCrae & John, 1992).

<sup>2</sup> Four of the five personality scale items used can be characterized as "positive" measures with higher values indicating more generally desirable personality states. In the case of *Neuroticism*, the sole exception to this pattern, we expect an inverse relationship with both trust and virtual team performance.

Surprisingly, there is a paucity of research investigating the relationships between team leader personality and trust among group members, even in the context of traditional teams. Thus, to a significant extent, the relationships we anticipate here reflect novel theorizing. However, our hypotheses are grounded in broader observations regarding the association of the five factor model of personality and leadership effectiveness. These insights can be extended to speculation regarding the relationship between leader personality traits and trust because of the inherent element of persuasion in effective leadership. As Hogan, Curphy and Hogan (1994) note: "Leadership is persuasion, not domination; persons who can require others to do their bidding because of their power are not leaders. Leadership only occurs when others willingly adopt, for a period of time, the goals of a group as their own" (p. 3). Thus we state the following high level hypothesis:

***Hypothesis 1:*** *A virtual team leader's personality traits of extraversion, agreeableness, conscientiousness, (low) neuroticism, and openness will have a positive effect on the level of trust among team members.*

**H1a:** **A virtual team leader's extraversion will positively influence the level of trust among team members.**

**H1b:** **A virtual team leader's agreeableness will positively influence the level of trust among team members.**

**H1c:** **A virtual team leader's conscientiousness will positively influences the level of trust among team members.**

**H1d:** **A virtual team leader's neuroticism will negatively influence the level of trust among team members.**

**H1e:** **A virtual team leader's openness to experience will positively influence the level of trust among team members.**

***Hypothesis 2:*** *A virtual team leader's personality traits of extraversion, agreeableness, conscientiousness, (low) neuroticism, and openness have a positive effect on perceived virtual team effectiveness.*

*H2a:* *A virtual team leader's extraversion has a positive effect on perceived virtual team effectiveness.*

*H2b:* *A virtual team leader's agreeableness has a positive effect on perceived virtual team effectiveness.*

*H2c:* *A virtual team leader's conscientiousness has a positive effect on perceived virtual team effectiveness.*

*H2d:* *A virtual team leader's neuroticism has a negative effect on perceived virtual team effectiveness.*

*H2e:* *A virtual team leader's openness to experience has a positive effect on perceived virtual team effectiveness.*

***Hypothesis 3:*** *Team member trust has a positive effect on perceived virtual team effectiveness.*

*H3a:* *Personality based trust among the members of a virtual team has a positive effect on perceived virtual team effectiveness.*

*H3b: Institutional based trust among the members of a virtual team has a positive effect on perceived virtual team effectiveness.*

*H3c: Cognitive based trust among the members of a virtual team has a positive effect on perceived virtual team effectiveness.*

## **Research Design and Data Collection**

### **Background of the Study**

In 1995, the United States Department of Defense (DoD) adopted the integrated product team approach in an effort to improve its processes for weapon systems acquisition (GAO, 2001). The *integrated product team* (IPT) is a team structure and method that emphasizes multi-disciplinary representation and military-civilian collaboration. The IPT format is used to manage the acquisition of a wide range of products, including software systems and aircraft, to support the United States military. While the DoD has seen several advances in efficiency and effectiveness as a result of the IPT concept, the results of these efforts remain mixed. Despite the intention of the program, the generation of cross-functional solutions for difficult acquisition problems has not been uniformly achieved (GAO, 2001). The management of distributed team members has been cited as one of the central challenges of the IPT approach (GAO, 2001).

### **Data Collection and Sample Characteristics**

Of the 3,500 virtual team members surveyed, 1,045 participants responded, a response rate of 29.9%. Of those participants who completed the survey, 873 records were maintained, while 172 were eliminated due to reporting errors or incomplete responses. For those participants who reported virtual team leader gender, there were 522 male (59.8%) and 351 female (40.2%) leaders noted. Teams consisting of 4 to 9 members dominated at 588 teams (67.4%). Teams having 10 to 19 members accounted for an additional 19.6%. The remaining 13.1% represented teams having 20 members or more. With regard to team leader selection, 53.7% of leaders were appointed, 17.6% were formally elected by team members, and 28.6% emerged informally. Over half (53.5%) of the team leaders had 5 years of experience or less; 24.5% had 6 to 9 years of experience; and 22% had over 10 years of experience in leading a virtual team. With respect to project topics, 28.5% were technical in focus, 39.8% were management related, and 31.7% were a combination of management and technical. Finally, contractors held 74.2% of the virtual team leader positions, civil servants held 23.2%, and military personnel held 2.7%.

### **Data Analysis**

The interpretation of the data consisted of an iterative process that began with close analysis of the descriptive statistics to gain an overall impression of normality, means, and standard deviations for each data item. Structural equation modeling (SEM) was used to test for significant correlations and relationships between the independent and dependent variables with and without mediation. Reliability analysis was conducted on all constructs, with all Cronbach's  $\alpha$  measurements exceeding .758 (see Table 1). A comprehensive test for mediation was conducted using the causal steps method developed by Baron and Kenny (1986; MacKinnon, 2008). The initial theoretical model was compared with a range of alternative SEM models to identify the most parsimonious quantitative model (i.e., reflecting the best goodness-of-fit results without over-specification).

## Results

As noted above, a thorough assessment of construct reliability was conducted. The results are summarized in Table 1. For the core constructs of the study, the coefficient alphas range from .758 to .938, well within acceptable standards. Similarly, measures of composite reliability range from .764 to .952, with only one construct having a composite reliability of less than .800.

**Table 1. Internal Reliability of Scales**

Scale Construct	Cronbach's Alpha	Composite Reliability
Openness	.875	.816
Agreeableness	.778	.804
Conscientiousness	.875	.871
Neuroticism	.849	.869
Extraversion	.758	.764
Personality Based Trust	.938	.945
Cognitive Based Trust	.934	.952
Institutional Based Trust	.824	.860
Perceived Team Effectiveness	.896	.879

Utilizing exploratory factor analysis (EFA), there is clear evidence of convergent and discriminate validity for all items within the research model. The pattern matrix for the complete model reveals the expected major loadings for all items, with no significant cross-loadings (see Appendix 3).<sup>3</sup> The factor correlation matrix indicates no cross-factor correlations greater than .685. Using AMOS, confirmatory factor analysis (CFA) identifies ten first order latent constructs and one second order latent construct (i.e., perceived effectiveness). The CFA produces the following model fit statistics: Chi-square = 1152.78, df = 396, p = .000; CFI=.961, PCFI=.818, NFI=.942, IFI=.961, and RMSEA=.047. The standardized factor loadings were all statistically significant (t-values > 2.32, p < .001) and all greater than .5, with the vast majority between .7 and .9. Overall, the analysis of measurement model strongly suggests that the items are suitable and that the constructs are appropriate for subsequent analysis and interpretation.

