

Tacit knowledge sharing, self-efficacy theory, and application to the Open Source community

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Abstract

Purpose – The purpose of this paper is to apply the self-efficacy model to compare knowledge-sharing activities in the Open Source community versus those in a traditional organization.

Design/methodology/approach – Current literature on tacit knowledge sharing and information about the Open Source community is synthesized in the study with research concerning self-efficacy formation. The knowledge-sharing literature is applied in the paper to the self-efficacy model.

Findings – Through a synthesis of different streams of literature, the paper concludes that the self-efficacy model serves as a useful framework for better understanding the effects of context on tacit knowledge sharing. Furthermore, it is concluded that the Open Source community may provide an ideal set of subjects to whom the model can be applied.

Research limitations/implications – Only propositions are offered, and the conclusions are suggestions for future research. The self-efficacy model has been successfully applied to other areas of research in early stages (e.g. entrepreneurship) and provides a valid, tangible framework that allows many research possibilities.

Practical implications – The self-efficacy model is practical and usable in a real-world situation. A software manager (or other manager) can easily look at the inputs and outcomes of the model and see where he/she could positively affect tacit knowledge sharing.

Originality/value – This paper takes a highly valid and respected model and applies it to individual tacit knowledge sharing, a field in which little cross-discipline work is done. This paper bridges a central organizational behavior/psychological theory with knowledge management research.

Keywords Knowledge management, Open systems, Public domain software, Knowledge sharing

Paper type Research paper

Introduction

Highly complex, tacit knowledge can be a source of sustainable competitive advantage in organizations (Chen and Edgington, 2005; Grant and Baden-Fuller, 1995; Jashapara, 2003; López, 2005), especially in knowledge-based organizations such as software firms (Bryant, 2005). Complex, tacit knowledge is difficult to express and is often context specific, which provides the source of potential sustainability. However, due to its tacit quality, knowledge derived from the process of joint decisions is difficult to share with others outside the team, and may be difficult to study using research tools available today (Nonaka and Takeuchi, 1995). Tacit knowledge in this paper refers to the joint reasoning behind tradeoff decisions in software design work, such as in architecture, standards, and strategic intent. The software team must make these tradeoffs, but they are not expressed in the final written software source code.

Past knowledge sharing research focuses on causes and impediments, but not as much on how knowledge sharing results in individual or group performance (Haas and Hansen, 2005). Recently, however, a few researchers have looked specifically at knowledge sharing as a system of influences, resulting in outcomes such as performance, and the impacts of feedback on future knowledge sharing (Bock *et al.*, 2005; Haas and Hansen, 2005; Tsai and

“Self-efficacy theory provides a unique theoretical model that illustrates how individuals may be motivated to share complex, tacit knowledge.”

Tsai, 2005). The current paper expands on this research by using the self-efficacy model of motivation to explain knowledge-sharing behavior as a system of influence, outcomes, and feedback.

Because data or simple information only gains competitive value when integrated with individual experience (Dougherty, 1999), cognitive processes are central to the understanding of knowledge sharing. Most knowledge research is conducted at the organizational level (e.g., Chen and Edgington, 2005), leaving a fruitful ground for research on knowledge sharing at the individual level (Haas and Hansen, 2005; Tsai and Tsai, 2005). Furthermore, the current study seeks to build on the fact that more knowledge sharing research today focuses on interdisciplinary, theory-based frameworks (Jashapara, 2005; Ko *et al.*, 2005). Self-efficacy is one of the most validated and researched theory of motivation, across subject and task types (Bandura, 1997), and is an ideal theory to understand why people choose to share knowledge in some contexts and not in others.

Volunteer organizations or informal organizations outside normal firm boundaries may better facilitate fluid knowledge transfer at the individual level than within the traditional organization structure (Donaldson *et al.*, 2005), and extrinsic organizational rewards may exert a negative effect on one's intention to share knowledge (Bock *et al.*, 2005). Specifically, software developers in the Open Source software are presented as a prime example of voluntary and effective knowledge sharing (e.g., Shen, 2005), which may be explained by the inputs and rewards that differ in the Open Source versus traditional organizational structure (e.g., Bock *et al.*, 2005). Using Gist and Mitchell's (1992) self-efficacy model and recent research findings, a theoretical model is adapted to represent self-efficacy to share complex, tacit knowledge. Propositions and future research indications are offered.

