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# Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories

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**Abstract**

The biggest challenge in fostering a virtual community is the supply of knowledge, namely the willingness to share knowledge with other members. This paper integrates the Social Cognitive Theory and the Social Capital Theory to construct a model for investigating the motivations behind people's knowledge sharing in virtual communities. The study holds that the facets of social capital — social interaction ties, trust, norm of reciprocity, identification, shared vision and shared language — will influence individuals' knowledge sharing in virtual communities. We also argue that outcome expectations — community-related outcome expectations and personal outcome expectations — can engender knowledge sharing in virtual communities. Data collected from 310 members of one professional virtual community provide support for the proposed model. The results help in identifying the motivation underlying individuals' knowledge sharing behavior in professional virtual communities. The implications for theory and practice and future research directions are discussed.


*Keywords:* Knowledge sharing; Outcome expectations; Social capital; Social cognitive theory; Virtual communities

## 1. Introduction

The proliferation of network access has facilitated the rapid growth of virtual communities. The impact of virtual communities is increasingly pervasive, with activities ranging from the economic and marketing to the social and educational [70]. Many individuals participate in virtual communities, especially in professional virtual communities (i.e., virtual communities of practice: CoPs), for seeking knowledge to resolve problems at work. According to the BUSINESS WEEK/Harris Poll, 42% of those involved in a virtual community say it is related to their profession [38]. Driven by a knowledge economy, many organizations have recognized knowledge as a valuable intangible resource that holds the key to competitive advantages [33] and begun to support the development and growth of CoPs to meet their business needs and objectives. For example, Caterpillar Inc. — a *Fortune* 100 manufacturer of construction and mining equipments, launched its Knowledge Network as a Web-based system delivered via Internet to 12 CoPs in 1999 [61]. Now, Caterpillar's Knowledge Network thrives with 3000 tightly focused CoPs. Such a project has been successful, showing a 200% return-on-investment (ROI) and more than 700% ROI for its external

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communities. Information technology (IT) industry has also gained positive feedbacks from virtual communities. Davis Dorbin, an analyst at B2B Analysis Inc., pointed out that Java has succeeded partially because it has global virtual communities where developers can trade notes and share codes [68].

However, without rich knowledge, virtual communities are of limited value. Jay Marathe, the head of consulting at Durlacher Research Ltd, pointed out that content (i.e., knowledge) of virtual communities is the king [41]. The significance of member-generated content cannot be over-emphasized. Though difficult to stimulate, it is this characteristic more than any other that defines the virtual community [34]. Clearly, the biggest challenge in fostering a virtual community is the supply of knowledge, namely the willingness to share knowledge with other members. It is then important to explain why individuals elect to share or not to share knowledge with other community members when they have a choice. Identifying the motivations underlying the knowledge sharing behavior in virtual communities would help both academics and practitioners gain insights into how to stimulate knowledge sharing in virtual communities. To this end, two complementary social theories are applied: the Social Cognitive Theory and the Social Capital Theory.

The Social Cognitive Theory [9,10] has been widely applied in the information systems (IS) literature with demonstrated validity. The theory defines human behavior as a triadic, dynamic, and reciprocal interaction of personal factors, behavior, and the social network (system). Of all the factors that affect human functioning, and standing at the core of the theory, are self-efficacy and outcome expectations. Self-efficacy is "a judgment of one's ability to organize and execute given types of performances," whereas an outcome expectation is "a judgment of the likely consequence such performances will produce" ([11], p. 21). Several recent studies drawing upon the Social Cognitive Theory have examined the relationship between personal cognition, i.e., self-efficacy and/or outcome expectations, and computer use and Internet behaviors [23,40,39,50].

Virtual communities are online social networks in which people with common interests, goals, or practices interact to share information and knowledge, and engage in social interactions. It is the nature of social interactions and the set of resources embedded within the network that sustains virtual communities. Therefore, studies on virtual communities address issues related to both personal cognition and social network and should be different from the aforementioned studies concerning computer use and Internet behaviors, which focus only on personal cognition. However, the Social Cognitive Theory is limited in addressing what components are within a social network and how they influence an individual's behavior, necessitating the introduction of additional theory as the foundation for exploring the impact of social network on knowledge sharing in virtual communities. Consequently, the Social Capital Theory is introduced to supplement the Social Cognitive Theory to address our research questions.

The Social Capital Theory suggests that social capital, the network of relationships possessed by an individual or a social network and the set of resources embedded within it, strongly influence the extent to which interpersonal knowledge sharing occurs [55]. Bandura [10] also argues that individuals' behavior is a product of their social network. Through close social interactions, individuals are able to increase the depth, breadth, and efficiency of mutual knowledge exchange [45]. Nahapiet and Ghoshal [55] define social capital with three distinct dimensions: structural (the overall pattern of connections between actors), relational (the kind of personal relationships people have developed with each other through a history of interactions), and cognitive (those resources providing shared representation, interpretations, and systems of meaning among parties).

The study draws on both the Social Cognitive Theory and the Social Capital Theory to investigate the influence of outcome expectations and facets of the three dimensions of social capital on the knowledge sharing in virtual communities in terms of quantity and quality. Following Nahapiet and Ghoshal [55], the structural dimension of social capital is manifested as social interaction ties, the relational dimension is manifested as trust, norm of reciprocity and identification, and the cognitive dimension is manifested as shared vision and shared language. Following Compeau and Higgins [23], two types of outcome expectations concerning knowledge sharing are identified: community-related and personal. The professional virtual community under study is a global virtual community that can be accessed by its members via the Web and the knowledge sharing is voluntary. In a voluntary setting, individuals who have no confidence in their ability to share knowledge would be unlikely to perform the behavior. Therefore, the research model does not include self-efficacy. The proposed theoretical model is shown in Fig. 1.

This paper makes three key contributions. First, it extends the concept of outcome expectation to include both personal and community-related outcome expectations. This study emphasizes that not only expectation of personal benefits but also expectation of benefits to professional virtual communities can stimulate knowledge