### Evaluation of the Theoretical Model

SEM results for the path model, including the tests for mediation, are provided in Appendix 4. The analysis provides strong evidence that team leader personality traits do indeed have a positive effect on both team trust and perceived team effectiveness to varying direct and indirect degrees. In addition, the findings suggest that all three forms of trust have a statistically significant (p=<.01) effect on perceived team effectiveness, with cognitive based trust having the most profound effect. A comparison of multiple models (including partially mediated, fully mediated, and unmediated variants) with respect to goodness-of-fit results are provided in Table 2.

<sup>3</sup> Major loadings include those greater than .500. Significant cross-loading would be indicated by differences of less than .300 between primary and secondary loadings across distinct constructs.

**TABLE 2. Goodness-of-Fit Comparisons**

<b>Metrics</b>	<b>Partially Mediated</b>	<b>Fully Mediated</b>	<b>Unmediated</b>	<b>Hybrid Model*</b>
<b>Chi<sup>2</sup></b>	1684.2	1707.14	3747.4	1512.33
<b>df</b>	575	580	590	516
<b>p</b>	0.000	0.000	0.000	0.000
<b>CFI</b>	0.952	0.951	0.863	0.954
<b>PCFI</b>	0.822	0.828	0.765	0.827
<b>NFI</b>	0.929	0.928	0.842	0.932
<b>TLI</b>	0.944	0.944	0.845	0.947
<b>RMSEA</b>	0.047	0.047	0.078	0.047

\* The hybrid model reflects adjustments based on the integration of the other three models: Full mediation for all virtual team leader personality constructs except Conscientiousness and elimination of the Institutional Trust construct.

Details regarding how individual personality traits and the team trust factors interrelated will be discussed in the following section. The findings pertaining to the hypotheses articulated for this study include the following:

***Hypothesis 1:*** A virtual team leader’s personality traits of extraversion, agreeableness, conscientiousness, (low) neuroticism, and openness have a positive effect on team trust.

The results (see Appendix 4 for a summary of the results for the models evaluated) indicate very strong support for Hypothesis 1 and all of the associated sub-hypotheses. The coefficients for all five personality factors range between .7 and .85 (in the case of *neuroticism*, the direction of effect is, as expected, inverse with coefficients ranging from -.779 to -.852 for the three forms of trust). For all personality trait-trust construct relationships, a significance of  $p < .001$  was observed in both the full and partial mediation conditions assessed. This indicates a statistically significant relationship between each of the five leader personality factors and the individual factors defining team trust.

***Hypothesis 2:*** A virtual team leader’s personality traits of extraversion, agreeableness, conscientiousness, (low) neuroticism, and openness have a positive effect on perceived virtual team effectiveness.

The results from the unmediated model suggest substantial support for Hypothesis 2. The coefficients for the four positive leader personality factors of agreeableness, openness, extraversion, and conscientiousness have an effect on perceived virtual team effectiveness with a significance ranging from  $p = .012$  to  $p < .001$ . Similarly, the “negative” construct of neuroticism is, as anticipated, inversely related to perceived virtual team effectiveness ( $B = -.217$ ,  $p < .001$ ).

Interestingly, in the partially mediated model, the results indicate that only conscientiousness has a statistically significant direct effect ( $B = .236$ ,  $p = .013$ ) on perceived virtual team effectiveness (when partially mediated by cognitive and personality based trust). Finally, in the fully mediated model, the remaining four leader personality factors (i.e., openness, extraversion, agreeableness, neuroticism) are statistically significant ( $p < .001$ ) in their effects on the three forms of trust. Assessing the three models together, we see a clear indication that the effects of virtual

team leader personality on virtual team effectiveness are almost completely mediated through the constructs of team trust. Specifically, the effects of these team leader characteristics appear to be mediated through the cognitive and personality based form of trust. Intriguingly, institutional based trust does not serve a significant mediating role. The implications of these results will be addressed further in the Discussion section.

***Hypothesis 3:*** *Team member trust (in personality, institutional, and cognitive based forms) has a positive effect on perceived virtual team effectiveness.*

The results offer complete support for Hypothesis 3 and each of the sub-hypotheses outlined. In the case of personality based trust, the unmediated model reveals a strong and statistically significant influence on perceived virtual team effectiveness ( $B=.160, p < .001$ ). Similarly, the results indicate a significant relationship between institutional based trust and perceived virtual team effectiveness, although the loading is the weakest of the three trust constructs ( $B=.068, p < .01$ ). Finally, the consideration of cognitive based trust reveals the strongest loading of the three trust constructs on perceived virtual team effectiveness ( $B=.283, p < .001$ ). Thus, these results reinforce earlier findings regarding the relationship between various forms of trust and virtual team effectiveness.

## **Discussion & Conclusion**

The nuances observed between the different dimensions of perceived virtual team leader personality and virtual team trust in their effects on perceived virtual team effectiveness provide several critical insights. Some of these observations reinforce arguments in the existing literature on virtual teams, while others push the virtual team research in new and intriguing directions. The strong support for each of the hypothesized sets of relationships in our theoretical model presents a range of significant implications for researchers, managers, and other knowledge professionals.

### **The Role of Leadership**

One of the most interesting findings from the current study is that the perceived personality traits of virtual team leaders have a substantive influence on the perceived effectiveness of their teams, but this influence is almost completely mediated through the development and maintenance of team trust (specifically, the cognitive and personality based dimensions of trust). Virtual team leaders who are perceived agreeable, emotionally stable, extraverted, open, and conscientious may have a positive effect on the performance of their teams, because they engender feelings of trust among the team members. This has a number of important implications. The findings suggest qualities that organizational leaders should consider in the hiring and assignment of virtual teams leaders. As with virtual teams in real-world organizational contexts, most of the virtual teams in the study have leaders that were assigned from the inception of the group, underscoring the importance of leadership selection criteria and assignment processes employed by organizational executives. Many companies use personality assessment tools (e.g., the Myers-Briggs Type Indicator) to assist in matching the personality attributes of employees to specific work assignments. This study presents a number of the personality traits that are particularly relevant for those being considered for a leadership role in a virtual team environment. The key takeaway for organizational decision-makers is that assessment of leadership potential in virtual teams is less about an individual's ability to directly affect the outcomes of a team (e.g., via strong technical skills within the relevant domain) than the professional's capacity for fostering trust among team members. The one critical exception to this insight is the observation that conscientiousness and the associated ability to structure tasks

effectively may improve virtual team performance both directly and through the development of greater levels of intra-team trust (this insight is discussed further below).

In addition to aiding in the selection of leaders in virtual team environments, the findings of this study suggest areas for ongoing training and development of virtual team leaders. In contrast to the perception that personality traits are strictly innate to an individual, a growing body of evidence suggests that organizational leaders can be effectively trained to enhance their charismatic characteristics and in turn to improve team performance (Barling, Weber, & Kelloway, 1996; Kelloway & Barling, 2000; Towler, 2003). In the case of the virtual team leadership characteristics considered in this study, certain traits appear particularly amenable to training. For example, one might imagine that the traits of agreeableness and openness in dealing with the suggestions and contributions of team members could be effectively fostered in organizational leaders, whereas extraversion and emotional stability (i.e., the counterpoint of neuroticism) may be more difficult to influence through formal training.