Literature review

Creating and sharing complex knowledge

Complex knowledge sharing can be defined as transferring information that is specific to the organization (or group) and that involves subjective insights, intuitions, hunches, and know-how (Polanyi, 1969). The topic of organizational knowledge is often viewed as an extension of the resource-based theory of the firm. Organizational knowledge is considered a valuable resource and potential source of capabilities and competencies for innovations and new product development (Grant and Baden-Fuller, 1995). Knowledge consists of information, technology, know-how, and skills. Value and sustainability are created from the integration of these resources better than competitors.

Organizational knowledge is first acquired at the individual level (Polanyi, 1962). Effective transformation of knowledge from the individual to the organizational level is essential for knowledge to become the basis of organizational capability (Kogut and Zander, 1993). Knowledge creation is a spiraling process of interactions between explicit and tacit knowledge (Nonaka, 1994). There are four steps in the knowledge conversion process – socialization, externalization, combination, and internalization. Socialization is sharing of tacit knowledge between individuals, by spending time, activities, and actively working together on solving problems. Externalization involves the expression of tacit knowledge into comprehensible form. Combination is the conversion of explicit knowledge into a complex set of knowledge. Internalization results from the conversion of explicit knowledge into the organization's tacit knowledge.

Tacit-to-tacit, or person-to-person, knowledge transfer is the most effective way to share tacit, complex knowledge (Lee, 2000). Person-to-person knowledge sharing is also more likely to be internalized by the receiver than, for example, person-to-document-to-person knowledge transfer. Tacit knowledge transfer may be in spoken word, but also could occur through body language or other actions. Tacit knowledge sharing in software development organizations may include activities such as team discussions, helping others adapt to customer requirements, team-to-team knowledge transfer, updating other team members on technologies or tasks, or sharing information on how to be successful or most productive on a project (Bryant, 2005).

Theorists have defined important facets of knowledge to be tacitness, dependence, and complexity (Garud and Nayyar, 1994). First, complex knowledge is tacit in that it is highly personal and hard to express in codes (words, numbers, programming languages, etc.), as compared to explicit knowledge that is easy to express and quantify (Polanyi, 1969). Tacit knowledge is found in subjective insights, intuitions, hunches, and know-how, and can often only be acquired through experience (Nelson and Winter, 1982; Berman *et al.*, 2002; Polanyi, 1966). The tacit nature of knowledge may stem from technical processes (personal skills and know-how) or may emerge from cognitions that are more difficult to express and, therefore, share with others (ideals, values, and mental models). However, information only becomes valuable as knowledge when it is combined with personal experience (Dougherty, 1999). In essence, tacit knowledge only exists because of people and their limited ability to understand other's experiences through language alone.

Second, complex knowledge is also dependent on context (part of a system of knowledge). Knowledge that is highly dependent on context is sometimes referred to as specific knowledge (Jensen and Meckling, 1992). The extent to which the knowledge is embedded in a specific context (specific organizational situation, specific individual situation) determines its dependence. Highly dependent knowledge can only be described in relation to a whole body of knowledge. In contrast, independent knowledge can be described by itself. Diffusion of independent knowledge is easier than that of dependent knowledge. Context has been used to more effectively transfer complex, tacit knowledge (Gick and Holyoak, 1987). For example, Gick and Holyoak proposed that using a relevant and familiar context aids in knowledge transfer.

The most difficult type of knowledge to transfer is highly complex, non-technical (from cognitions), and dependent knowledge (Teece, 1977; Zander and Kogut, 1995). This type of knowledge is resistant to imitation, possibly for long time periods. For such knowledge to become a source of competitive advantage, it must be shared throughout the organization. Therefore, the sharing of difficult-to-transfer, complex knowledge within the organization becomes an important activity.