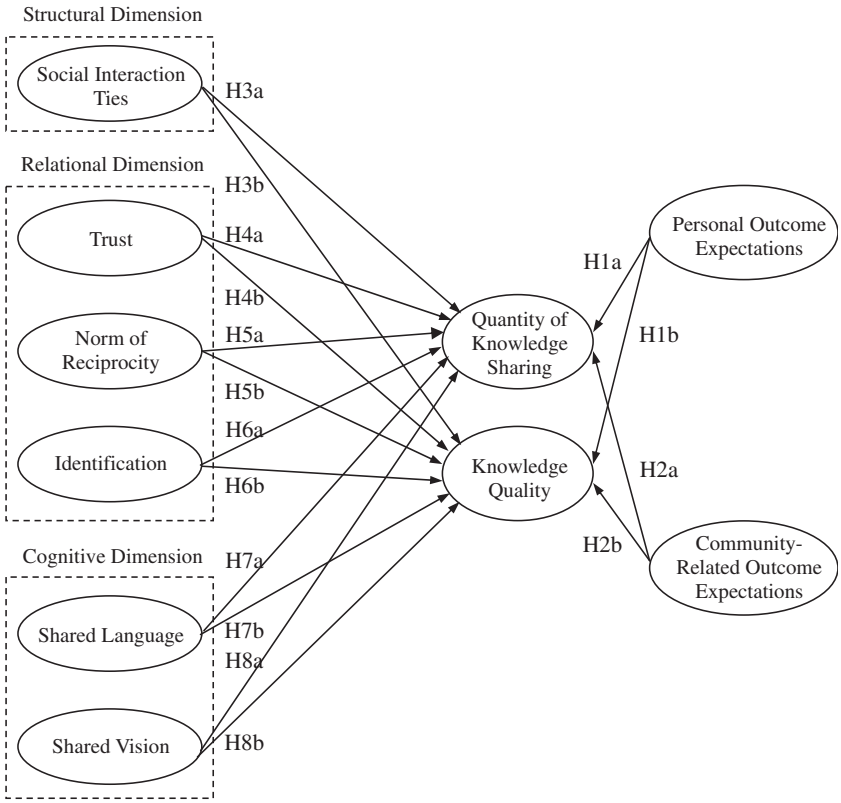


Fig. 1. Research model for knowledge sharing in virtual communities.

sharing. Second, to the best of our knowledge, this is the first study that completely follows Nahapiet and Ghoshal's [55] manifestations of the three dimensions of social capital and applies them to the study of knowledge sharing in a professional virtual community, reflecting more accurately the important facets of social capital in studying knowledge sharing in professional virtual communities. Third, while previous research has predominately focused on personal cognition or social network, the study examines the integrated influence of outcome expectations and social capital on knowledge sharing in virtual communities. In sum, by explicating the unique role of social capital and outcome expectations, this paper aims at contributing to the continued development and success of virtual communities in general.

## 2. Theoretical background

### *2.1. Social Cognitive Theory and knowledge sharing*

People who come to a virtual community are not just seeking information or knowledge and solving problem; they also treat it as a place to meet other people, to seek support, friendship and a sense of belongingness [4,80]. In other words, they attempt to develop social relationships with other people inside the community [81]. According to the Business Week/Harris Poll, 35% of those involved in a virtual community say their community is a social group [38].

The Social Cognitive Theory argues that a person's behavior is partially shaped and controlled by the influences of social network (i.e., social systems) and the person's cognition (e.g., expectations, beliefs) [10]. Bandura advances two types of expectation beliefs as the major cognitive forces guiding behavior: outcome expectations and self-efficacy. During the past decade, studies in the information systems (IS) literature have demonstrated the importance of self-efficacy and outcome expectations for predicting and improving computer training performance, computer usage, and Internet behaviors. According to Bandura [8], if individuals were not confident in their ability to share knowledge, then they would be unlikely to perform the behavior, especially when knowledge sharing is voluntary. Consequently, self-efficacy is not considered in this study.

Researchers interested in understanding the motivations prompting people to share knowledge or participate

in virtual communities have shown the importance of social influences. They have focused on impersonal configuration of linkages between people or units (e.g., community ties or social interaction) and assets that are rooted in the network of relationships (e.g., trust, norms, and identification). For example, strong community ties could provide important environmental conditions for knowledge exchange [67,76]. Langerak et al. [46] concluded that satisfaction with member–member interactions and organizer–member interactions have positive effects on member participation. Trust has been identified as a key element in fostering the level of participation or knowledge sharing in virtual communities [5,64]. Dholakia et al. [26] found that group norms have a strong effect on we-intentions (group intentions) to participate in virtual communities. Kankanhalli et al. [42] found that reciprocity is positively related to the usage of electronic knowledge repositories by knowledge contributors under conditions of weak pro-sharing norms. Bock et al. [17] found that anticipated reciprocal relationships have a positive effect on attitude toward knowledge sharing and subjective norm has a positive effect on intention to share knowledge. Furthermore, some studies found that a sense of community [36,79] and social identity [26] can enhance the likelihood of members' contribution and participation in a virtual community.

Prior studies drawing upon the Social Cognitive Theory have ignored the importance of social network influence, while studies in the virtual community literature have paid less attention to the role of personal cognition, such as outcome expectations. According to the Social Cognitive Theory, the question — why do individuals spend their valuable time and effort on sharing knowledge with members in virtual communities, should be addressed from the perspectives of both personal cognition and social network. Yet the Social Cognitive Theory is silent concerning what resources are embedded within a social network and how they affect an individual's behavior. Consequently, the Social Capital Theory is introduced to supplement the Social Cognitive Theory to address our research question.

### 2.2. Social Capital Theory and knowledge sharing

The tenet of the Social Capital Theory is that social relationships among people can be productive resources [21]. Putnam [62] suggested that social capital facilitates coordination and cooperation for mutual benefit. Social capital has been defined as "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" ([55], p. 243). Building on Nahapiet and Ghoshal [55], Tsai and Ghoshal [73] empirically justified how social capital facilitates resource exchange and production innovation within the organization, while Yli-Renko et al. [78] examined the effects of social capital on knowledge acquisition and exploitation in young technology-based firms. However, virtual communities differ notably from organizational settings since interaction among community members is through online communication. Consequently, whether the impact of social capital on resource exchange and knowledge management activities found in the organizational settings could be generalized to virtual communities is still unclear.

Putnam [63] suggested that the Internet decreases social capital, while Wellman et al. [77] indicated that Internet use supplements social capital by extending existing levels of face-to-face and telephone contacts. Uslaner [74] concluded that the Internet neither destroys nor creates social capital. Members in virtual communities differ from general Internet users in that virtual community members are brought together by shared interests, goals, needs, or practices. This begs the key question — whether the social capital developed in virtual communities is strong enough to stimulate members to overcome the barriers of complex knowledge sharing process, and then share valuable knowledge, especially when no extrinsic reward is provided. By following the theory proposed by Nahapiet and Ghoshal [55], a theoretical model is developed to address the question, as shown in Fig. 1.

Of direct relevance to this study is the work of Wasko and Faraj [75]. They examined how individual motivations and social capital influence knowledge contribution in electronic networks of practice. There are three notable differences between the research model of this study and that of Wasko and Faraj in terms of independent variables (individual motivations and facets of social capital) and the dependent variable (knowledge sharing). First, Wasko and Faraj [75] addressed individual motivations (expectation of personal benefits) in terms of reputation and enjoy helping. Our measure for personal outcome expectations also contains items for measuring reputation and enjoy helping. This study, however, also examines individual motivations in terms of community-related outcome expectations (i.e., expectation of benefits to the virtual community), which was ignored by Wasko and Faraj. Second, Wasko and Faraj [75] followed Nahapiet and Ghoshal [55] to classify social capital into three dimensions (structural, relational, and cognitive) but did not adopt Nahapiet and Ghoshal's [55] manifestations of each of these dimensions. This study follows Nahapiet

and Ghoshal's manifestations of each of these dimensions. Finally, they measured knowledge contribution in terms of helpfulness and volume of contribution, while we measured knowledge sharing in terms of quality and quantity. In Wasko and Faraj's study, the response messages were reviewed by one of the authors and a domain expert to assess the helpfulness. In this study, the quality of knowledge sharing (knowledge quality) is a self-report measure.

