

A Theoretical Knowledge Creation Process in Virtual Teams: A Socio-Technical Perspective

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ABSTRACT

Virtual teams have made such an impact on many organizational phenomena, particularly knowledge management. Based on socio-technical perspective, this paper suggests that trust and IT are the underlying foundation of knowledge creation in virtual teams. Based on such foundation, this paper proposes a theoretical model of knowledge creation process in virtual teams called Adaptive Social-Externalization by drawing from Nonaka's Organizational Knowledge Creation theory as well as Adaptive Structuration theory and Agency theory. The characteristics of the process are derived: Adaptiveness, Simultaneity, and Goal Congruency and Information Symmetry. As a result, those characteristics can be used to determine whether a virtual team is likely to perform well in both knowledge creation and overall team effectiveness. Implications for both researchers and practitioners are discussed.

INTRODUCTION

Knowledge Management (KM) is a complex organizational phenomenon that has been highlighted among researchers and practitioners. The survey results of a KM Review in 2001 showed that practitioners are increasingly acknowledging competitive advantages of knowledge. Much KM literature mostly focuses on social aspects such as determinants of sharing behaviors (Chennamaneni, 2006), behavioral intentions and motivation factors on sharing (Bock et al., 2005), and knowledge acquisition processes among individuals (Ryu et al., 2005). Researchers suggest the potential roles of information systems to facilitate KM processes in different contexts be explored (Alavi and Leidner, 2001; Alavi and Tiwana, 2002). Particularly, researchers need to focus more on working conditions that facilitate knowledge creation, which is considered fundamental to the survival of a business nowadays (Alavi and Leidner, 2001; Chen and Edgington, 2005). As a ubiquitous working mode in modern organizations, virtual teams are believed to increase the value of KM significantly (Griffith et al., 2003). However, that knowledge becomes highly distributed in virtual environment challenges researchers to reevaluate knowledge creation processes in organizations (Lee and Cole, 2003). Researchers point out that despite the impacts of virtual teams, theoretical justification of their dynamic working processes is scarce (Maznevski and Chudoba, 2000; Schiller and Mandviwalla, 2007). Indeed, Schiller and Mandviwalla (2007) reviewed how virtual team research is conducted and found that only 13 out of 58 articles from 1990 to 2005 are theoretical-grounded.

To develop the research model, this paper first uses socio-technical approach to analyze and theoretically merge the two phenomena “knowledge creation” and “virtual teams” into one phenomenon “knowledge creation in virtual teams” and propose that the common underlying foundation of the phenomenon is trust and IT. Many researchers recommend that to better understand IS phenomena, socio-technical approach should be used (Koh and Kim, 2004; Lee and Choi, 2003; Lee et al., 2006; Rasmussen and Wangel, 2007). Specifically, this study explores the following research questions:

1. *How different is the knowledge creation process in virtual teams from that in traditional face-to-face teams (**the nature of the process**)?*
2. *How is such knowledge creation process different between effective and ineffective virtual teams (**the characteristics of the process**)?*

The objective of this paper is to propose a theoretical model of knowledge creation process in virtual teams and its key characteristics by drawing from multiple theories such as Nonaka’s Organizational Knowledge Creation theory, Adaptive Structuration theory, and Agency theory. As a result, those characteristics can be used to determine how well a virtual team performs regarding its knowledge creation and overall team effectiveness. This paper is organized as follows. First, prior literature on knowledge creation and virtual teams is reviewed. Next, conceptually integrating the two phenomena by using socio-technical lens to analyze the underlying foundation of both phenomena, this paper posits that trust and IT can unite knowledge creation and virtual teams to one phenomenon “knowledge creation in virtual teams”. Subsequently, the research model and propositions are discussed. Finally, both theoretical and practical implications are discussed as well as conclusion.