Individual cognitions and complex, tacit knowledge sharing

Self-efficacy in complex tasks. As mentioned above, one of the most complex forms of knowledge sharing is that which is dependent on individual cognitions. In order to understand why and how individuals choose to share tacit knowledge, their motivation must be understood. The motivation sequence, motivation hub, and motivation core (Locke, 1991) combines the most validated and widely-researched group of motivational concepts into a simple model.

Assigned goals, personal goals, and self-efficacy interrelate to affect performance (Locke, 1991). Self-efficacy, or one's belief in the ability to perform a specific task, is the central cognitive mediator of the motivational process (Bandura, 1997) and is the focus of this discussion. Self-efficacy provides a theoretically sound context in which tacit, cognition-based knowledge can be analyzed. The construct has been validated to predict action and attitudes in a variety of contexts and sample types, and is a predictor of action in highly complex tasks, also (e.g., Bandura and Wood, 1989a, b; Dulebohn, 2002; Kuhn and Yockey, 2003; Quiñones, 1995; Stock and Cervone, 1990; Stone, 1994). Therefore, it can be assumed that self-efficacy in the ability to share complex, tacit knowledge would predict actual knowledge-sharing activity.

The process of self-efficacy formation provides useful information into how people may decide to share tacit, complex knowledge. Self-efficacy perceptions are formed through a judgment process that people engage in when deciding whether they can execute an action based on the influence of contextual and personal factors (Bandura, 1997). When people develop self-efficacy perceptions about performance in a specific area, these perceptions are incorporated into their belief systems. The process involves what could be categorized as double-loop learning (Argyris and Schön, 1978), or reframing central beliefs about one's ability based on performance feedback.

Self-efficacy is a proven mediator of the relationship between input variables such as assigned goals or persuasion, and outcome variables such as effort, personal goal setting, and performance (Bandura and Locke, 2003). When studying why people behave a certain way, self-efficacy can be easily and validly measured (Bandura, 1995). Self-efficacy in the ability to share knowledge should predict actual knowledge sharing behavior.

The Gist and Mitchell (1992) model in Figure 1 shows the four primary ways to alter self-efficacy (enactive mastery, vicarious experience, verbal persuasion, physiological arousal). Individuals then estimate their self-efficacy in a certain task by analyzing the task characteristics, their personal experience, and the personal/situational resources and constraints involved. Once an estimation of self-efficacy is made for the given task, personal goals are set and effort is made toward task performance. Feedback then influences self-efficacy reformation in future attempts at the task.

Application of self-efficacy theory to tacit knowledge sharing. Figure 2 illustrates the application of Gist and Mitchell's (1992) model to complex, tacit knowledge sharing behavior. Self-efficacy to share complex, tacit knowledge should increase under certain conditions: viewing others like oneself successfully share knowledge (vicarious experience); actually having the opportunity to successfully share knowledge (enactive mastery); and/or receiving praise or encouragement from others to share knowledge (persuasion).

In an attributional analysis, a person is positively or negatively prompted to consider his/her capability based on the environment, task, and beliefs about ability (which may be perceived or objective). For example, a good model may discuss how to present tacit knowledge to others, give examples, and role play the process. In fact, knowledge in technical work is often learned from co-workers or mentors (Bryant, 2005; Das, 2003; Hildreth *et al.*, 2000). For example, Bryant (2005) found that peer mentoring increased knowledge sharing in a high-tech software firm. Organizations should help individuals effectively use "the 'vicarious' experience of their peers" (Das, 2003, p. 430). Bock *et al.* (2005) used the Theory of Reasoned Action (TRA) to explain one's intentions to share knowledge. The authors found that employees will intend to share knowledge if they expect

Figure 1 Theoretical model of the antecedents and effects of self-efficacy perceptions