## 3. Hypotheses

Virtual communities differ notably from conventional organizations. There is no concrete reward system in place to reinforce the mechanisms of mutual trust, interaction, and reciprocity among individuals. However, online knowledge sharing activities cannot be successful without the active participation of online members. Lack of motivation from a knowledge contributor impedes the knowledge sharing. Under such circumstances, social capital becomes all the more important, because the resources inherent in the online social network mediate between the individuals and hence foster their intention and activeness to perform this voluntary behavior.

Following Nahapiet and Ghoshal's theoretical model, we define social capital in terms of three distinct dimensions: structural, relational, and cognitive. Among the most important facets of the structural dimension is the presence or absence of social interaction ties between actors [66,68]. Among the most key facets of the relational dimension are trust [20,29], norm of reciprocity [63], and identification [55]. Among the most key facets of the cognitive dimension are shared vision [20,73] and shared language [55]. In addition to social capital, knowledge contributors' outcome expectations are also important in explaining knowledge sharing in virtual communities. Following Compeau and Higgins [23], we identified two types of outcome expectations concerning knowledge sharing: community-related and personal. Note that the outcome expectation constructs in our model are post-use constructs, which are formed based on the experience of initial usage. In what follows, we discuss how community-related outcome expectations, personal outcome expectations, and each of the six facets of social capital facilitates knowledge sharing.

### 3.1. Community-related and personal outcome expectations

Outcome expectations refer to an individual's belief that task accomplishment leads to a possible outcome. In this study, community-related outcome expectations refer to a knowledge contributor's judgment of likely consequences that his or her knowledge sharing behavior will produce to a virtual community, while personal outcome expectations refer to the knowledge contributor's judgment of likely consequences that his or her knowledge sharing behavior will produce to him or herself. According to the Social Cognitive Theory, individuals are more likely to engage in the behavior that they expect to result in favorable consequences. Several studies in IS research provided support for this contention. One study found that performance-related outcome expectations had a significant effect on computer use [23]. Another study found that outcome expectations were significantly related to computer end-user's organizational commitment [69].

Some studies [4,80] suggested that individuals would share knowledge within virtual communities with the expectations of enriching knowledge, seeking support, making friends, etc. Butler et al. [18] suggested that the primary reason for individuals to share knowledge is their expectation of being seen as skilled, knowledgeable or respected. Other studies suggested that individuals share knowledge with the expectation of helping the virtual community to accumulate its knowledge, continue its operation, and grow [16,44,48]. Thus Hypotheses 1a, 1b, 2a and 2b are as follows:

**H1a.** Members' personal outcome expectations are positively associated with their quantity of knowledge sharing.

**H1b.** Members' personal outcome expectations are positively associated with the quality of knowledge shared by them.

**H2a.** Members' community-related outcome expectations are positively associated with their quantity of knowledge sharing.

**H2b.** Members' community-related outcome expectations are positively associated with the quality of knowledge shared by them.

### 3.2. Social interaction ties

Tsai and Ghoshal [73] considered social interaction ties (network ties) as channels for information and resource flows. Granovetter [32] described tie strength as a combination of the amount of time, the emotional intensity, and intimacy (mutual confiding), and the reciprocal services that characterize the tie. In this study, social interaction ties represent the strength of the

relationships, and the amount of time spent, and communication frequency among members of virtual communities. Nahapiet and Ghoshal [55] argued that "the fundamental proposition of the Social Capital Theory is that network ties provide access to resources" (p. 252). Larson [47] and Ring and Van de Ven [65] noted that the more social interactions undertaken by exchange partners, the greater the intensity, frequency, and breadth of information exchanged. Knowledge is important in providing a basis for action but is costly to obtain. The social interaction ties among members of a virtual community allow a cost-effective way of accessing a wider range of knowledge sources. Nahapiet and Ghoshal [55] argued that "network ties influence both access to parties for combining and exchanging knowledge and anticipation of value through such exchange" (p. 252). Furthermore, network ties provide the opportunity to combine and exchange knowledge. Recent studies have provided empirical support for the influence of social interaction ties on interunit resource exchange and combination [73], knowledge sharing among units that compete with each other for market shares [72], and knowledge acquisition [78]. Accordingly, Hypotheses 3a and 3b are as follows:

**H3a.** Members' social interaction ties are positively associated with their quantity of knowledge sharing.

**H3b.** Members' social interaction ties are positively associated with the quality of knowledge shared by them.

### 3.3. Trust

Trust has been viewed as a set of specific beliefs dealing primarily with the integrity, benevolence, and ability of another party in the management literature [51,31]. This study focuses on integrity, which refers to an individual's expectation that members in a virtual community will follow a generally accepted set of values, norms, and principles. Trust has been recognized as an important antecedent of IS group performance [57], intellectual capital exchange [55], organizational value creation [73], online transactions [19,31,30,60], and knowledge sharing in virtual communities [64]. Nahapiet and Ghoshal [55] suggested that when trust exists between the parties, they are more willing to engage in cooperative interaction. Nonaka [58] indicated that inter-personal trust is important in teams and organizations for creating an atmosphere for knowledge sharing. An important characteristic of informal interactions is that individuals' contributions are difficult to evaluate [12]. Therefore, trust is particularly important in volitional behaviors such as knowledge sharing in a virtual community. According to Blau [15], trust creates and maintains exchange relationships, which in turn may lead to sharing knowledge of good quality.