Finally, it is interesting to note that, of all the virtual team leader personality traits considered, only conscientiousness had an influence on team effectiveness that was not simply mediated by the dimensions of team trust.<sup>4</sup> Why is this the case? One plausible explanation is that the direct effect of conscientiousness is tied to the task oriented facet of the construct. Readers will recall that the construct of conscientiousness incorporates both an organizing facet and a discernment oriented facet.<sup>5</sup> The organizing element may be most relevant here. Virtual team leaders who are organizationally diligent and task oriented may be more effective at fostering the adequate structure for virtual team processes. As we noted earlier, several researchers have argued for the enhanced importance of structure as teams move from co-located to virtual contexts (Kayworth & Leidner, 2001; Poole & Zhang, 2005). Thus, the influence of team leader conscientiousness may go beyond the formation of team trust by supporting the structure necessary to keep team members on the same page operationally.

In addition to the implications for the management of virtual teams, we believe the present study contributes significantly to the research on virtual teams. First, by studying existing virtual technical and managerial teams, we provide an opportunity to better understand the dynamics of virtual teams *in situ*. The literature on ad hoc virtual teams in academic settings has established a strong base for theorizing about this emergent phenomenon, but additional research should be directed at virtual teams as they actually occur within contemporary organizations. We believe the current study contributes to this agenda. Second, the study introduces an empirical evaluation of the ways in which virtual team leader personality traits are relevant for the functioning of virtual teams. This creates a natural complement to the behavioral focus of the earlier virtual team leadership research. Finally, the current study offers an integrated look at antecedents of virtual team effectiveness which have generally been considered in isolation. By considering the ways in which leadership and team trust interact, we began to see a more complex and nuanced understanding of the factors that contribute to success in the management of virtual teams.

### **Virtual Team Effectiveness and the Dimensions of Trust**

The current study provides a strong validation of earlier research regarding the role of virtual team trust in establishing a foundation for virtual team success. As we have noted, several researchers have argued that trust is a critical success factor for virtual teams (Costa, Roe, &

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<sup>4</sup> The direct effects of conscientiousness are in addition to indirect effects that were mediated by team trust.

<sup>5</sup> The two facets of conscientiousness have been combined in the five-factor research literature because of a consistent finding of strong covariance of the facets (McCrae & John, 1992).

Taillieu, 2001; Hinds & Bailey, 2003; Jarvenpaa & Leidner, 1999; Kostner, 1996; Lipnack & Stamps, 1997). By demonstrating a significant positive relationship between each of the three forms of team trust and perceived team effectiveness, this study reinforces the findings of these researchers. The implications for managers and other organizational leaders are substantial. It appears that virtual teams would benefit from having their members share personal information with each other. Team building exercises that help members discover the things they have in common will help strengthen their bond and cognitive trust in each other. As in traditional teams, it is important for team members to know and share a common goal and vision. Members need to feel as though they are all working toward the same mission and sharing the same challenges. Furthermore, team members must have confidence that the other members of the team have the skills and reliability to address their respective contributions to the broader effort.

While the general insight about the importance of trust for team effectiveness is interesting, the differences observed between the three forms of trust in their effect on virtual team effectiveness are even more insightful. In the study, we find the largest effect on perceived virtual team trust is associated with the cognitive based dimension of trust. This finding offers support for the contention that cognitively oriented trust is more relevant than affectively oriented trust in the context of virtual teams (Kanawattanachai & Yoo, 2002). In the absence of regular social interaction, virtual team members appear to place a premium on rational assessments of the dependability and competence of their fellow team members. Importantly, personality based trust is also shown to have a significant effect on perceived virtual team effectiveness at the  $p < .001$  level. With the third form of trust, i.e., institutional based trust, the significance of the effect is not as strong.<sup>6</sup> In the non-mediation model, the effect size for this form of trust is substantially lower than for the other two forms of trust, resulting in significance at the  $p = .01$  level (compared to  $p < .001$  for the other two dimensions). Furthermore, in the full and partial mediation models, the effect of institutional trust on perceived virtual team effectiveness appears to disappear altogether.

### **Assumptions, Limitations and Implications for Research**

Our findings suggest several intriguing avenues for additional research on the interplay between team leader personality and the emergence of trust in virtual teams. First, we believe a longitudinal study may be warranted. In the present study, we examined the relationship between virtual team leader personality, trust, and perceived virtual team effectiveness at a single point in time. However, the teams in the study had been in existence for varying lengths of time and the development of trust may be expected to vary over time. While we believe that the focus on existing virtual work teams is one of the strengths of the study, it does not allow us to assess the ways in which the dynamics of team leader characteristics, trust, and effectiveness change over time. Future research should include longitudinal studies to determine if the relationships between team leader personality, trust, and perceived virtual team effectiveness are strengthened, weakened, or simply maintained over time.

Second, this study was conducted within a single organizational context (albeit with individuals from across multiple “parent” organizations). Subsequent research should include participants from multiple organizations to determine if the results are similar across populations. Similarly, the population for this study was a mixture of participants who worked virtually only some of the time and those who worked virtually all of the time. The degree of virtuality may affect the relationship between virtual team leader personality, trust, and team effectiveness.

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<sup>6</sup> The reader will recall that institutional based trust refers to an individual’s belief in the norms and rules of the relevant institution and the perception that these norms will guide the behavior of others (Sarker et al., 2003).

Finally, future studies should examine multiple configurations of virtual working to determine what differences exist between these populations and how the differences may affect the interplay of virtual team leadership and team trust. Of particular importance is supporting technology and how different teams with different configurations and sophistication levels may achieve differential levels of trust and in turn virtual team effectiveness.

We acknowledge a number of potential limitations associated with the present study. First, the study assumes there will be a measurable level of trust among virtual teams (Walters, 2004). Despite the strong validity of the Virtual Team Trust instrument, measuring trust on only three dimensions (personality, cognitive and institutional) could preclude unacknowledged factors such as fidelity and accuracy. Second, as Zellars and Perrewé (2001) point out, the use of single-source, self-report data can overstate the actual behavior of the team. However, the impact of this issue greatly depends upon the research questions being investigated. In this study, perceptions are of theoretical interest and thus single source bias may not be a serious concern. Other limitations may be considered based on the specific context investigated. As noted, the IPTs maintained by the DOD generally have a leader assigned prior to the initiation of team activities. We perceive this to be a distinct strength of our study in that it reflects the prevailing approach to the determination of leader roles in real-world virtual teaming efforts, but it may limit the generalizability of findings to virtual teams marked by emergent leadership. Similarly, while the virtual teams studied were geographically distributed, they were not global in scope – all virtual team members were based in the United States. Thus, the study does not account for cultural differences that may emerge in virtual teams that include members from distinct national contexts. Finally, there is a potential limitation related to the characteristics of the participants themselves. Many participants in this study were members of more than one virtual team. Even though participants were instructed to rate only one virtual team (if he or she was a member of more than one team), their perceptions of the trust and effectiveness of their other teams, which could be in various stages of team development, could have spilled over into the ratings provided in the current study.