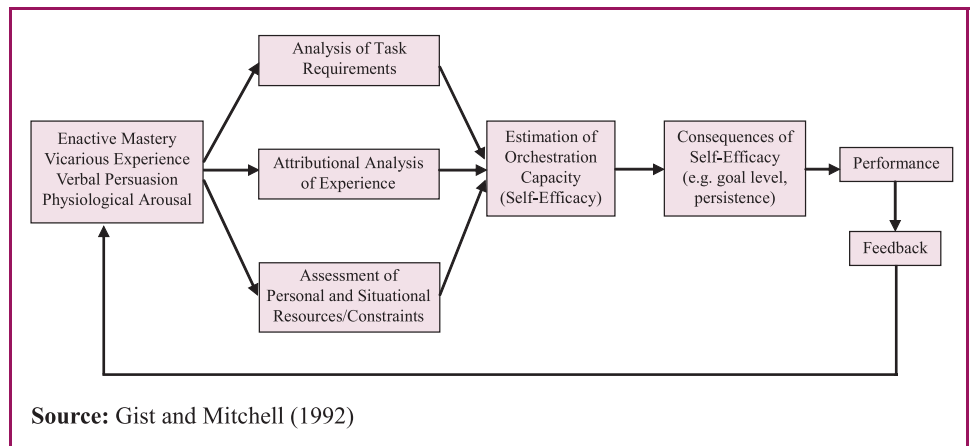
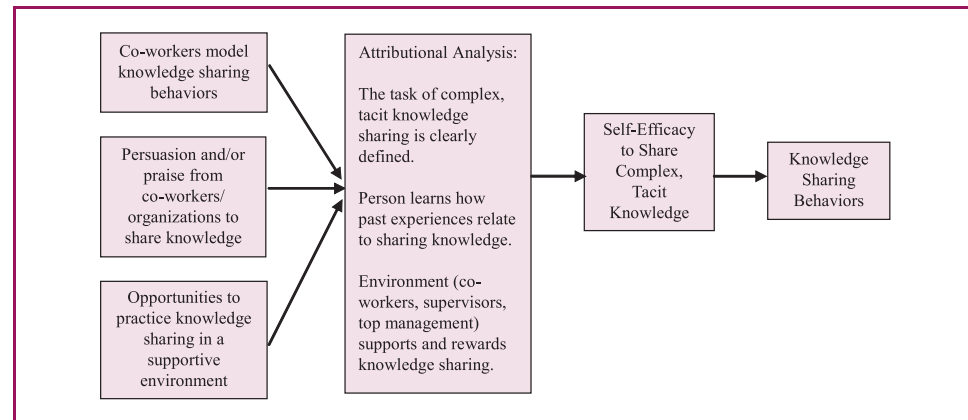


Figure 2 Gist and Mitchell's self-efficacy model adapted to individual complex, tacit knowledge sharing



reciprocal knowledge sharing from coworkers or if they perceive that the organization's norms of behavior include knowledge sharing.

The second way to raise self-efficacy to share complex, tacit knowledge is a person's direct past experiences. Das (2003) suggested that organizations should facilitate employees drawing on their own past experiences to harness and share knowledge. For example, effective training may promote sharing past successful knowledge sharing experiences or uncovering related skills that can enhance knowledge sharing, such as emotional intelligence, empathy, and active listening skills.

Last, persuasion should increase tacit knowledge sharing. Support may be through praise, recognition, performance appraisals that include measures of knowledge sharing behaviors, or goals that are motivating. In the software community, motivation to freely share expertise may be increased respect and a reputation as an "expert" (Wasko and Faraj, 2005). A persuasive environmental stimulus may be senior management's support of knowledge sharing activities (Lin and Lee, 2004). In a survey of Taiwanese senior managers, the authors showed that a supportive supervisor and his/her attitude toward knowledge sharing behavior positively influenced intentions to encourage knowledge sharing. Other researchers also found that senior management support is essential to promote knowledge sharing (e.g., Gupta and Govindarajan, 2000; Macneil, 2001; Hislop, 2003).

When external information from persuasion, mastery experiences, or role models provide evidence that one can perform a task such as tacit knowledge sharing, a person then analyzes the environment and the self to determine self-efficacy. In other words, the person must not only believe in his/her ability, but also in his/her support system.