**H4a.** Trust is positively associated with the quantity of knowledge sharing.

**H4b.** Trust is positively associated with the quality of knowledge shared by members.

### 3.4. Norm of reciprocity

In this study, norm of reciprocity refers to knowledge exchanges that are mutual and perceived by the parties as fair. According to Blau ([15], p. 6), reciprocity implies "actions that are contingent on rewarding reactions from others and that cease when these expected reactions are not forthcoming." The Social Exchange Theory [71] suggests that participants in virtual communities expect mutual reciprocity that justifies their expense in terms of time and effort spent sharing their knowledge. According to Davenport and Prusak's [24] idea of knowledge market, reciprocity is one of the factors that drive knowledge sharing. Prior research shows that knowledge sharing in electronic networks of practice is facilitated by a strong sense of reciprocity [75]. Thus, the hypotheses are:

**H5a.** Norm of reciprocity is positively associated with the quantity of knowledge sharing.

**H5b.** Norm of reciprocity is positively associated with the quality of knowledge shared by members.

### 3.5. Identification

Identification refers to "one's conception of self in terms of the defining features of self-inclusive social category" ([7], p. 11), in this case, the virtual community. Nahapiet and Ghoshal [55] noted that "identification is the process whereby individuals see themselves as one with another person or group of people. (p. 256)" In this study, identification refers to an individual's sense of belonging and positive feeling toward a virtual community, which is similar to emotional identification proposed by Ellemers et al. [27]. Emotional identification fosters loyalty and citizenship behaviors in the group setting [14,54], and is useful in explaining individuals' willingness to maintain committed relationships with virtual

communities [7,26]. Nahapiet and Ghoshal [55] argued that identification acts as a resource influencing the motivation to combine and exchange knowledge. In contrast, distinct and contradictory identities within groups constitute significant barriers to information sharing, learning, and knowledge creation. Virtual communities are informal entities, which exist in the minds of their members, and are glued together by the connections the members have with each other, and by their specific shared problems or areas of interest [6]. Given that valuable knowledge is embedded in individuals and people usually tend to hoard the knowledge, one would not contribute his knowledge unless another person is recognized as his group-mate and the contribution is conducive to his welfare. The perception of social unity and togetherness of the community will elevate one's activeness to share knowledge and increase the depth and breadth of shared knowledge. Thus, the hypotheses are:

**H6a.** Identification is positively associated with the quantity of knowledge sharing.

**H6b.** Identification is positively associated with the quality of knowledge shared by members.

### 3.6. Shared language

Shared language goes beyond the language itself; it also addresses "the acronyms, subtleties, and underlying assumptions that are the staples of day-to-day interactions" ([49], p. 836). Shared codes and language facilitate a common understanding of collective goals and the proper ways of acting in virtual communities [73]. Nahapiet and Ghoshal [55] stated that shared language influences the conditions for the combination and exchange of intellectual capitals in several ways. First, shared language facilitates people's ability to gain access to people and their information. Second, shared language provides a common conceptual apparatus for evaluating the likely benefits of exchange and combination. Finally, shared language also stands for the overlap in knowledge. It thus enhances the capability of different parties to combine the knowledge they gained through social exchange. Shared language is essential to learning in virtual communities. It provides an avenue in which participants understand each other and build common vocabulary in their domains. In this regard, shared language not only helps share ideas but also enhances the efficiency of communication between people with similar background or practical experience. Accordingly, shared language will help motivate the participants to actively involve in knowledge exchange activities and enhance the quality of shared knowledge.

**H7a.** Shared language is positively associated with the quantity of knowledge sharing.

**H7b.** Shared language is positively associated with the quality of knowledge shared by members.

### 3.7. Shared vision

Tsai and Ghoshal [73] noted that a shared vision "embodies the collective goals and aspirations of the members of an organization" (p. 467). A shared vision is viewed as "a bonding mechanism that helps different parts of an organization to integrate or to combine resources" ([73], p. 467). Organization members who share a vision will be more likely to become partners sharing or exchanging their resources [73]. Virtual communities are groups of people brought together by common interests and goals. Cohen and Prusak [20] argued that shared values and goals bind the members of human networks and communities, make cooperative action possible, and finally benefit organizations,

Table 1
Demographics (the number of subjects=310)

| Measure | Items | | |
|---|---|---|---|
| Age | Average | 27.4 | |
| Working experience | Average | 4.7 | years |
| Job Title | IS manager: | 4.5% | (14/310) |
| | Project manager: | 2% | (6/310) |
| | Programmer: | 15.8 | (49/310) |
| | Software engineer: | 16.7% | (52/310) |
| | Web application engineer: | 3% | (9/310) |
| | Students: | 20.6% | (64/310) |
| | Others: | 37.4% | (116/310) |
| Education | High school or below: | 7.1% | (22/310) |
| | College (2 years): | 21% | (65/310) |
| | University: | 57.4% | (178/310) |
| | Graduate school or above: | 14.5% | (45/310) |
| Gender | Female: | 21.6% | (67/310) |
| | Male: | 78.4% | (243/310) |
| Member history | <3 month: | 11.6% | (36/310) |
| | 3–6 month: | 9% | (28/310) |
| | 6 month–1 year: | 14.9% | (46/310) |
| | 1 year–2 year: | 23.5% | (73/310) |
| | 2 year–3 year: | 16.5% | (51/310) |
| | Over 3 year: | 24.5% | (76/310) |

Table 2
Summary of measurement scales

| Construct | Measure | Mean | Std. Dev. | Loading |
|---|---|---|---|---|
| *Personal outcome expectations (POE) composite reliability = 0.91* | | | | |
| POE1 | Sharing my knowledge will help me to make friends with other members in the BlueShop virtual community. | 5.62 | 1.01 | 0.77 |
| POE2 | Sharing my knowledge will give me a feeling of happiness. | 5.86 | 0.93 | 0.76 |
| POE3 | Sharing my knowledge can build up my reputation in the BlueShop virtual community | 5.48 | 1.06 | 0.77 |
| POE4 | Sharing my knowledge will give me a sense of accomplishment. | 5.71 | 0.94 | 0.82 |
| POE5 | Sharing my knowledge will strengthen the tie between other members in the BlueShop virtual community and me. | 5.28 | 1.08 | 0.84 |
| POE6 | Sharing my knowledge will enable me to gain better cooperation from the outstanding members in the BlueShop virtual community. | 5.53 | 1.07 | 0.80 |
| *Community-related outcome expectations (COE) composite reliability = 0.93* | | | | |
| COE1 | Sharing my knowledge will be helpful to the successful functioning of the BlueShop virtual community. | 5.83 | 0.95 | 0.80 |
| COE2 | Sharing my knowledge would help the BlueShop community continue its operation in t he future. | 5.86 | 0.91 | 0.88 |
| COE3 | Sharing my knowledge would help the BlueShop community accumulate or enrich knowledge. | 5.97 | 0.88 | 0.92 |
| COE4 | Sharing my knowledge would help the BlueShop community grow. | 5.94 | 0.92 | 0.90 |
| *Social interaction ties (SIT) composite reliability = 0.90* | | | | |
| SIT1 | I maintain close social relationships with some members in the BlueShop virtual community | 3.95 | 1.69 | 0.78 |
| SIT2 | I spend a lot of time interacting with some members in the BlueShop virtual community. | 3.95 | 1.58 | 0.90 |
| SIT3 | I know some members in the BlueShop virtual community on a personal level. | 3.67 | 1.66 | 0.80 |
| SIT4 | I have frequent communication with some members in the BlueShop virtual community. | 3.89 | 1.67 | 0.84 |
| *Trust (TR) composite reliability = 0.89* | | | | |
| TR1 | Members in the BlueShop virtual community will not take advantage of others even when the opportunity arises. | 5.06 | 1.32 | 0.71 |
| TR2 | Members in the BlueShop virtual community will always keep the promises they make to one another. | 5.12 | 1.11 | 0.78 |
| TR3 | Members in the BlueShop virtual community would not knowingly do anything to disrupt the conversation. | 5.38 | 1.12 | 0.77 |
| TR4 | Members in the BlueShop virtual community behave in a consistent manner. | 5.00 | 1.14 | 0.84 |
| TR5 | Members in the BlueShop virtual community are truthful in dealing with one another. | 5.39 | 1.03 | 0.81 |
| *Norm of reciprocity (NR) composite reliability = 0.82* | | | | |
| NR1 | I know that other members in the BlueShop virtual community will help me, so it's only fair to help other members. | 5.67 | 1.03 | 0.87 |
| NR2 | I believe that members in the BlueShop virtual community would help me if I need it. | 5.82 | 0.93 | 0.79 |
| *Identification (ID) composite reliability = 0.90* | | | | |
| ID1 | I feel a sense of belonging towards the BlueShop virtual community. | 5.15 | 1.15 | 0.84 |
| ID2 | I have the feeling of togetherness or closeness in the BlueShop virtual community. | 4.57 | 1.24 | 0.84 |
| ID3 | I have a strong positive feeling toward the BlueShop virtual community. | 4.69 | 1.27 | 0.87 |
| ID4 | I am proud to be a member of the BlueShop virtual community. | 5.25 | 1.16 | 0.77 |
| *Shared language (SL) composite reliability = 0.84* | | | | |
| SL1 | The members in the BlueShop virtual community use common terms or jargons. | 4.66 | 1.09 | 0.70 |
| SL2 | Members in the BlueShop virtual community use understandable communication pattern during the discussion. | 5.14 | 1.04 | 0.83 |
| SL3 | Members in the BlueShop virtual community use understandable narrative forms to post messages or articles. | 5.23 | 1.01 | 0.86 |