## References

- Anderson, G., C. Viswesvaran. 1998. An update of the validity of personality scales in personnel selection: A meta-analysis of studies published after 1992. *13th Annual Conference of the Society of Industrial and Organizational Psychology*. Dallas, Texas, USA,
- Archer, N. P. 1990. A comparison of computer conferences with face-to-face meetings for small group business decisions. *Behaviour & Information Technology*. **9**(4) 307-317.
- Armstrong, D. J., P. Cole. 2002. Managing distances and differences in geographically distributed work groups. P. Hinds, S. Kiesler. *Distributed Work*. MIT Press, Cambridge, MA, 167-186.
- Aubert, B. A., B. L. Kelsey. 2003. Further understanding of trust and performance in virtual teams. *Small Group Research*. **34**(5) 575-589.
- Avolio, B. J., S. Dionne, L. Atwater, A. Lau, J. Camobreco. 1996. Antecedent predictors of a "full range" of leadership and management styles. U.S. Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA.
- Barker, R. A. 2001. The nature of leadership. *Human Relations*. **54**(4) 469-494.
- Barling, J., T. Weber, E. K. Kelloway. 1996. Effects of transformational leadership training on attitudinal and financial outcomes: A field experiment. *Journal of Applied Psychology*. **81**(6) 827-832.

- Baron, R. M., D. A. Kenny. 1986. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*. **51**(6) 1173-1182.
- Barrick, M., M. Mount. 1991. The big five personality dimensions and job performance: A meta-analysis. *Personnel Psychology*. **44**(1) 1-26.
- Barry, B., G. Stewart. 1997. Composition, process, and performance in self-managed groups: The role of personality. *Journal of Applied Psychology*. **82**(1) 62-78.
- Bell, B. S., S. W. J. Kozlowski. 2002. A typology of virtual teams: Implications for effective leadership. *Group & Organization Management*. **27**(1) 14-49.
- Bromiley, P., L. Cummings. 1995. Transaction costs in organizations with trust. *Research on Negotiations in Organizations*. **5** 219-247.
- Butler Jr., J. 1991. Toward understanding and measuring conditions of trust: Evolution of a conditions of trust inventory. *Journal of Management*. **17**(3) 643.
- Campion, M., E. Papper, G. Medsker. 1996. Relations between work team characteristics and effectiveness: A replication and extension. *Personnel Psychology*. **49**(2) 429-452.
- Chidambaram, L., R. Bostrom. 1993. Evolution of group performance over time: A repeated measures study of GDSS effects. *Journal of Organizational Computing*. **3**(4) 443-469.
- Chidambaram, L., L. L. Tung. 2005. Is out of sight, out of mind? An empirical study of social loafing in technology-supported groups. *Information Systems Research*. **16**(2) 149-168.
- Cook, J., T. Wall. 1980. New work attitude measures of trust, organizational commitment and personal need non-fulfillment. *Journal of Occupational Psychology*. **53**(1) 39-52.
- Costa, A., R. Roe, T. Taillieu. 2001. Trust within teams: The relation with performance effectiveness. *European Journal of Work and Organizational Psychology*. **10**(3) 225-244.
- Costa, P. T., R. R. McCrae. 1988. Personality in adulthood: A six-year longitudinal study of self-reports and spouse ratings on the NEO Personality Inventory. *Journal of Personality and Social Psychology*. **54**(5) 853-863.
- Cramton, C. D. 2001. The mutual knowledge problem and its consequences for dispersed collaboration. *Organization Science*. **12**(3) 346-371.
- Cramton, C. D., K. L. Orvis. 2003. Overcoming barriers to information sharing in virtual teams. C. B. Gibson, S. Cohen. *Virtual Teams That Work*. Jossey-Bass, San Francisco, CA, 214-229.
- Cummings, L., P. Bromiley. 1996. The organizational trust inventory (OTI). R. M. Kramer, T. R. Tyler. *Trust in organizations: Frontiers of theory and research*. SAGE Publications, Thousand Oaks, CA, 302-330.
- Davis, D. D. 2004. The Tao of leadership in virtual teams. *Organizational Dynamics*. **33**(1) 47-62.
- DeNeve, K. M., H. Cooper. 1998. The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin*. **124**(2) 197-229.
- Digman, J. M. 1989. Five robust trait dimensions: Development, stability, and utility. *Journal of Personality*. **57**(2) 195-214.
- Digman, J. M. 1990. Personality structure: Emergence of the five-factor model. *Annual Reviews in Psychology*. **41**(1) 417-440.
- Duarte, D. L., N. T. Snyder. 2000. *Mastering virtual teams: Strategies, tools, and techniques that succeed*. Jossey-Bass, San Francisco, CA.

- Edwards, H. K., V. Sridhar. 2003. Analysis of the effectiveness of global virtual teams in software engineering projects. *System Sciences, 2003. Proceedings of the 36th Annual Hawaii International Conference*. 9.
- Fayol, H. 1949. *General and industrial management*. Pitman, London, UK.
- Fells, M. J. 2000. Fayol stands the test of time. *Journal of Management History*. **6**(8) 345-360.
- Friedman, H. S., J. S. Tucker, J. E. Schwartz, C. Tomlinson-Keasey, L. R. Martin, D. L. Wingard, M. H. Criqui. 1995. Psychosocial and behavioral predictors of longevity. The aging and death of the "termites". *American Psychologist*. **50**(2) 69-78.
- Fulk, J., G. DeSanctis. 1995. Electronic communication and changing organizational forms. *Organization Science*. **6**(4) 337-49.
- GAO. 2001. Best practices: DOD teaming practices not achieving potential results. U.S. General Accounting Office, Washington, DC.
- Goffin, R. D., M. G. Rothstein, N. G. Johnston. 1996. Personality testing and the assessment center: Incremental validity for managerial selection. *Journal of Applied Psychology*. **81**(6) 746-756.
- Goldberg, L. R. 1990. An alternative "description of personality": The big-five factor structure. *Journal of Personality*. **59**(6) 1216-1229.
- Haas, D. 2003. Government-wide Information Technology (IT) Acquisitions. *Program Manager*. **32**(3) 12-23.
- Hackman, J. R. 1990. *Groups that work (and those that don't)*. Jossey-Bass, San Francisco, CA.
- Handy, C. 1995. Trust and the virtual corporation. *Harvard Business Review*. **73**(3) 40-50.
- Henry, J. E., M. Hartzler. 1997. Virtual teams: Today's reality, today's challenge. *Quality Progress*. **30**(5) 108-109.
- Hinds, P., M. Mortensen. 2005. Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organization Science*. **16**(3) 290-307.
- Hinds, P. J., D. E. Bailey. 2003. Out of sight, out of sync: Understanding conflict in distributed teams. *Organization Science*. **14**(6) 615-632.
- Hogan, R., G. Curphy, J. Hogan. 1994. What we know about leadership: Effectiveness and personality. *American Psychologist*. **49**(6) 493-504.
- Hogan, R., J. Hogan, B. W. Roberts. 1996. Personality measurement and employment decisions. Questions and Answers. *American Psychologist*. **51**(5) 469-77.
- Hough, L. M., D. S. Ones, C. Viswesvaran. 1998. Personality correlates of managerial performance constructs. *13th Annual Conference of the Society for Industrial and Organizational Psychology*. Dallas, TX,
- Hoyle, R. H., A. M. Crawford. 1994. Use of individual-level data to investigate group phenomena issues and strategies. *Small Group Research*. **25**(4) 464-485.
- Huff, L. C., J. Cooper, W. Jones. 2002. The development and consequences of trust in student project groups. *Journal of Marketing Education*. **24**(1) 24.
- Hurtz, G. M., J. J. Donovan. 2000. Personality and job performance: The big five revisited. *Journal of Applied Psychology*. **85**(6) 869-79.
- Iacono, C. S., S. Weisband. 1997. Developing trust in virtual teams. *Thirtieth Hawaii International Conference on System Sciences*. Wailea, HI, 412-420.