High self-efficacy in one's ability to share tacit knowledge then may result in challenging personal goals, as well as higher effort, persistence, satisfaction, and performance (Bandura, 1997). These positive outcomes fuel the self-beliefs that one can perform even better when self-efficacy is estimated again. This double-loop learning process that appears in the self-efficacy model has been found to occur in individual knowledge sharing activities (Jashapara, 2003). Specifically, Jashapara investigated UK construction firms' use of organizational learning and found that the occurrence of double-loop learning positively affects organizational performance.

The importance of organizational context. People analyze their environmental support when forming self-efficacy and the organizational environment is a critical factor that affects knowledge sharing (Donaldson *et al.*, 2005). Research supports that persuasion, or support through the social environment, leads to effective knowledge sharing (e.g., Donaldson *et al.*, 2005; Jashapara, 2003). When individuals are embedded in a strong social network, they are motivated to more freely share knowledge (Wasko and Faraj, 2005). The importance of

social context on knowledge sharing is found in research on networking theory (Hildreth *et al.*, 2000). For example, research has linked power relationships (Dovey and White, 2005), support from other organizational members (Lin and Lee, 2004), and subjective norms (Bock *et al.*, 2005) to complex knowledge sharing.

Researchers, then, have asked what kind of social context best facilitates complex knowledge sharing. Donaldson *et al.* (2005) discovered that volunteer organizations may provide higher levels of support systems than traditional organizations, thus better facilitating the development of knowledge sharing self-efficacy. Contrary to expectations, Bock *et al.* (2005) found that extrinsic reward structures negatively impacted intentions to share knowledge. These two studies suggest that volunteer organizations with strong social networks and no formal extrinsic reward structure may result in the most effective tacit knowledge sharing activity.

In order to study individual self-efficacy to share complex, tacit knowledge and the importance of organizational context, subjects with two different work contexts would be ideal. These subjects would share tacit knowledge as a major part of their work. This group of subjects would belong to two distinct work groups, one in which knowledge sharing is prevalent, and one in which knowledge sharing encounters more barriers. People who fit these criteria are software engineers who belong to the Open Source software community. These individuals are professionals who are asked to share knowledge about software coding as a primary part of their jobs, and also share knowledge voluntarily with groups of non-paid software engineers in the Open Source community (www.opensource.org). The next section describes the Open Source community and differences with the traditional organization. These differences then illustrate what aspects of context may increase individual self-efficacy to share knowledge in organizations.

The Open Source software community and knowledge sharing

The purpose of the “Open Source” software community is essentially knowledge sharing and collaboration (Shen, 2005). The central Open Source Initiative (OSI) states that the goal of the Open Source community is to develop, distribute, redistribute, and share source code of software that benefits individuals and organizations, with no discrimination and with restricted licensing (www.opensource.org). “Software developed with a General Public License (GPL) creates the freedom for people to copy, study, modify and redistribute software. It forbids anyone to forbid others to copy, study, modify and redistribute the software” (Shen, 2005, p. 27).

Software coding practices and methods would be considered complex, tacit knowledge which is difficult to express and codify (Walz *et al.*, 1993). Efficient, peer-to-peer knowledge sharing is the cornerstone of the open source community. “Open source promotes software reliability and quality by supporting independent peer review and rapid evolution of source code” (www.opensource.org/advocacy/faq.php). Koch and Schneider (2002) found that in one large-scale Open Source project, although individuals worked in “relative isolation” from one another on modules, that the network involving group work was critical. The project involved a total of 52 developers, but a group of 11 developers formed a core of the development activity. This subgroup made the tradeoffs in design, phasing, and quality of the overall project through richer collaboration.

Knowledge sharing plays a central role in the Open Source community practices (Shen, 2005) and complex social relationships are formed among Open Source participants (e.g., Bergquist and Ljungberg, 2001). In fact, researchers state that “the success of an open source project will clearly depend on the clarity of the shared vision of the goals of the software” (Coyle, 2002, p. 33). In fact, many of the more recent team-based software management processes emphasize collaboration among team members. For example, “Extreme Programming” is a list of collaborative activities used by successful teams, and is designed to create shared vision (www.extremeprogramming.org/). The vision is illustrated through active assertions or tests made by those for whom the software is being designed.