(continued on next page)

Table 2 (*continued*)

| Construct | Measure | Mean | Std. Dev. | Loading |
|---|---|---|---|---|
| *Shared vision (SV) composite reliability=0.88* | | | | |
| SV1 | Members in the BlueShop virtual community share the vision of helping others solve their professional problems. | 5.93 | 0.96 | 0.83 |
| SV2 | Members in the BlueShop virtual community share the same goal of learning from each other. | 5.88 | 0.91 | 0.83 |
| SV3 | Members in the BlueShop virtual community share the same value that helping others is pleasant. | 5.69 | 0.98 | 0.86 |
| *Knowledge quality (KQ) composite reliability=0.92* | | | | |
| KQ1 | The knowledge shared by members in the BlueShop virtual community is relevant to the topics. | 5.55 | 0.98 | 0.74 |
| KQ2 | The knowledge shared by members in the BlueShop virtual community is easy to understand. | 5.50 | 0.88 | 0.74 |
| KQ3 | The knowledge shared by members in the BlueShop virtual community is accurate. | 5.35 | 1.03 | 0.87 |
| KQ4 | The knowledge shared by members in the BlueShop virtual community is complete. | 5.04 | 1.09 | 0.82 |
| KQ5 | The knowledge shared by members in the BlueShop virtual community is reliable. | 5.32 | 1.00 | 0.85 |
| KQ6 | The knowledge shared by members in the BlueShop virtual community is timely. | 5.31 | 1.04 | 0.79 |
| *Quantity of knowledge sharing (QKS) composite reliability=1.0* | | | | |
| QKS1 | Average volume of knowledge sharing per month. (converted to seven-point scale) | 2.85 | 1.92 | 1.00 |

now to be mentioned — better knowledge sharing in terms of quantity and quality. The common goals, interests, visions that members of a virtual community share will help them see the meaning of their knowledge sharing, which in turn increases the quantity and quality of their knowledge sharing. Thus, the hypotheses are:

**H8a.** Shared vision is positively associated with the quantity of knowledge sharing.

**H8b.** Shared vision is positively associated with the quality of knowledge shared by members.

## 4. Research methodology

### 4.1. Measurement development

Measurement items were adapted from the literature wherever possible. New items were developed based on the definition provided by the literature. A pretest of the questionnaire was performed using 6 experts in the IS area to assess its logical consistencies, ease of understanding, sequence of items, and contextual relevance. The comments collected from these experts led to several minor modifications of the wording and the item sequence. Furthermore, an online pilot study was conducted involving another two professors, three Ph D. students and 20 master students who have been members of various professional virtual communities. Comments and suggestions on the item contents and structure of the instrument were solicited.

The dependent variables in this study are two characteristics of knowledge sharing. We examined these two independently measured dependent variables based on message postings: (1) the quantity of knowledge sharing, and (2) the quality of knowledge shared (knowledge quality). We examined the quantity of knowledge sharing based on the average volume of an individual's knowledge sharing per month. The virtual community under study provides a mechanism that allows the use of each respondent's nickname to retrieve the information for calculating the average volume of knowledge sharing per month. To normalize the data, however, we transformed the average volume of knowledge sharing per month to seven-point scale with 1=less than once per month, 2=about once per month, 3=about 2 times per month, 4=about 4 times per month, 5=about 8 times per month, 6=about 16 times per month, and 7=more than 30 times per month.

Knowledge quality was assessed with items adapted from DeLone and McLean [25] and McKinney et al. [52]. These items measured six attributes of the content of shared knowledge: relevance, ease of understanding, accuracy, completeness, reliability, and timeliness. Items for measuring social interaction ties focus on close relationships, time spent in interacting, and frequent communication with other members, similar to those applied by Tsai and Ghoshal [73]. Trust was assessed with items adapted to reflect an individual's beliefs in other members' non-opportunistic behavior, promise keeping, behavior consistency, and truthfulness, following prior studies [53,64,73]. Reciprocity was measured with items adapted from Wasko and Faraj [75]. The measure focused on the fairness of knowledge

sharing. Identification was assessed with items adapted to reflect an individual's sense of belonging, feeling of togetherness, and positive feeling toward the virtual community, following prior studies [7,35,55]. Shared vision was assessed with items based on Nahapiet and Ghoshal [55] and Tsai and Ghoshal [73]. The items measured an individual's perceptions of whether members share the same vision, goal, and value about knowledge sharing. Shared language was measured with items adapted from Nahapiet and Ghoshal [55]. The measure focused on common terms, meaningful communication pattern, and message understandability. Community-related outcome expectations were adapted from prior studies [2,16,44,48]. Personal outcome expectations were measured with items based on Bock and Kim [16], Coleman [21], and Hendriks [37]. For all the measures, a seven-point Likert scale was adopted with anchors ranging from strongly disagree (1) to strongly agree (7).

