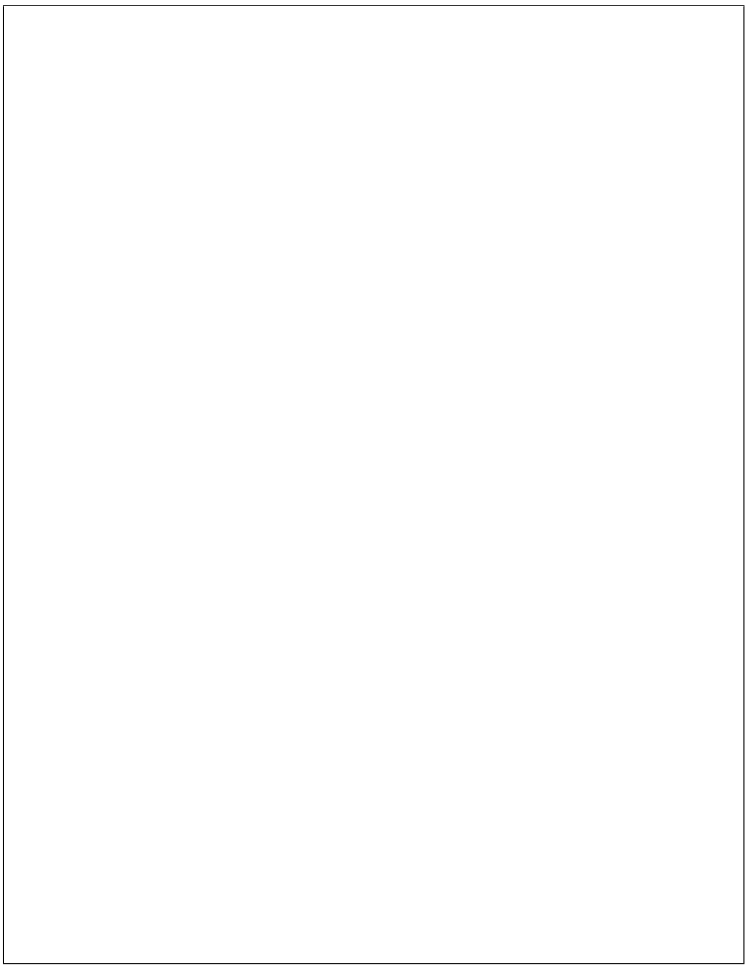

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E-commerce communities as knowledge bases for firms

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ABSTRACT

Most studies in the knowledge management literature investigate diversified issues from a *firm and organizational* perspective. Based on the observations of practices in Asia, many knowledge activities occur at the *e-commerce community* level and represent knowledge activities for whole communities. Hence, this study is intended to explore knowledge management issues in e-commerce communities, and comprehend the way it is practiced. This study reports on a series of in-depth interviews, reviews academic and practical knowledge management cases to construct a model, and categorizes knowledge management activities in e-commerce communities in four different modes. They include *knowledge dissemination, knowledge advancement, knowledge sharing deals,* and *knowledge generation*. A number of hypotheses are proposed that relate e-commerce-related knowledge management's impact on innovativeness performance. This research involves an empirical study of 107 leading organizations in the business-to-business e-commerce community in China and Taiwan. The statistical results provide evidence to confirm the proposed model and the effects of e-commerce community-based knowledge management on innovativeness.

1. Introduction

Many newly-industrialized economies (NIEs) in Asia are modest and emerging markets relative to their western counterparts. Some Asian firms perform successfully in manufacturing, but they may not have sufficient experience in conducting business activities like their European and U.S. competitors due to their lack of budget, expertise, and even market scale. At the same time, many Asian NIEs, such as China and Taiwan, have encountered a great potential rivalry with some of the less-developed countries. Their competitive advantage and technological base force them to transform their manufacturing-driven strategy into a knowledge and R&D-driven approach. One of the ways to improve their competitiveness is to conduct knowledge activities, including knowledge creation, sharing, and utilization (Bierly and Chakrabarti 1996, Conner and Prahalad 1996, Lee 2003).