- Jarvenpaa, S. L., D. E. Leidner. 1999. Communication and trust in global virtual teams. *Organization Science*. **10**(6) 791-815.
- Judge, T., J. Bono. 2000. Five-factor model of personality and transformational leadership. *Journal of Applied Psychology*. **85**(5) 751-765.
- Judge, T., J. Bono, R. Ilies, M. Gerhardt. 2002. Personality and leadership: A qualitative and quantitative review. *Journal of Applied Psychology*. **87**(4) 765-780.
- Kanawattanachai, P., Y. Yoo. 2002. Dynamics of trust in virtual teams. *Journal of Strategic Information Systems*. **11**(3/4) 187-213.
- Kayworth, T. R., D. E. Leidner. 2001. Leadership effectiveness in global virtual teams. *Journal of Management Information Systems*. **18**(3) 7-40.
- Kelloway, E. K., J. Barling. 2000. What we have learned about developing transformational leaders. *Leadership & Organization Development Journal*. **21**(7) 355-362.
- Kickul, J., G. Neuman. 2000. Emergent leadership behaviors: The function of personality and cognitive ability in determining teamwork performance and KSAs. *Journal of Business and Psychology*. **15**(1) 27-51.
- Kiesler, S., J. N. Cummings. 2002. What do we know about proximity and distance in work groups? A legacy of research. P. Hinds, S. Kiesler. *Distributed work*. MIT Press, Cambridge, MA, 57-82.
- King, N., A. Majchrzak. 2003. Technology alignment and adaptation for virtual teams involved in unstructured knowledge work. C. B. Gibson, S. G. Cohen. *Virtual Teams That Work*. Jossey-Bass, San Francisco, CA, 265-291.
- Knoll, K., S. L. Jarvenpaa. 1998. Working together in global virtual teams. M. Igarria, M. Tan. *The virtual workspace*. Idea Group Publishing, Hershey, PA, 2-23.
- Kostner, J. 1996. *Virtual leadership: Secrets from the round table for the multi-site manager*. Warner Books, New York, NY.
- Kurland, N. B., T. D. Egan. 1999. Telecommuting: Justice and control in the virtual organization. *Organization Science*. **10**(4) 500-513.
- Larzelere, R., T. Huston. 1980. The dyadic trust scale: Toward understanding interpersonal trust in close relationships. *Journal of Marriage and the Family*. **42**(3) 595-604.
- Lawler III, E. E. 2003. Pay systems for virtual teams. C. B. Gibson, S. G. Cohen. *Virtual teams that work*. Jossey-Bass, San Francisco, CA, 121-144.
- Lewis, J. D., A. Weigert. 1985. Trust as a social reality. *Social Forces*. **63**(4) 967-985.
- Lipnack, J., J. Stamps. 1997. *Reaching across space, time, and organizations with technology*. Wiley & Sons, Inc., New York, NY.
- Lurey, J. S., M. S. Raisinighani. 2001. An empirical study of best practices in virtual teams. *Information & Management*. **38**(8) 523-544.
- MacKinnon, D. P. 2008. *Introduction to statistical mediation analysis*. Lawrence Erlbaum Associates, New York, NY.
- Majchrzak, A., R. Rice, A. Malhotra, N. King, S. Ba. 2000. Technology adaptation: The case of a computer-supported inter-organizational virtual team. *MIS Quarterly*. **24**(4) 569-600.

- Mayer, D., L. Nishii, B. Schneider, H. Goldstein. 2007. The precursors and products of justice climates: Group leader antecedents and employee attitudinal consequences. *Personnel Psychology*. **60**(4) 929-963.
- Mayer, R. C., J. H. Davis, F. D. Schoorman. 1995. An integrative model of organizational trust. *Academy of Management Review*. **20**(3) 709-734.
- Maznevski, M. L., K. M. Chudoba. 2000. Bridging space over time: Global virtual team dynamics and effectiveness. *Organization Science*. **11**(5) 473-492.
- McAllister, D. J. 1995. Affect- and cognition-based trust as foundations for interpersonal cooperation in organizations. *Academy of Management Journal*. **38**(1) 24-59.
- McCrae, R. R., P. T. Costa. 1997. Personality trait structure as a human universal. *American Psychologist*. **52**(5) 509-516.
- McCrae, R. R., P. T. Costa Jr. 1997. Conceptions and correlates of openness to experience. R. Hogan, J. Johnson, S. Briggs. *Handbook of personality psychology*. Academic Press, San Diego, CA, 825-847.
- McCrae, R. R., O. P. John. 1992. An introduction to the five-factor model and its applications. *Journal of Personality*. **60**(2) 175-215.
- Meyerson, D., K. Weick, R. Kramer. 1996. Swift trust and temporary groups. *Trust in Organizations: Frontiers of Theory and Research*. **195**(3) 32-55
- Montoya-Weiss, M. M., A. P. Massey, M. Song. 2001. Getting it together: Temporal coordination and conflict management in global virtual teams. *Academy of Management Journal*. **44**(6) 1251-1262.
- Morgan, R. M., S. D. Hunt. 1994. The commitment-trust theory of relationship marketing. *Journal of Marketing*. **58**(3) 20-38.
- Mowshowitz, A. 1997. Virtual organization. *Communications of the ACM*. **40**(9) 30-37.
- Nardi, B., S. Whittaker. 2002. The place of face-to-face communication in distributed work. P. Hinds, S. Kiesler. *Distributed Work*. MIT Press, Cambridge, MA, 83-112.
- Nilles, J. 1998. *Managing telework: Strategies for managing the virtual workforce*. John Wiley & Sons, New York, NY.
- Nohria, N., R. G. Eccles. 1992. Face-to-face: Making network organizations work. N. Nohria, R. G. Eccles. *Networks and organizations: Structure, form, and action*. Harvard Business School Press, Boston, MA,
- Norman, W. T. 1963. Toward an adequate taxonomy of personality attributes: Replicated factors structure in peer nomination personality ratings. *Journal of Abnormal & Social Psychology*. **66**(6) 574-583.
- Nowack, K. 1996. Personality inventories: The next generation. *Performance in Practice*.
- O'Connor, T. 2006. General administrative theorists. *MegaLinks in criminal justice*. International Journal of Police Science & Management: September 2008, Vol. 10, No. 3, pp. 255-266
- Panteli, N. 2005. Trust in global virtual teams. *Ariadne*. **43**(2) 1-9.
- Pauleen, D. J. 2003. Leadership in a global virtual team: An action learning approach. *Leadership & Organization Development Journal*. **24**(3) 153-162.