LITERATURE BACKGROUND

Knowledge Creation

Knowledge creation is critical to the survival of an organization (Chen and Edgington, 2005). Holden (2001) defined knowledge creation process as “the act of combining a variety of internal and external sources such as documents, computer databases, and interactions among people into new knowledge.” Two fundamental elements in knowledge creation concept are the taxonomies and epistemology of knowledge and the creation processes (Nonaka et al., 2006). Knowledge is categorized as tacit and explicit. Tacit knowledge is rooted in action, commitment and experience, and involves in a specific context. Tacit knowledge has a personal quality and thus is hard to formalize. Explicit knowledge is codified in formal systematic formats such as archives, databases, and statistics. Nonaka (1994) suggested that the articulation of tacit knowledge is the key in knowledge creation. Capturing tacit knowledge is one of the challenges that keep researchers’ attentions (Holden 2001). Researchers estimate that only 20 percent of knowledge in an organization is ever captured and made accessible, while 80 percent remains in the minds of employees (Botkin and Seeley, 2001). Understanding of creation processes may illuminate the nature of such challenge. Knowledge creation process includes: Socialization, Externalization, Combination, and Internalization mode (SECI) (Nonaka, 1994; Nonaka and Konno, 1998). Socialization enables exchanging tacit knowledge through either people interactions. Externalization converts or codifies tacit knowledge into explicit knowledge. Combination gathers and systematically combines explicit knowledge scattered in organization into new explicit knowledge for either routine or strategic organizational uses. Internalization converts explicit knowledge back to tacit in human minds through individuals’ learning processes.

Challenges in Knowledge Creation

Mobilizing tacit knowledge is a key factor in knowledge creation process (Nonaka, 1994). The focus of socialization lies at both quantity and quality of social interactions among individuals. Mutual trust is so crucial that it significantly determines whether individuals are willing to share their knowledge (Lee and Choi, 2003; Nonaka, 1994). However, the reality rarely matches the expectations. Indeed, Gupta and Govindarajan (2000) quoted from an interview with a CEO, “my managers would rather die than learn from each other.” Practices such as building mutual trust and relying on group-based incentives are expected to improve knowledge sharing (Gupta and Govindarajan, 2000). To advance knowledge for organizational uses, individuals also need to externalize their knowledge formally into certain systems. Self-transcendence is vital; individuals need to realize greater values of knowledge for others (Nonaka and Konno, 1998). Two eminent issues are the lack of commitment and the loss of potential knowledge during the conversion (Alavi and Leidner, 2001; Glisby and Holden, 2003). First, the conversion is both effort and time consuming (Nonaka, 1994). Time and effort are key determinants in knowledge sharing behaviors explained by social exchange theory (Lee et al., 2006). The KPMG KM Report 2000 reported that the lack of time to share knowledge is the most concerned problem (Holden 2001). Second, during the conversion, much of potential knowledge especially its context is lost (Alavi and Leidner, 2001; Alavi and Tiwana, 2002; Botkin and Seeley, 2001). Context adds richness, background information, and history of usage including successes and failures (Botkin and Seeley, 2001). Without sufficient contextual details of certain knowledge, ineffective uses are likely to occur. To combine explicit knowledge scattered in an organization, inter-departmental rivalry typically awaits (Glisby and Holden, 2003). As explicit knowledge becomes accessible, individuals should be trained to be aware of information security issues (Glisby and Holden, 2003). Once individuals learn, adjust and absorb knowledge into their minds, internalization occurs. The willingness and motivation to learn not only their own responsibilities but new skills through trainings are also key factors (Glisby and Holden, 2003).

Virtual Teams and Knowledge Creation

Virtual collaborations are proliferating in organizations. Researchers consider virtual teams a new ubiquitous form of work structure in the 21st century (Alavi and Tiwana, 2002; Schiller and Mandviwalla, 2007). Virtual teams are defined as “ones whose members share a common purpose, but are separated by distance, time, and organizational boundaries.” (Noble, 2004) Virtual team members may, if hardly, never have physical interactions at all, except in cyberspace (Gould, 1997; Maznevski and Chudoba, 2000; Rayner, 1997). Communications among virtual team members are thus important. In virtual teams, communication issues exist in both human and technology aspects (Rasmussen and Wangel, 2007). First, researchers acknowledge that trust is always pivotal in virtual team members’ interactions by investigating topics such as the effects of the antecedents of trust (Jarvenpaa et al., 1998) and how to create and sustain trust (Greenberg et al., 2007). Second, IT such as collaboration systems can be employed to support not only interactions in virtual teams, but importantly knowledge creation processes (Alavi and Leidner, 2001). IT is widely acknowledged as an important enabler of KM (Alavi and Leidner, 2001; Alavi and Tiwana, 2002; Chennamaneni, 2006; Lee and Choi, 2003). Appropriate use of IT determines not only the effectiveness of virtual teams but also that of KM. In short, to manage KM in virtual teams successfully, effective combinations of trust and IT management are crucial.