The knowledge management literature typically views the *firm as a knowledge base* as the basic analytical unit (Conner and Prahalad 1996, Grant 1996, Kogut and Zander 1998). Academic and practice efforts tend to concentrate knowledge management at the *firm* or *organizational* layer (Nonaka and Takeuchi 1995, Sanchez and Heene 1997, Lincoln et al. 1998), while some focus on the national layer (Freemantle 1996, Roessner et al. 1996). The research still follows these perspectives (Davenport and Klahr 1998, Zack 1998).

The typical *firm and organizational* perspective may be insufficient and problematic in Asia, though in reality knowledge management may take place on the e-commerce community front (Lee 2003, Lin et al. 2007). Take, for example, the personal computer (PC) manufacturing industries in Taiwan. Since the capital and the scale of individual firms cannot compare to their U.S., European, and Japanese competitors, Taiwanese firms may be losers in the rivalry due to the lack of R&D and knowledge resources. In the mid-1980s, they integrated into some industrial clusters, each of which consisted of a variety of sectors and people in Taiwan and foreign countries (Lin et al. 2007). With help from information and communication technology (ICT), members of the clusters constructed B2B e-commerce for their daily operations.

E-commerce initially designated the duties of each firm, such as manufacturing components that subsequently yielded new insights into component and parts manufacturing. E-commerce provided extensive communication and dialogue between the members and helped them to improve, develop, and transfer knowledge. E-commerce helped establish a flexible, distinctive, and effective knowledge system that made Taiwanese firms very competitive. Hence, knowledge management not only occurs within or across *firms* and *organizations*, but it came about in the layer of an *e-commerce community* (Porter 1990, Dyer and Nobeoka 2000). This is an alternative perspective for knowledge management practices in Asia.

The e-commerce community concept originates from the developing role of the *community of practices*. This refers to the social learning process that occurs when people have a common interest

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to share ideas, find solutions, and build innovations (Wenger and Snyder 2000). ICT has enhanced the effectiveness of communities of practice in the e-commerce context, particularly for the B2B ones (Hellstrom et al. 2000, Dubé et al. 2005). ICT provides communities of practice operations for immediate and economical support and helps the members conduct knowledge activities through e-commerce infrastructure. The convergence of communities of practice and ICT shapes the form of an e-commerce community. Reports in 2008 show that over 34,530,000 firms, accounting for 34.2% of China's small and medium-sized firms, employed e-commerce (iResearch 2008).

E-commerce community address the requirements of Asian firms and can provide significant benefits to them due to the following reasons. First, for firms lacking R&D resources, e-commerce communities provide an alternative to create, diffuse, learn, and utilize knowledge with their colleagues through real-time, highly flexible, and low-cost ICT. Second, dramatic competition has brought the firms resource demand constraints and smaller manufacturers in Asia find it tough to gain sufficient quality knowledge resources that their competitors have access to (Stahle and Hong 2003). Thus, they need to team up with people, provide financing, and execute knowledge activities jointly via e-commerce communities, which are what they have been doing for decades. These joint knowledge activities share costs and support in order to achieve economies of scale (McMillan 1989). Third, Asian firms' connections or "guanxi" with their partners are tight and sophisticated (Dayasindhu 2003). Even though the knowledge base of intangible intellectual capital and tangible resources (Tarn 2006, Lin et al. 2007) of each individual firm is weak, the firms will utilize and share their knowledge via the e-commerce community and build knowledge synergy (Gardner 1990). To survive in highly competitive markets, Asian firms need to continuously rethink how to revitalize these connections and joint knowledge activities (Li and Scullion 2006). Here, an e-commerce community is just one of the answers for many firms, and e-commerce community knowledge management is a practical and alternative way for Asia. Thus, it is reasonable and practical to treat an e-commerce community as a *knowledge base*. This study defines an *e-commerce community* as the learning process that occurs via socialization and codification of e-commerce, whereby members with common interests conduct knowledge activities.