The OSI proposes to make software available freely so that rapid progress is more easily made to improve it, for the better of all consumers. Well-known Open Source projects include the Linux operating system, Apache server software, Python coding language, and OpenSSL system secure communication software. The OST over the last 30 + years is responsible for some of the most widely-used and dependable software packages available (Bretthauer, 2002).

Jorgensen (2001) surveyed Open Source software developers and found that approximately 43 percent developed Open Source software for their employers and were paid (Jorgensen, 2001). However, over half were part of groups that were unpaid and separate from their workplaces. For example, Shen (2005) reported that a group at University of California, Berkeley, developed a series of Open Source operating systems for the PC and Macintosh. One can apply to be a part of an Open Source development project, or membership may be based on affiliation (such as with the university). The individuals may be paid employees of an organization, but also unpaid members of an open source development group.

Membership in these groups is voluntary, and the software developed only becomes affiliated with the OSI if it is granted an OSI Certification. This certification is granted after an application process and examination of licenses (www.opensource.org). Although members of open source software development projects are unpaid, a person may acquire some degree of status in the software community as a result of “free” knowledge sharing activities (Wasko and Faraj, 2005). In addition to status, members of the Open Source community may have the opportunity for financial gain based on their in-demand persona in the software arenas (Fitzgerald and Feller, 2001). The reward is not formal or assured, but may be a motivator to participate.

In contrast to the free and fluid flow of tacit knowledge in the Open Source community, knowledge sharing is often limited in organizations, especially knowledge that is complex and tacit (Donaldson *et al.*, 2005). Donaldson *et al.* (2005) investigated a volunteer organization, a UK charity, with a high degree of knowledge sharing among its members. The authors suggested that groups that are not a part of the organizations formal structure, but that extend outside normal boundaries, are not managed like other teams inside the formal structure. The informal process between individuals’ results in a more fluid sharing of knowledge, especially that which incorporates tacit, individual experiences.

In summary, the study of individual knowledge sharing is most difficult when the knowledge is tacit, complex, and dependent on context (Garud and Nayyar, 1994). Because members of the Open Source community report as their central goal to share tacit, complex knowledge, the context that supports this behavior is of interest. More than half of this unique group of individuals belongs to another context in which they are asked to share tacit, complex knowledge – the traditional, often hierarchical and bureaucratic, organization. By comparing individual self-efficacy to share complex, tacit knowledge in the Open Source versus traditional organizational contexts, researchers may add to the knowledge of how and why knowledge sharing occurs. Literature suggests that the traditional organization differs from the Open Source less formal organization and these differences can be investigated as predictors of self-efficacy to share knowledge. Specific propositions follow in the next section.

Propositions

Based on the literature review presented here, propositions were developed for a future study. Subjects for the proposed study would include software developers who are paid to

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work for an employer, and who are also voluntary members of a software project developed for the Open Source community. The method for gathering data should be through surveys, e-mailed to subjects because they would most likely be scattered throughout the world. In the following propositions, “traditional” work community is defined as the subject’s place of paid employment.

First, organizational context should predict self-efficacy to share complex, tacit knowledge. Researchers suggested that volunteer organizations have the important contextual difference from traditional organizations of more fluid knowledge flow (Donaldson *et al.*, 2005). Therefore, it is proposed that organizational context will distinguish whether individual self-efficacy to share knowledge is increased or decreased:

- P1. Organizational context will predict self-efficacy to share complex, tacit knowledge.
- P2. Subjects will have a higher self-efficacy to share complex, tacit knowledge in their open source group versus in their traditional work community.

Self-efficacy research strongly supports that self-efficacy to share complex, tacit knowledge will positively predict the action of sharing tacit knowledge (e.g., Bandura, 1997). The measurement of tacit knowledge sharing is difficult (Lee, 2000). Social network analysis is one method for measuring tacit knowledge sharing (e.g., Tsai, 2002).