### 4.2. Survey administration

The research model was tested with data from members of one professional virtual community called BlueShop. BlueShop is a well-known IT-oriented virtual community in Taiwan. It is dedicated to sharing knowledge about programming, databases, and operating systems and is a member of the Microsoft community alliance program. A banner with a hyperlink connecting to our Web survey was posted on the homepage of the BlueShop from July 11 to August 18, 2005 and members with knowledge sharing experience were cordially invited to support this survey. Thirty randomly selected respondents were offered an incentive in the form of cash amounting to $20. The first page of the questionnaire explained the purpose of this study and ensured the confidentiality. By the time this survey was concluded, 336 questionnaires were collected. The exclusion of 26 invalid questionnaires resulted in a total of 310 complete and valid ones for data analysis. Table 1 lists the demographic information of the respondents.

### 4.3. Questionnaire data analysis

Data analysis utilized a two-step approach as recommended by Anderson and Gerbing [3]. The first step involves the analysis of the measurement model, while the second step tests the structural relationships among latent constructs. The aim of the two-step approach is to assess the reliability and validity of the measures before their use in the full model.

Confirmatory factor analysis (CFA) was applied to assess the construct validity of the ten scales (personal outcome expectation, community-related outcome expectation, social interaction ties, trust, reciprocity, identification, shared language, shared vision, quantity of knowledge sharing, and knowledge quality) with LISREL. Each item was modeled as a reflective indicator of its latent construct. The ten constructs were allowed to co-vary freely in the CFA model. Model estimation was done using the maximum likelihood approach, with the item correlation matrix as input. Table 2 presents the results of the CFA analysis.

For a measurement model to have sufficiently good model fit, the chi-square value normalized by degrees of freedom ($\chi^2/df$) should not exceed 5 [13], and Non-Normed Fit Index (NNFI) and Comparative Fit Index

Table 3
Correlations and AVE

| Construct | AVE | Construct | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | POE | COE | SIT | TR | NR | ID | SL | SV | QKS | KQ |
| POE | 0.63 | **0.79** | | | | | | | | | |
| COE | 0.77 | 0.70 | **0.88** | | | | | | | | |
| SIT | 0.69 | 0.42 | 0.25 | **0.83** | | | | | | | |
| TR | 0.61 | 0.47 | 0.45 | 0.35 | **0.78** | | | | | | |
| NR | 0.69 | 0.42 | 0.40 | 0.28 | 0.62 | **0.83** | | | | | |
| ID | 0.69 | 0.60 | 0.45 | 0.62 | 0.57 | 0.44 | **0.83** | | | | |
| SL | 0.64 | 0.45 | 0.41 | 0.40 | 0.56 | 0.42 | 0.58 | **0.80** | | | |
| SV | 0.71 | 0.52 | 0.57 | 0.33 | 0.57 | 0.63 | 0.54 | 0.55 | **0.84** | | |
| QKS | 1.00 | 0.18 | 0.18 | 0.28 | 0.11 | 0.12 | 0.24 | 0.09 | 0.02 | **1.00** | |
| KQ | 0.64 | 0.58 | 0.62 | 0.34 | 0.60 | 0.52 | 0.56 | 0.61 | 0.64 | 0.10 | **0.80** |

*Diagonal elements (in bold) are the square root of the average variance extracted (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements.
*POE=personal outcome expectations; COE=community-related outcome expectations; SIT=social interaction ties; TR=trust; NR=norm of reciprocity; ID=identification; SL=shared language; SV=shared vision; QKS=quantity of knowledge sharing; KQ=knowledge quality.

Table 4
Model fit indices for the structural model

| Model fit indices | Results | Recommended value |
|---|---|---|
| Chi-square statistic $\chi^2/df$ | 1.95 | ≤5 |
| NNFI | 0.93 | ≥0.9 |
| CFI | 0.94 | ≥0.9 |
| RMSEA | 0.056 | ≤0.08 |

(CFI) should exceed 0.9. For the current CFA model, $\chi^2/df$ was 1.96 ($\chi^2=1194$; $df=610$), NNFI was 0.93, and CFI was 0.94, suggesting adequate model fit.

Additionally, the convergent validity of the scales was verified by using three criteria suggested by Fornell and Larcker [28]: (1) all indicator loadings should be significant and exceed 0.7, (2) construct reliabilities should exceed 0.8, and (3) average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). For the current CFA model, all loadings were above the 0.7 threshold (see Table 2). The composite reliabilities of the constructs ranged between 0.82 and 0.93 (see Table 3). AVE ranged from 0.61 to 1.00 (see Table 3). Hence, all the three conditions for convergent validity were met.

Finally, the discriminant validity of the scales was assessed using the guideline suggested by Fornell and Larcker [28]: the square root of the AVE from the construct should be greater than the correlation shared between the construct and other constructs in the model. Appendix A lists the covariances among the constructs. Table 3 lists the correlations among the constructs, with the square root of the AVE on the diagonal. All the diagonal values exceed the inter-construct correlations; hence the test of discriminant validity was acceptable. Therefore we conclude that the scales should have sufficient construct validity.

The structural model reflecting the assumed linear, causal relationships among the constructs was tested with the data collected from the validated measures. The model fit indices were within accepted thresholds: $\chi^2$ to degrees of freedom ratio of 1.95 ($\chi^2=1194$; $df=611$), NNFI=0.93, CFI=0.94, and RMSEA=0.056 (see Table 4).

Fig. 2 shows the results of hypotheses tests. Nine out of the sixteen paths exhibited a *P*-value less than 0.05, while the remaining seven were not significant at the 0.05 level of significance. Community-related outcome expectations exhibited a strong positive effect on

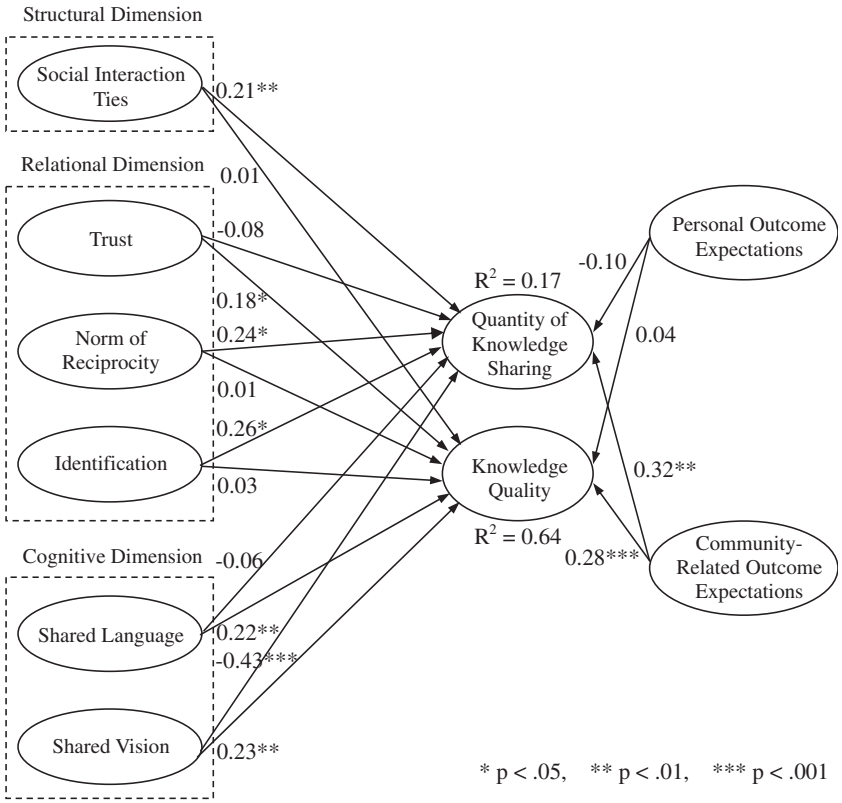


Fig. 2. SEM analysis of research model.