- Piccoli, G., B. Ives. 2000. Virtual teams: Managerial behavior control's impact on team effectiveness. *Proceedings of the twenty first international conference on Information systems*. 575-580.
- Ployhart, R. E., B.-C. Lim, K.-Y. Chan. 2001. Exploring relations between typical and maximum performance ratings and maximum performance ratings and the five factor model of personality. *Personnel Psychology*. **54**(4) 809-843.
- Poole, M. S., H. Zhang. 2005. Virtual teams. S. A. Wheelan. *Handbook of group research and practice*. Sage Publications, Thousand Oaks, CA, 363-384.
- Raymark, P. H., M. J. Schmit, R. M. Guion. 1997. Identifying potentially useful personality constructs for personnel selection. *Personnel Psychology*. **50**(3) 723-736.
- Rubin, R. S., D. C. Munz, W. H. Bommer. 2005. Leading from within: The effects of emotion recognition and personality on transformational leadership behavior. *The Academy of Management Journal*. **48**(5) 845-858.
- Sally, D. 1995. Conversation and cooperation in social dilemmas: A meta-analysis of experiments from 1958 to 1992. *Rationality and Society*. **7**(1) 58-92.
- Sarker, S., J. S. Valacich, S. Sarker. 2003. Virtual team trust: Instrument development and validation in an IS educational environment. *Information Resources Management Journal*. **16**(2) 35-55.
- Stinnett, N., J. Walters. 1977. *Relationships in marriage and family*. Macmillan, New York, NY.
- Towler, A. J. 2003. Effects of charismatic influence training on attitudes, behavior, and performance. *Personnel Psychology*. **56**(2) 363-381.
- Townsend, A. M., S. M. DeMarie, A. R. Hendrickson. 1998. Virtual teams: Technology and the Workplace of the Future. *Academy of Management Executive*. **12**(3) 17-29.
- Tupes, E. C., R. E. Christal. 1992. Recurrent personality factors based on trait ratings. *Journal of Personality*. **60**(2) 225-251.
- Walters, K. K. G. 2004. A study of the relationship between trust and perceived effectiveness in virtual teams. Capella University.
- Warkentin, M. E., L. Sayeed, R. Hightower. 1997. Virtual teams versus face-to-face teams: An exploratory study of a web-based conference system. *Decision Sciences*. **28**(4) 975-996.
- Watson, D., L. A. Clark. 1997. Extraversion and its positive emotional core. R. Hogan, J. Johnson, S. Briggs. *Handbook of Personality Psychology*. Academic Press, San Diego, CA, 767-793.
- Watson-Manheim, M. B., K. M. Chudoba, K. Crowston. 2002. Discontinuities and continuities: A new way to understand virtual work. *Information Technology & People*. **15**(3) 191-209.
- Weick, K. E., K. H. Roberts. 1993. Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly*. **38**(3) 357-381.
- Yoo, Y., M. Alavi. 2004. Emergent leadership in virtual teams: What do emergent leaders do? *Information and Organization*. **14**(1) 27-58.
- Zellers, K., P. Perrewe. 2001. Affective personality and the content of emotional social support: Coping in organizations. *Journal of Applied Psychology*. **86**(3) 459-67.
- Zigurs, I. 2003. Leadership in virtual teams: Oxymoron or opportunity? *Organizational Dynamics*. **31**(4) 339-351.