We have shown that e-commerce communities for knowledge management are very common in Asia's knowledge management practices, but relatively little academic attention has been directed toward it. Thus, to address the previous academic and practical gaps, this study attempts to answer the following research questions. First, is it proper to treat an e-commerce community as a unit of analysis to study knowledge management issues? Second, what are the contents of knowledge management practices in Asian's e-commerce layer, and how can we construct an e-commerce community knowledge management model? Third, what are the effects of e-commerce community knowledge management? Does e-commerce community knowledge management help to improve the performance of the firms?

To respond these questions, this study makes the following efforts. First, it conducts some exploratory in-depth interviews to explore the contents of e-commerce community knowledge management. The industry-level knowledge management model of Lin et al. (2007) is employed as the theoretical foundation for the construction of the e-commerce community knowledge management framework and hypotheses. Additionally, to examine the framework, we made an effort to survey the literature and perform some case studies to form the basis of scale measures and an empirical survey. Selected e-commerce community members from two representative economies in Asia, China and Taiwan, are sampled in the survey to examine the hypotheses. This study also evaluates some performance indicators to verify the validity of the proposed scale. Finally, it provides some new insights and suggestions toward e-commerce community knowledge management research and practices for the future.

2. E-commerce community knowledge management practices

To explore the e-commerce community knowledge management model, this study first reviews the literature regarding communities of practice. The communities of practice-related literature has explored related topics from diverse perspectives, including its boundaries (Wenger and Snyder 2000), formalism (Lesser and Everest 2001), member selection (Dubé et al. 2005), and stability and reliance on ICT (Dubé et al. 2005). In Asian practices, in order to integrate the members, some leading organizations may come forward to shape the configuration of existing industrial activities. The leading organizations may be from different sectors based on different contexts of strategic purposes, resources, and market conditions, such as own-brand firms subcontracting their manufacturing operations, manufacturers integrating resources from members, central or regional governments, or research-based organizations (Ernst 2000, Lee 2003, Tarn 2006).

E-commerce community knowledge management is a particular business mode in Asia, and relatively little literature has studied it (Luo 1999). This study conducts in-depth interviews to identify the dimensions and contents of e-commerce community knowledge management. The interviews involved six experts in China and Taiwan: two are CEOs (experts A and B) and the remaining four are high-level managers in charge of e-commerce practices (C, D, E, and F). The interviews were conducted face-to-face (B, C, D, E) and by video conference (A and F) due to geographical distance and time limitation.

The in-depth interviews conclude some critical information helpful to leverage two critical viewpoints to construct the e-commerce community knowledge management model. The first is *who are the ones participating in* e-commerce community knowledge management (as mentioned by experts A, B, D, and E) and the second follows *what knowledge is utilized* in relation to e-commerce community knowledge management (as that described by experts C, D, and F). The two viewpoints correspond to how Lin et al. (2007) classify knowledge activities in Asia on an industry level. Due to the significant gap in knowledge base and resources with those large-scale competitors, they argue Asian firms are used to conducting knowledge activities at the industry level, rather than an individual firm level, in order to share cost, operational scale, and R&D funds that are not affordable on their own. They view it as industry-level knowledge management and classify it with two dimensions: whether knowledge management is consistent with its industry, and whether the knowledge body is consistent with existing ones. The 2×2 classification forms a four-mode framework of knowledge clustering, enlarging, exchanging, and sharing initiation. Their empirical study confirms the framework and exhibits the particular functions of each mode on innovativeness.