The relationships between virtual teams and knowledge creation are reciprocal: while virtual teams and trust management can enhance knowledge creation (Griffith et al., 2003; Lavrac et al., 2007), effective knowledge creation in turn can improve trust and social interactions among virtual team members (Rasmussen and Wangel, 2007). Noble (2004) suggested that organizations pay attention to how to utilize technologies and how virtual teams communicate and share information. Research using socio-technical perspective is encouraged as it better reflects the nature of the phenomena (Koh and Kim, 2004; Lee and Choi, 2003; Lee et al., 2006; Rasmussen and Wangel, 2007). Consequently, using socio-technical lens, this paper theoretically links knowledge creation and virtual teams via the concept of trust and IT. Figure 1 depicts trust and IT as an underlying foundation of knowledge creation and virtual teams. Specifically, trust plays a role of key mediator in socio perspective, while communication technology is a complementary enabler in technical perspective.

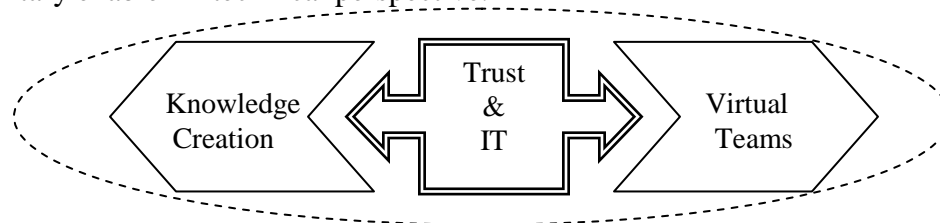


Figure 1: The underlying foundation of knowledge creation and virtual teams

Trust: A Key Socio Mediator

Trust is always at the center of successful virtual teams and knowledge creation processes and remains challenging for both researchers and managers (Aubert and Kelsey, 2003; Gould, 1997; Greenberg et al., 2007; Jarvenpaa et al., 1998; Jarvenpaa and Leidner, 1999; Lavrac et al., 2007; Noble, 2004; Rasmussen and Wangel, 2007; Sarker, 2002). Trust is basically “based on the expectation that others will behave as expected” (Jarvenpaa et al., 1998). Researchers recognize that trust, if carefully managed, will bring many advantages of virtual collaborations (Aubert and Kelsey, 2003; Gould, 1997; Lavrac et al., 2007). McAllister (1995) classified trust as cognitive and affective-based. Cognitive trust is developed on facts or information individuals have on one another such as reliability and competence, whereas affective trust is rooted in emotional bonds among individuals. Trust solidifies primarily through the extent to which individuals perceive ability, integrity, and benevolence of one another (Jarvenpaa et al., 1998). Ability refers to a set of skills or the degree of competency individuals are perceived to possess. Integrity is adherence to a set of principles such as reliability. Benevolence is the extent of interpersonal care individuals express to others. With limited prior information on team members, time constraints and, often, no expectation to re-collaborate in the future, virtual team members face challenges in developing trust. Thus, the question becomes “what propels virtual team members to continue their cooperation without proper trust building stage?” Researchers resort to swift trust to explain such a paradox (Aubert and Kelsey, 2003; Greenberg et al., 2007; Jarvenpaa et al., 1998; Jarvenpaa and Leidner, 1999). Unlike affective and cognitive-based trust, swift trust is a form of impersonal and action-oriented trust (Jarvenpaa et al., 1998; Jarvenpaa and Leidner, 1999). Swift trust is initially based on well-defined social structures such as goals, roles, and expertise, and subsequently on actions. Virtual team members assume, as opposed to develop, trust in the form of swift trust at the inception of the project. Swift trust enables virtual team members to act as if traditional trust exists. Then, members assess their interactions and subsequently develop trust in the cognitive and affective forms (Greenberg et al., 2007; Jarvenpaa et al., 1998; Rasmussen and

Wangel, 2007). Specifically, once importing swift trust, members assess one another's ability and integrity (cognitive trust). Once establishing working norms, members focus more on accomplishing the tasks and start to express benevolence (affective trust) toward one another while still somewhat concerned on integrity.