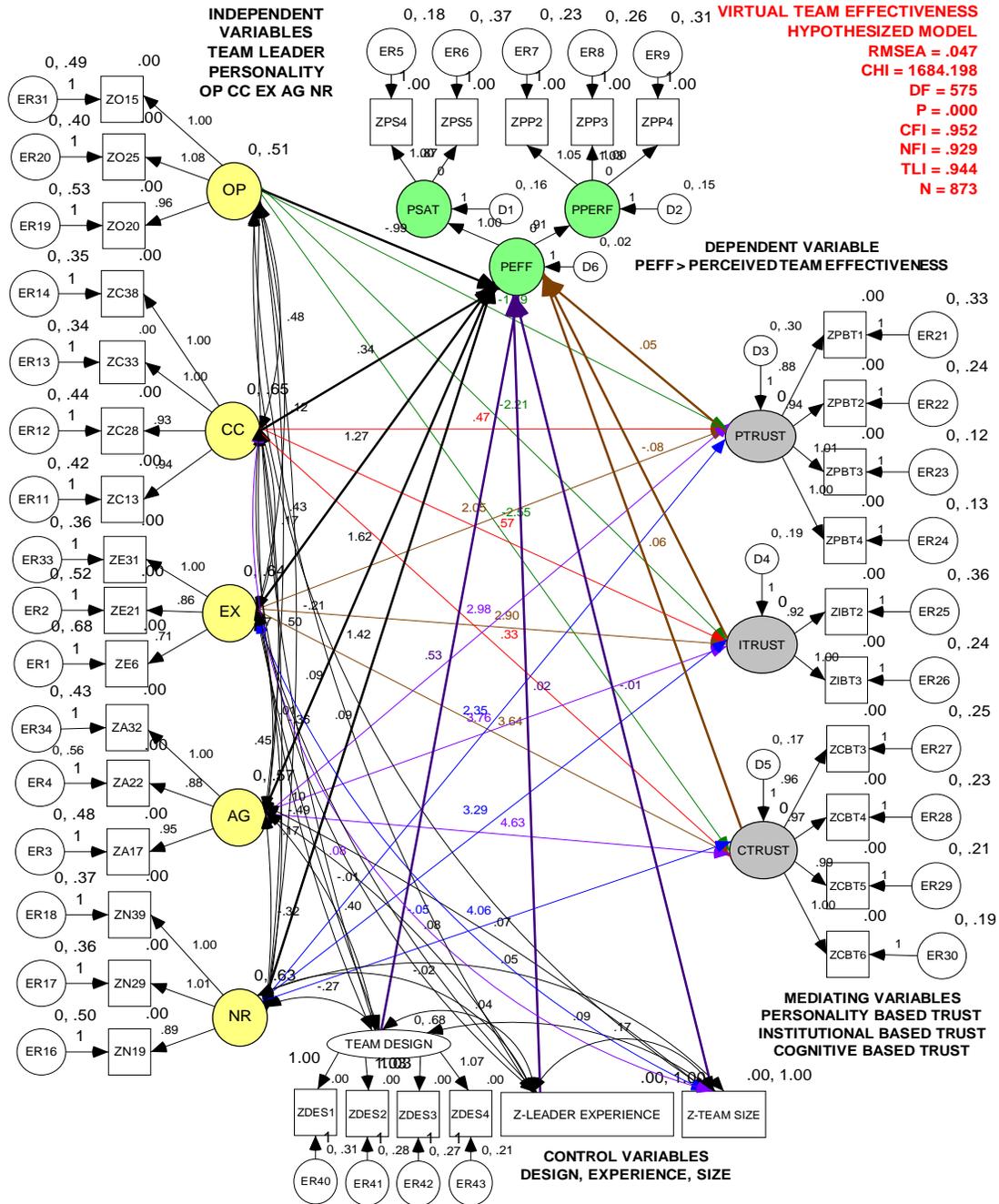
## Appendix 1

### Table of Constructs

Construct	Description	Sources
<i>Team Leader Personality Constructs</i>		
<b>Openness</b>	A disposition to be imaginative, nonconforming, open to ideas, and unconventional	Goldberg, 1990; McCrae & Costa Jr., 1997; McCrae & John, 1992
<b>Conscientiousness</b>	The disposition that combines the tendency to be governed by conscience with diligence and thoroughness in organizing behavior [ <i>The dimensions are combined because past research supports the empirical assertion of strong covariance in these traits (McCrae &amp; John, 1992)</i> ]	Goldberg, 1990; McCrae & Costa Jr., 1997; McCrae & John, 1992
<b>Extraversion</b>	The tendency to be sociable, assertive, and active, and to experience positive affects, such as energy and zeal	Goldberg, 1990; McCrae & John, 1992; Watson & Clark, 1997
<b>Agreeableness</b>	The tendency to be trusting, compliant, caring, and gentle	Digman, 1990; Goldberg, 1990; McCrae & John, 1992
<b>Neuroticism</b>	The tendency to exhibit poor emotional adjustment and experience negative affects, such as anxiety, insecurity, and hostility	Goldberg, 1990; McCrae & John, 1992
<i>Virtual Team Trust Constructs</i>		
<b>Personality based trust</b>	Trust that develops due to the personal propensity to trust among individual team members	Sarker et al., 2003
<b>Institutional based trust</b>	Trust that is a function of the belief in institutional norms and procedures	Sarker et al., 2003
<b>Cognitive based trust</b>	Trust that develops from social cues, impressions, and interactive experiences that an individual has with others	Sarker et al., 2003
<b>Perceived Team Effectiveness Constructs</b>		
<b>Perceived performance</b>	Team members' discernment of the team's ability to complete their work assignments	Lurey & Raisinghani, 2001; Walters, 2004
<b>Perceived Satisfaction</b>	The levels of satisfaction with the team processes achieved by team members	Lurey & Raisinghani, 2001; Walters, 2004

## Appendix 2

### Detailed Hypothesized Model with AMOS Output



### Appendix 3

#### Exploratory Factor Analysis – Pattern Matrix

Item/Factors	1	2	3	4	5	6	7	8	9	10
Extraversion1						0.711				
Extraversion2						0.783				
Extraversion3						0.529				
Agreeableness1								0.779		
Agreeableness2								0.620		
Agreeableness3								0.598		
Conscientiousness1				0.574						
Conscientiousness2				0.536						
Conscientiousness3				0.875						
Conscientiousness4				0.806						
Neuroticism1			-0.775							
Neuroticism2			-0.872							
Neuroticism3			-0.683							
Openness1							0.504			
Openness2							0.829			
Openness3							0.568			
PersTrust1		0.795								
PersTrust2		0.724								
PersTrust3		1.011								
PersTrust4		0.976								
InstTrust1										0.782
InstTrust2										0.636
CogTrust1	0.800									
CogTrust2	0.789									
CogTrust3	0.905									
CogTrust4	0.935									
PercPerf1					0.519					
PercPerf2					1.054					
PercPerf3					0.724					
PercSatis4									0.845	
PercSatis5									0.744	

Extraction Method: Maximum Likelihood.

Rotation Method: Promax with Kaiser Normalization.

## Appendix 4

### Comparison of Alternative Models

Relationship	Partial Mediation		Full Mediation		Non-Mediation	
	<i>Std Est.</i>	<i>P</i>	<i>Std Est.</i>	<i>p</i>	<i>Std Est.</i>	<i>p</i>
Openness → Team Effectiveness	0.136	0.375			0.140	0.002
Neuroticism → Team Effectiveness	-0.059	0.762			-0.217	***
Extraversion → Team Effectiveness	0.483	0.459			0.158	0.012
Agreeableness → Team Effectiveness	0.178	0.230			0.251	0.004
Conscientiousness → Team Effectiveness	0.236	0.013			0.487	***
Personality Trust → Team Effectiveness	0.082	0.033	0.144	***	0.169	***
Institutional Trust → Team Effectiveness	-0.009	0.855	0.059	0.126	0.068	0.010
Cognitive Trust → Team Effectiveness	0.185	***	0.216	***	0.283	***
Openness → Personality Trust	0.792	***	0.791	***		
Openness → Institutional Trust	0.861	***	0.853	***		
Openness → Cognitive Trust	0.852	***	0.846	***		
Neuroticism → Personality Trust	-0.779	***	-0.779	***		
Neuroticism → Institutional Trust	-0.852	***	-0.852	***		
Neuroticism → Cognitive Trust	-0.830	***	-0.830	***		
Extraversion → Personality Trust	0.781	***	0.781	***		
Extraversion → Institutional Trust	0.869	***	0.869	***		
Extraversion → Cognitive Trust	0.868	***	0.868	***		
Agreeableness → Personality Trust	0.823	***	0.823	***		
Agreeableness → Institutional Trust	0.853	***	0.853	***		
Agreeableness → Cognitive Trust	0.826	***	0.826	***		
Conscientiousness → Personality Trust	0.795	***	0.794	***		
Conscientiousness → Institutional Trust	0.836	***	0.837	***		
Conscientiousness → Cognitive Trust	0.778	***	0.777	***		

English Abstract

# Technology, Trust and Effectiveness in Virtual Teams

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## Abstract

Business and government organizations today need to compete and interoperate globally to survive. Effective virtual team management through technology is a key factor. Virtual teams present advantages for cost control and access to global expertise. Previous research suggests a variety of factors for effective functioning of virtual teams. This study explored technology and relationships between team leader personalities, team trust, and team perceived effectiveness by surveying 873 engineers. The findings suggest that a virtual team leader's personality has a significant impact on the team's perceived effectiveness but this effect is mediated through cognitive and personality based trust. Implications for managers and further research are discussed.