- P3. Self-efficacy to share complex, tacit knowledge will positively predict knowledge sharing.

Self-efficacy theory also supports that self-efficacy mediates the relationship between environmental context variables and action (Gist and Mitchell, 1992). Therefore, the following is proposed:

- P4. Self-efficacy to share complex, tacit knowledge will mediate the relationship between organizational context and knowledge sharing.

Conclusions and implications

In conclusion, self-efficacy theory provides a unique theoretical model that illustrates how individuals may be motivated to share complex, tacit knowledge. The value of the model is not only in its strong validity and predictive power for actual knowledge sharing activities, but also in its detail of the cognitions that are affected by external influences. Specifically, researchers have found that knowledge sharing is enhanced by the same external influences used to raise self-efficacy – enactive mastery, vicarious experience, and persuasion. Self-efficacy theory suggests that people consider the complexity of the knowledge sharing task, their own personal ability and experiences that may affect their personal ability to share tacit knowledge, and the degree of support their environment provides for knowledge sharing. The source of the environmental support may be supervisors or co-workers in a social network.

Therefore, the context of the organization or group is central in affecting the formation of self-efficacy to share tacit knowledge, and context is specifically also stated as a key component of tacit knowledge-sharing behavior as well (Garud and Nayyar, 1994). A specific example is provided in software development activities, which researchers have stated rely specifically on complex, tacit knowledge-sharing activities (Bryant, 2005). It is proposed that the effects of context on individual knowledge sharing may best be illustrated by a comparison of a software developer who belongs to two distinct work contexts – one unpaid, volunteer organization and one paid, traditional work structure. The Open Source software community members are unique in that they freely give their time and talents to the development of free software that is made available to all, but who also may be employed in a traditional, more formal organization as paid workers. Researchers have suggested that volunteers and, specifically, those who give “free” advice and help on IT issues through internet groups participate in a higher degree of tacit, complex knowledge sharing than workers in more formal organizational structures (e.g., Donaldson *et al.*, 2005; Wasko and Faraj, 2005). Social networks that operate outside organizational boundaries are also

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suggested to involve more tacit knowledge-sharing activities, as would be the case of the Open Source community members.

If subjects do have stronger self-efficacy in their ability to share complex, tacit knowledge in the Open Source community versus at their traditional work places, future researchers may ask why this takes place. Additional data may be gathered concerning the outcomes these subjects value (status, pay, praise) and how these are tied to their knowledge sharing activities in each work context.

Data may also be gathered that indicate the role of personal goals and assigned goals in affecting self-efficacy to share knowledge, following the motivation hub theory (Locke, 1991). It may be that the complexity involved in tacit knowledge sharing distorts traditional organizational goals that are standardized and formalized (e.g., Taylor *et al.*, 1992). Even valuable outcomes such as additional pay or praise may be viewed as unattainable because the formal organizational goals may be perceived to be impossible.

Another fruitful line of research is the generalization of the individual knowledge sharing practices to the organizational knowledge gained, and furthermore, to the organization's profitability. Although researchers have linked the importance of knowledge sharing to success in organizations (Grant and Baden-Fuller, 1995; Jashapara, 2003; López, 2005), including software firms (Bryant, 2005), little research is now conducted linking individual activities to the organizational level (Haas and Hansen, 2005). In addition, the assumption of much knowledge management research is that knowledge sharing is necessary and positive (Haas and Hansen, 2005). However, this may not be the case in some organizations, and it is necessary to delineate between types of employees that must employ tacit knowledge sharing from those who may not need to.

Another consideration is the inherent co-occurrence of informal and formal social networks in organizations (Lee, 2000). In a given organization, tacit-to-tacit knowledge sharing may occur in some groups but not in others. In addition, some informal, strong social networks that effectively transfer knowledge may be embedded in otherwise formal structures. Therefore, it is very important to use random sampling methods and control for organizational variables such as size.

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