Communication Technology: A Technical Enabler

Despite the issues of trust, virtual teams possess an inherent advantage over traditional teams: technology-mediated communication. Virtual environment allows people to exchange more information in less time and links people from different geography (Rayner, 1997). As virtual collaboration is becoming an organizational norm, IT systems for distributed uses are ever more important (Buckman, 2005). Nonaka et al. (2006) suggested that socialization requires a human-focused strategy for knowledge sharing. Complementarily, this study suggests that effective integrations of IT to enhance communication among virtual team members can significantly maximize and expedite knowledge creation processes. This subsection discusses the role of communication technology as an IT enabler to knowledge creation processes in virtual teams. It is important that managers appropriately select technologies that support both socialization and knowledge creation in virtual teams (Sivunen and Valo, 2006). In the KM context, Knowledge Management Systems (KMS) are basically a class of information systems to support KM (Alavi and Leidner, 2001). Researchers suggest that a KMS may not appear drastically different from existing forms of information systems, but essentially the notions of knowledge to the information stored in the systems and effective strategies have to be applied (Alavi and Leidner, 2001; Griffith et al., 2003). For example, emails and web-boards can be viewed as both communication tools and KMSs (Griffith et al., 2003).

To support both virtual team members' interactions and their knowledge creation processes, team leaders face a number of challenges. To manage KM in virtual teams, trust remains a top priority. However, importantly, to maximize the benefits of the technology choices, they should also alleviate those aforementioned key challenges in knowledge creation processes. While many challenges exist, this subsection only emphasizes certain issues IT is able to support notably. First, as trust is fundamental to both virtual teams and knowledge sharing, managers should consider, besides trust management practices, systems with design elements that facilitate trust building. Researchers suggest that text-based communication using emoticons or pictures may improve trust and overall communication among team members as they can perceive feelings (Gould, 1997). Studies in the field of human computer interaction also show that using different media such as image, audio, and video affects how individuals develop trust in virtual socializations (Nathan et al, 1998, 2002; Riegelsberger et al., 2007). Second, appropriate technology choices should also alleviate some of the key challenges in knowledge creation processes. Particularly, researchers recognize much contextual knowledge is lost during the knowledge conversion processes. Contextual knowledge allows individuals to refer to the information of the knowledge such as the history of usage and may not be much useful unless it is available to all members. Appropriate technology choices should help maintain contextual knowledge and ultimately improve conversion processes. Consider using emails vs. online forums as follows. Although researchers find that email remains the most widely used communication tool in both virtual environment and knowledge sharing (Chennamaneni, 2006; Gould, 1997; Sivunen and Valo, 2006), its advantages are quite limited in knowledge creation in virtual team context. Despite its popularity and benefits, team leaders recognize that email lacks

capacity in knowledge sharing (Sivunen and Valo, 2006). On the contrary, web boards provide superior knowledge sharing functions, but are perceived to be inferior in terms of supporting virtual communication (Sivunen and Valo, 2006). Web boards allow team members not only to interact among one another but also to store knowledge especially its context. Thus, to align these impacts of IT to the knowledge creation SECI model, superior technology choices such as web boards support not only virtual team members' socialization (general interactions), but particularly externalization (systematic knowledge conversion).

A KNOWLEDGE CREATION PROCESS IN VIRTUAL TEAMS

After establishing that IT and trust are the underlying foundation of the knowledge creation in virtual team, this paper now proposes a theoretical model called Adaptive Social-Externalization (ASX) as a knowledge creation process in virtual teams by drawing from Organizational Knowledge Creation, Adaptive Structuration, and Agency theory. The ASX process tackles the first research question (the nature of the process) of the paper. Then, the characteristics of the ASX process are derived to respond to the second question (the characteristics of the process).

Adaptive Structuration Theory

DeSanctis and Poole (1994) proposed Adaptive Structuration Theory (AST) to emphasize social outcomes such as new social structures and decisions from social interaction processes based on individuals using IT systems in an organization. Social processes refer to how individuals use the systems, or "technology appropriation", to support their "decision processes." To illustrate the key concept of the AST, one may view IT systems and organizational and task factors as inputs, social interactions based on the systems as processes, and new social structures and decision outcomes as outputs of the theory respectively. The outcomes may be continually adjusted because of changes or adaptations in social processes. AST approach allows researchers to investigate technology choices of virtual teams on not only either rational or social basis but on the interaction between social and technical perspective with an emphasis on social aspects (DeSanctis and Poole, 1994; Sivunen and Valo, 2006). AST is thus appropriate for this study because the research interest is in socio-technical perspective. By using AST, this paper analyzes how virtual team members use technology choices not only to support their social interactions, but also how they adapt their social structures based on such choices to benefit their knowledge creation processes. First, as previously discussed, technology choices are likely to affect more visibly on socialization and externalization (than on combination and internalization), due to the nature of the challenges in each mode discussed in the knowledge creation section. Specifically, IT can alleviate more noticeably on trust and loss of contextual knowledge issues in socialization and externalization (than security awareness and self motivation in combination and internalization). After the inception phase, virtual team members start to establish communication norms using the technology choices. In other words, they appropriate the technology choices to accommodate their socialization process. However, unlike traditional face-to-face teams, virtual teams can maximize the inherent benefits of technology-mediated communication by considering socialization and externalization simultaneously, thus minimizing challenges of knowledge codification and loss of knowledge due to the conversion from tacit to explicit knowledge in socialization and externalization. In other words, virtual team members can overcome such challenges if they externalize knowledge while socializing among one another by appropriating their social interaction processes based on the technology choices. For example, as previously discussed, unlike emails, web boards with embedded social profiles, if