quantity of knowledge sharing and knowledge quality, while personal outcome expectation showed no significant influence on quantity of knowledge sharing and knowledge quality. Consequently, hypotheses 2a and 2b were supported empirically while hypotheses 1a and 1b were not. Social interaction ties significantly and positively affected quantity of knowledge sharing, supporting hypothesis 3a. Contrary to hypothesis 3b, the results showed an insignificant path between social interaction ties and knowledge quality. The paths from reciprocity and identification to quantity of knowledge sharing were positive and significant, while trust showed no significant influence on quantity of knowledge sharing. Consequently, hypotheses 5a and 6a were supported while hypothesis 4a was not. The path from trust to knowledge quality was positive and significant, while reciprocity and identification showed no significant influences on knowledge quality. Consequently, hypothesis 4b was supported while hypotheses 5b and 6b were not. Shared language exhibited a positive and significant effect on knowledge quality, but not on quantity of knowledge sharing. Hypothesis 7b was supported, while hypothesis 7a was not supported. The results showed a negative and significant path between shared vision and quantity of knowledge sharing, while a positive and significant path was found between shared vision and knowledge quality. Consequently, hypothesis 8b was supported, while hypothesis 8a was not supported.

The explanatory power of the research model is also shown in Fig. 2. The *R*-square values show that personal outcome expectations, community-related outcome expectations, social interaction ties, trust, norm of reciprocity, identification, shared vision, and shared language account for 17% of variance of quantity of knowledge sharing and 64% of variance of knowledge quality.

## 5. Discussion and implications

### *5.1. Summary of results*

This study helps understanding the complex process in which outcome expectations and social capital influence knowledge sharing in virtual communities. The results indicate that community-related outcome expectations play an important role underlying knowledge sharing in terms of both quantity and quality, while personal outcome expectations have a negative but insignificant effect on quantity of knowledge sharing. The negative relationship between personal outcome expectations and quantity of knowledge sharing suggests that individuals contribute less knowledge, even though they expect that knowledge sharing will produce desirable consequences to them. We performed additional LISREL analyses, which indicated that the path coefficient of personal outcome expectations increased from −0.10 to 0.13 by removing community-related outcome expectations from the research model. One possible explanation for this finding might be that when the impact of community-related outcome expectation is taken into account, knowledge contributors are more concerned about the successful functioning, survival, and growth of the virtual communities than the benefits that will produce to themselves.

The study shows that social interaction ties, reciprocity, and identification increased individuals' quantity of knowledge sharing but not knowledge quality. The results are similar to Wasko and Faraj's [75] findings that reciprocity is not a significant predictor of helpfulness of knowledge contribution in electronic networks of practice. Tsai and Ghoshal [73] found that social interaction ties had a strong effect on trust in the context of resource exchange and production innovation within the organization. According to Blau [15], norm of reciprocity builds trust, which in turn is centrally important to social exchange relationships. We performed additional LISREL analyses, which indicated that norm of reciprocity and identification exerted positive and strong effects on trust. Accordingly, a possible explanation for the findings may be that social interaction ties, norm of reciprocity, and identification have indirect effects on knowledge quality via trust.

Contrary to our expectation, trust did not have a significant impact on quantity of knowledge sharing. One possible explanation may be that individuals are willing to share their personal knowledge due to close and frequent interaction among members, fairness in exchanging knowledge, and strong feelings toward the virtual community, without necessarily trusting other members in the virtual community. Another possible explanation is that trust is not crucial in less risky knowledge sharing relationships. Coleman [22] argued that only in risky situations do we need trust.

Contrary to our expectations, shared language did not have a significant impact on quantity of knowledge sharing, while shared vision had a negative and strong influence on quantity of knowledge sharing. One plausible explanation is that with shared language and vision, contributors focus more on quality rather than quantity of contributions. This implies that they may not contribute just for the sake of contribution but may be more concerned about their quality of contribution. Tsai and Ghoshal [73] argued that individuals who share a

vision will be more likely to become partners sharing or exchanging their resources in the organizational settings. An avenue for future research is to examine why a negative relationship between shared vision and quantity of knowledge sharing exists in the virtual community settings.

### 5.2. Limitations

Although the findings are encouraging and useful, the present study has certain limitations. First, whether our findings could be generalized to all types of professional virtual communities is unclear. Knowledge sharing in global virtual communities of practice might be different from that of intra-organizational and inter-organizational virtual communities of practice. Further research is necessary to verify the generalizability of our findings. Second, the results may have been impacted by self-selection bias. Our sample comprises only active participants. Individuals who had already ceased to participate in virtual communities might have different perceptions about the influence of expectation beliefs and facets of social capital, and so could have been differently affected by them. Therefore, the results should be interpreted as only explaining knowledge sharing of current knowledge contributors of virtual communities. Whether the results can be generalized to nonparticipants or to disaffected participants will require additional research. Third, this study examined only one aspect of knowledge exchange-knowledge sharing. We did not investigate individuals who participate to receive knowledge but do not share (contribute). While it can be argued that knowledge sharing is key to sustaining virtual communities, future research should examine why individuals choose to participate in a virtual community. Fourth, the data presented are cross-sectional. The development of social capital leading to knowledge sharing is an ongoing phenomenon. These social capital factors were measured at a static point rather than as they were developing, thus losing time richness of explanation. An ideal empirical design for testing the proposed model would be a longitudinal comparison of users' initial use and long-term use of virtual communities for sharing knowledge, in order to faithfully capture the complex, dynamic interrelationships between initial and long-term knowledge sharing decisions. Finally, this study focused on the paths from six facets of social capital to knowledge sharing. Those facets are also argued to have impact on each other. For example, Tsai and Ghoshal [73] have shown that social interaction ties and shared vision are significant predictors of trust. Future research should examine the interrelationships among facets of social capital.