**Keywords:** Cognitive Trust, Leader personality, Personality-based Trust, Virtual Teaming, Big Five personality model, Structural equation modeling

French Abstract\*

Technology, Trust and Effectiveness in Virtual Teams

# Technologie, confiance et efficacité des équipes virtuelles

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## Résumé

Les organisations professionnelles et le gouvernement doivent aujourd'hui faire face à la concurrence et interagir au niveau mondial pour survivre. Une gestion efficace des équipes virtuelles ainsi que la technologie sont des facteurs clé de succès. Les équipes virtuelles présentent des avantages en termes de contrôle de coûts et de l'accès à l'expertise mondiale. Des recherches antérieures suggèrent une qu'il existe une variété de facteurs qui permettent un fonctionnement efficace des équipes virtuelles. Cette étude explore la technologie et les relations entre la personnalité du leader d'une équipe virtuelle, la confiance au sein de l'équipe et l'efficacité de l'équipe perçue par 873 ingénieurs, qui ont été questionnés. Les résultats suggèrent que la personnalité du chef d'une équipe virtuelle a un impact significatif sur la perception de l'efficacité de l'équipe, mais cet effet est médié par le biais cognitif et la confiance. Des implications pour les managers et pistes de recherche sont discutées.

**Mots-clés:** Confiance cognitive, la personnalité d'un leader, confiance personnelle, le modèle de personnalité *Big Five*, modélisation par équations structurelles

\* Translated by: Johannes Schaaper, Senior professor in International Management, BEM Bordeaux Management School

German Abstract\*

Technology, Trust and Effectiveness in Virtual Teams

# Technologie, Vertrauen und Effektivität in virtuellen Teams

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## Zusammenfassung

Unternehmen und staatliche Organisationen müssen heutzutage miteinander konkurrieren und global zusammenarbeiten um zu überleben. Ein Schlüsselfaktor ist das effektive virtuelle Team Management durch Technologie. Virtuelle Teams präsentieren dabei Vorteile der Kostenkontrolle und Zugang zu globalem Know-How. Vorangegangene Forschungen schlagen eine Vielzahl an Faktoren für ein effektives Funktionieren von virtuellen Teams vor.

Diese Studie erforscht die Technologie und die Beziehungen zwischen Führungspersönlichkeiten, Team Vertrauen und die wahrgenommene Effektivität durch das Team indem 873 Ingenieure befragt werden. Die Ergebnisse deuten an, dass eine virtuelle Führungspersönlichkeit eine signifikante Auswirkung auf die wahrgenommene Effektivität des Teams hat, aber der Effekt durch kognitives und persönlichkeitsbasiertes Vertrauen mediiert wird. Auswirkungen für Manager und weiterführende Forschungen werden diskutiert.

**Stichwörter:** kognitives Vertrauen, Führungspersönlichkeit, Persönlichkeit basiertes Vertrauen, Virtuelles Teaming, Big Five Personality-Modell, Strukturgleichungsmodell

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Spanish Abstract\*

Technology, Trust and Effectiveness in Virtual Teams

# Tecnología, Confianza y Eficacia en Equipos Virtuales

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## Resumen

Las organizaciones empresariales y del gobierno hoy en día necesitan competir e interactuar a nivel global para sobrevivir. La gestión eficaz de equipos virtuales mediante la tecnología es un factor clave. Los equipos virtuales presentan ventajas en el control de costes y el acceso a la experiencia global. Las investigaciones previas sugieren una variedad de factores para el funcionamiento eficaz de los equipos virtuales. En este estudio se exploran la tecnología y las relaciones entre la personalidad del líder del equipo, la confianza del equipo, la eficacia del equipo percibida mediante encuestas a 873 ingenieros. Los resultados sugieren que la personalidad de un líder de un equipo virtual tiene un impacto significativo en la eficacia percibida del equipo, pero este efecto es mediado por la confianza basada en la personalidad y el conocimiento. Finalmente se discuten las implicaciones para la empresa y para el ámbito académico.

**Palabras clave:** Confianza cognitiva, personalidad del líder, confianza basada en la personalidad, equipos virtuales, modelo de las cinco grandes personalidades, modelos de ecuaciones estructurales.

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Arabic Abstract\*

## Technology, Trust and Effectiveness in Virtual Teams

# التكنولوجيا، الثقة، والفاعلية في فرق العمل الافتراضية

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### المخلص

تحتاج منظمات الأعمال و الحكومات في الوقت الحالي الى التنافس و التعامل على الصعيد العالمي لتتمكن من البقاء حيث تعتبر الفرق الافتراضية الفعالة من خلال التكنولوجيا عامل اساسي في ذلك. حيث تتيح الفرق الافتراضية مزايا لمراقبة التكاليف والحصول على الخبرات العالمية. تشير الأبحاث السابقة الى عوامل مختلفة من أجل تحقيق الاداء الفعال للفرق الافتراضية. بحثت هذه الدراسة التكنولوجيا و العلاقات بين شخصية قائد الفريق، ثقة الفريق، و فعالية الفريق المدركة من قبل 873 مهندسا. حيث تشير النتائج إلى أن شخصية قائد الفريق الافتراضي لديها أثر كبير على فعالية الفريق المدركة، لكن يتوسط هذا التأثير أو هذه العلاقة الثقة المبنية على المعرفة و الشخصية. المزيد من البحوث و التطبيقات للمدراء تمت مناقشتها ايضا.

**الكلمات الدالة:** الثقة المعرفية، شخصية القائد، الثقة المبنية على الشخصية، الفرق الافتراضية، نموذج الصفات الشخصية الخمسة الكبيرة، نمذجة المعادلة المهيكلية.

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Italian Abstract\*

## Technology, Trust and Effectiveness in Virtual Teams

# Tecnologia, Fiducia e Efficacia in team virtuali

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### Abstract

Organizzazioni private e governative oggi devono competere nell'ambito globale per sopravvivere. La gestione virtuale di team attraverso la tecnologia rappresenta un fattore chiave a questo. I team virtuali presentano vantaggi riguardanti il controllo dei costi e accesso all'expertise globale. Ricerche precedenti suggeriscono una varietà di fattori per l'efficace funzionamento di team virtuali. Questo ha esplorato la tecnologia e la relazione fra i team leader e le loro personalità, la fiducia nei team, e l'efficacia percepita da 873 ingegneri coinvolti nello studio. Quanto riscontrato evidenzia che la personalità del leader del team ha un grosso impatto sulla prestazione del team ma questo impatto é mitigato dal senso di fiducia a livello cognitivo e di carattere. Sono evidenziati implicazioni per manager e spunti di ricerca aggiuntiva.

**Keywords:** Fiducia Cognitiva, Carattere del Leader, Fiducia basata sul Carattere, Team Virtuali, I modelli di Carattere basati sui 5 aspetti chiave, Modello di Equazione Strutturale

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