appropriately employed, allow socialization and externalization to occur concurrently, thereby preventing loss of contextual knowledge and allowing members to access it. In addition, virtual teams using communication technologies with higher extent are more likely to transform tacit to explicit knowledge and exchange knowledge more effectively (Griffith et al., 2003). During the appropriation stage, the characteristics of team members and other organizational factors may also determine their work structures. Over time, virtual team members are settled with their social interaction process. Then, new social structures of how virtual team members interact and exchange knowledge emerge. Importantly, due to technology appropriation, knowledge is supposedly shared and codified effectively and efficiently. In other words, in order to manage knowledge creation processes effectively, socialization and externalization process should occur simultaneously based on virtual team members' appropriation of technology. For example, a virtual team that selects web boards as its communication tool over email and, importantly, can adapt its social structure to accommodate both interactions and knowledge creation is expected to perform better than other teams that also select web boards yet cannot adapt its social structure accordingly. Collectively, two characteristics of the ASX process and the propositions are:

*Characteristic 1 **Adaptiveness**: the extent to which a virtual team's members adapt their social interaction structures and knowledge creation processes based on technology choices.*

Proposition 1: Virtual teams that can adapt their social interaction structures well to accommodate their knowledge creation processes based on technology choices will generally perform better than virtual teams that cannot do so.

*Characteristic 2 **Simultaneity**: the extent to which a virtual team's socialization and externalization processes occur simultaneously based on its appropriation of technology choices.*

Proposition 2: Virtual teams that choose the technology that allows socialization and externalization to occur simultaneously will be able to manage knowledge creation processes more effectively and efficiently than virtual teams that do not choose so.

Agency Theory

Agency Theory (AT) is also known as the principal-agent theory, because it focuses on the relationships between principals and agents (Jensen and Meckling, 1976). Different contexts determine who principals and agents are (Lavrac et al., 2007). Goal incongruity and information asymmetry are key issues of the theory (Keil et al., 2000; Tiwana and Bush, 2007). Conflicting relationships between principals and agents as each party acts to maximize their own interests create goal incongruity. In other words, agents are likely to act on their interests rather than principals' interests and vice versa. Information asymmetry occurs when agents possess valuable and private information but it is costly for principals to obtain such information. Typical mitigations for these problems are to pre-specify in formal contracts the expectations of the relationships and to monitor agents' behaviors (Tiwana and Bush, 2007). However, those approaches are generally costly and impractical to use (Keil et al., 2000). An alternative is to align the interests of principals and agents (Lavrac et al., 2007). Lockhart (2007) suggested that trust among individuals helps alleviate those issues of the theory. Since this paper analyzes how the relationships among virtual team members affect their knowledge creation processes, principals and agents may be 1) team leaders and team members, and 2) team members and team members. In the first scenario, since team leaders are responsible for setting rules and responsibilities for members to behave accordingly, goal incongruity and information asymmetry definitely exist. However, in reality these problems may not be as serious in virtual teams as in traditional teams. One of the advantages of virtual teams is less political involvement

and less hierarchy (Rayner, 1997). Moreover, time constraints on tasks may drive members to focus more on accomplishing the tasks than arguing with team leaders. In the second scenario, team members are supposed to exchange knowledge in order to accomplishing the tasks; hence, knowledge givers might be viewed as agents, while receivers as principals. In other words, there is no actual principal. In this scenario, team members share common goals and interests to accomplish the tasks quickly, so they willingly exchange knowledge. Importantly, both swift trust and traditional trust may help align individuals' interests and prevent future conflicts. Lee et al. (2006) stated that individuals in the same team are believed to be more cooperative and motivated to share their knowledge. Consequently, goal incongruence and information asymmetry can be significantly reduced. Therefore, the final characteristic of the ASX process and its proposition is:

Characteristic 3 Goal Congruency and Information Symmetry: *the extent to which a virtual team's members are willing to exchange information and knowledge to benefit one another in order to achieve the common goals.*

Proposition 3: *Virtual teams that have higher extent of goal congruency and information symmetry will perform better in both knowledge creation and overall team effectiveness to achieve the common goals than virtual teams that have lower extent.*

Collectively, Adaptiveness, Simultaneity, and Goal Congruency and Information Symmetry are the characteristics of the ASX process, a knowledge creation processes in virtual teams. Figure 2 represents the ASX process and its characteristics. Unlike traditional teams, virtual teams can benefit much more if they appropriately adapt their social structure based on their technology choices. This paper suggests that unlike the SECI model in traditional context, the ASX process emphasizes both virtual team members' collaboration and knowledge creation as in socialization and externalization, two modes that can visibly benefit from technology choices if appropriately adapted. Nonetheless, this paper does not intend to ignore how combination and internalization might be different in virtual teams. This paper acknowledges and leaves that limitation for future researchers, because: firstly, the latter two modes are related to many more factors that are beyond the key socio-technical framework (trust and IT) of this paper. Secondly, as previously stated, as technology choices will affect not only virtual teams' interactions but importantly their knowledge creation processes as well, it is fair to suspect that such challenging issues as information security and self motivation to learn, as discussed in the first section, in combination and internalization may not be as significantly different in traditional teams as in virtual teams, compared to the difference in socialization and externalization.

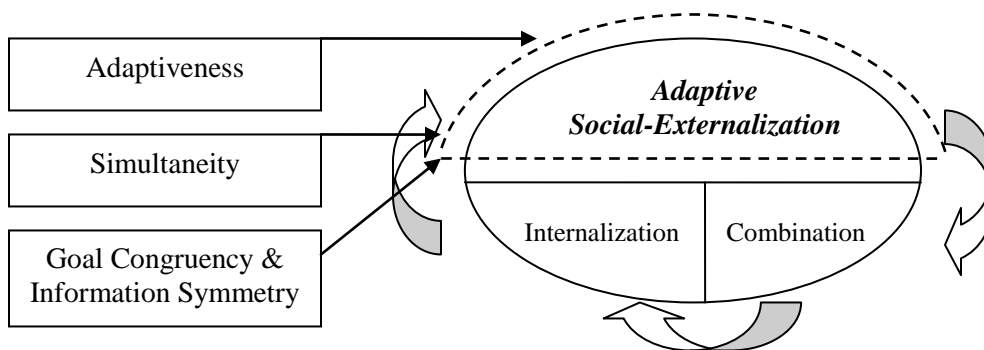


Figure 2: Adaptive Social-Externalization process and its characteristics

IMPLICATIONS AND CONCLUSION

This paper contributes to both researchers and practitioners. To researchers, first, this study fills in the existing gap on inadequate consideration of IT elements in both knowledge management and virtual team literature. Second, this paper should help stimulate the interest to study phenomena on virtual teams more theoretically. Third, the ASX process is a key contribution of this paper, and it can be used as a theoretical model of knowledge creation in virtual teams for future works. The characteristics of the ASX can be used to determine how well a virtual team will perform in its knowledge creation and overall performance. Scale development for those characteristics is encouraged. Empirical studies for the propositions are called for. Finally, this paper shows that socio-technical approach helps illuminate the nature of the knowledge management in virtual team phenomenon. Managers should acknowledge the importance of trust in both knowledge management and virtual teams. Rather than behavioral controls, trust management should be considered. Second, virtual team leaders should choose technologies that facilitate trust building, likely leading to better performance in both knowledge creation and overall team effectiveness. The integration of trust management and appropriate technology will improve knowledge management in virtual teams. In conclusion, using socio-technical lens, this paper considers trust and IT the underlying foundation of knowledge creation in virtual teams. Based on such foundation, this paper draws from multiple theories to propose a theoretical model of knowledge creation process in virtual teams, called Adaptive Social-Externalization. The key characteristics of the process are then derived and can be used to determine how well a virtual team will perform in both knowledge creation process and overall team effectiveness.

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