### 5.3. Implications for research and practice

#### 5.3.1. Implications for research

Facets of social capital positively relate to the quantity of knowledge sharing or the quality of knowledge shared by members. This research contributes to an overall conceptual understanding of the nature and the importance of facets of social capital in affecting the knowledge sharing in virtual communities. From a theoretical perspective, our findings imply that outcome expectations of knowledge sharing in virtual communities by themselves are insufficient for knowledge sharing. Outcome expectations can contribute to knowledge sharing to some extent, but it is the social capital factors (e.g., social interaction ties, trust, norm of reciprocity, identification, shared language, and shared vision) that lead to greater level of knowledge sharing in terms of quantity or quality. By identifying facets of social capital as the determinant of knowledge sharing, networks of relationships among members of professional virtual communities are characterized as a valuable resource for knowledge sharing beyond that of mere expectation beliefs.

Our findings suggest that outcome expectations and facets of social capital are helpful in explaining knowledge sharing in virtual communities. However, prior research [57] suggests that a greater level of knowledge sharing may lead to better development of social interaction ties, mutual trust, identification, and shared vision. Such relationships could be tested longitudinally. Future research should look at changes in social capital and outcome expectations over time and the relationships of those changes to knowledge sharing. In addition, our investigation of social capital of virtual communities also posed an interesting question: how is social capital created and accumulated inside a virtual community. Tsai and Ghoshal [73] suggested that organizational attributes may influence the creation and accumulation of social capital in the organizational setting. Narayan and Cassidy [56] indicated that communication and empowerment are primary determinants of the social capital. Later studies should explore what factors influence the facets of social capital in the virtual community setting.

The results imply that individuals are less concerned about the desirable consequences that knowledge sharing will produce to them. According to social exchange theory, however, individuals will behave according to rational self-interest. Therefore, knowledge

sharing will be stimulated when its rewards exceed its cost [43]. According to Blau [15], rewards can be either intrinsic (praise, respect) or extrinsic (money). Thus, another direction for future research is to examine whether reward systems are useful in motivating an individual to share knowledge in the virtual community and what form of reward or incentive plays a significant role.

Knowledge exchange in virtual community is one type of social exchange behavior that comprises two major activities: viewing (receiving) and posting (giving) knowledge. The significant relationship between norm of reciprocity and individuals' quantity of knowledge sharing implies that participants of a virtual community may seek a fair balance between what they contribute to the community and what they receive from it. According to Adams's equity theory [1], an individual's perception of fairness of exchange relationships is determined by comparing the outcome/input ratio for oneself with that of referent others. When the ratios are equal, people are satisfied. People become demotivated, reduce input and/or seek change whenever they feel their inputs are not being fairly rewarded [1]. This study discusses norm of reciprocity from the perspective of general fairness. Social exchange and organizational justice theorists have identified three dimensions of fairness: fairness of outcomes (distributive fairness), fairness of decision-making procedures (procedural fairness), and fairness of interpersonal treatment (interactional fairness). Accordingly, whether these dimensions of fairness will influence knowledge sharing in virtual communities is another interesting area for future research.

### 5.3.2. Implications for practice

The results indicated that social interaction ties were significant predictor of individuals' knowledge sharing in terms of quantity. Managers interested in developing and sustaining knowledge exchange through virtual communities should develop strategies or mechanisms that encourage the interaction and the strength of the relationships among members. For example, the BlueShop community often held face-to-face meetings or seminars and invited top knowledge contributors and professional instructors to share their knowledge and experience with members of the community, as a way of enhancing the social interaction ties among its members. The BlueShop community also provides personal message boards and blogs as tools for enhancing online communication and interaction among members.

Managers of virtual communities can encourage reciprocity by using extrinsic motivators such as rewards for sharing knowledge. For example, the BlueShop community provides a mechanism that knowledge receivers can donate value-added points (VP) to knowledge contributors as a return of favors. Earning VP by contributing knowledge can be considered as an approach to forcing an individual to reciprocate the benefits he or she received from others. The VP may represent knowledge contributors' status and reputation within the community and can also be changed into monetary rewards from the community. When a member ran out of VP, he or she could buy VP from the community.

Creating and maintaining a set of core and experienced individuals plays an important role in developing and sustaining a professional virtual community [75]. Raising these core knowledge contributors' identification with the virtual community is one of the approaches. This may be done by using intrinsic or extrinsic motivators. For example, the BlueShop community provides a list of top knowledge contributors for each week and month, enhancing the contributors' identification with the community and also their reputation within the community. Managers of the BlueShop community post information about job opportunities and outsourcing cases on the homepage and help top and well-recognized knowledge contributors get those job opportunities and outsourcing cases. This in turn leads to top knowledge contributors' identification with the community and motivate them to continue to share knowledge with other members.

The results suggest that trust plays an important role in increasing the quality of knowledge shared within virtual communities. Research suggests that there are various types of trust and the development of trust is multi-staged within virtual inter-organizational alliances [59]. Like the development of trust, the development of knowledge sharing is also multi-staged. Quantity of knowledge sharing may be the major concern at the early stage of a virtual community's development, whereas knowledge quality may be the major concern when the community becomes more mature. In addition, managers of virtual communities can facilitate trusting relationships among members by enhancing norm of reciprocity, social interaction ties (repeated interactions), and shared vision (experiences) [51] and by confiding personal information in virtual communities [64]. For example, BlueShop allows an individual to disclose personal information when registering as a new member and browse other members' information to get more acquainted with them.

Community-related outcome expectation plays an important role in knowledge sharing. However, the

development and maintenance of virtual communities depend not only on members' knowledge sharing but also managers' strategies for running the virtual communities. For example, BlueShop's strategy is to become members of famous alliance programs, receive online advertising cases, and win awards of excellent virtual communities to enhance its reputation and meet members' expectation of its sustenance and growth.

## Appendix A. Covariance matrix of latent variables

| | POE | COE | SIT | TR | NR | ID | SL | SV | QKS | KQ |
|---|---|---|---|---|---|---|---|---|---|---|
| POE | 0.59 | | | | | | | | | |
| COE | 0.46 | 0.61 | | | | | | | | |
| SIT | 0.44 | 0.28 | 1.76 | | | | | | | |
| TR | 0.38 | 0.36 | 0.50 | 0.87 | | | | | | |
| NR | 0.33 | 0.30 | 0.38 | 0.61 | 0.79 | | | | | |
| ID | 0.47 | 0.37 | 0.88 | 0.58 | 0.42 | 0.93 | | | | |
| SL | 0.31 | 0.30 | 0.45 | 0.50 | 0.37 | 0.50 | 0.67 | | | |
| SV | 0.35 | 0.39 | 0.38 | 0.48 | 0.51 | 0.45 | 0.41 | 0.61 | | |
| QKS | 0.30 | 0.28 | 0.74 | 0.23 | 0.21 | 0.48 | 0.13 | 0.04 | 3.69 | |
| KQ | 0.32 | 0.34 | 0.34 | 0.42 | 0.35 | 0.40 | 0.37 | 0.38 | 0.16 | 0.48 |

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