Lin et al.'s (2007) approach is similar to how we approach this problem in our research. First, they examine knowledge management based on Porter's (1990) clusters. *Clusters* consist of factors, markets, rivalries, supportive and related firms, and government institutions, which are identical to the e-commerce community that we discuss in this study. Second, they treat *industry* as the knowledge management unit of analysis. Porter's industry clusters were identified based on related activities from the value chain, including human resources, R&D, procurement, and manufacturing, in which intensive linkage and connection among the members are essential. Traditionally, frequent meetings, face-to-face

	KNOWLEDGE ACTIVITIES ARE CONDUCTED BASED ON IDENTICAL KNOWLEDGE PARADIGM	KNOWLEDGE ACTIVITIES ARE CONDUCTED BASED ON DIFFERENT KNOWLEDGE PARADIGM
Knowledge Activities are Conducted WITHIN the Industry	***Knowledge Dissemination***	***Knowledge Advancement***
Knowledge Activities are Conducted BEYOND the Industry	***Knowledge Sharing Deals***	***Knowledge Generation***

Fig. 1. ECKM typology.

coordination, and exchange visits are primary activities to smooth over the differences of opinion on matters between the members. In practice recently, ICT and e-commerce techniques have combined to help bring the cluster members together. ICT builds communities in the context of e-commerce activities. Thus, an e-commerce community supports an industry cluster and plays a critical role in what the industry cluster is able to do to improve its operations. Third, the two dimensions they employ in the model – within or beyond the industry, and a changed or unchanged knowledge paradigm – conform to what this study finds in its in-depth interviews. Fourth, there is evidence on the effects of the modes on firm innovativeness. To sum up, we will follow Lin et al.'s (2007) model to construct the e-commerce community knowledge management framework.

Fig. 1 shows our two-dimensional, four-mode model. The first dimension classifies an e-commerce community knowledge management by determining the knowledge activities as being conducted *within the industry's scope* or *beyond the industry's border* (Ansoff 1968, Smith and Wolfe 1995). Those within the industry employ knowledge resources from partners, customers, research institutes, and even competitors. Conversely, knowledge activities beyond the industry lead the firms into cooperating, contracting, and even dealing and bargaining with partners across industry borders.

The second dimension is based on whether the knowledge body or paradigm is *identical* to or *different* from the existing ones (Nonaka and Takeuchi 1995, Smith and Wolfe 1995). This study follows Bierly and Chakrabarti (1996) and defines e-commerce community knowledge activities under *identical existing paradigm* as those conducted with a homogeneous knowledge base, such as product modifications and improvement. Conversely, knowledge activities under a *different paradigm* refer to those with heterogeneous or diversified knowledge characteristics, such as new product development and entering the state-of-the-art knowledge domain.

Based on the classification, e-commerce community knowledge management is defined here as the knowledge dissemination, knowledge advancement, knowledge sharing deal and knowledge generation that occur via socialization and codification of e-commerce whereby members conduct knowledge activities with common interests.

3. The four modes of e-commerce community knowledge management

3.1. Knowledge dissemination

Knowledge dissemination activities occur within the same industry without a significant knowledge paradigm shift. The literature and practices in China's toy-making industry offer good insights. The e-commerce communities there consist of members from manufacturing and research institutes, suppliers from chemical, plastic, and electronic industries, and partners from service sectors such as design and marketing. Very few individual toy manufacturers can produce completed products on their own, and in order to satisfy demand from diversified marketplaces the manufacturers integrate partners so as to divide their work (Drucker 1993). The leading organizations receive orders and decide prototypes and then pass work onto their partners via ICT tools (Tsai and Yu 2000).

In the beginning, marketing consultants provide market and consumer information, including information about shifting fashions and what is in vogue. Design services are in charge of product development and planning (Malhotra et al. 2005). The sorting of parts and components is assigned to suppliers in different industries with final fabrication by the leading organizations. Throughout the processes, e-commerce community partners engage in intensive knowledge transfer, diffusion, sharing, and integration from a diverse market and technological knowledge within e-commerce communities (Richter and Vettel 1995, Gilbert and Cordey-Hayes 1996, van der Spek and Spijkerver 1997, Argote 1999, Argote and Ingram 2000, Lindsay et al. 2003, Reimers et al. 2004, Tan and Wu 2004, Guthrie 2005, Ko et al. 2005, Lin et al. 2005) in order to best utilize knowledge (Scheel 2002, Lindsay et al. 2003). Thus, knowledge dissemination refers to the extent of *effective knowledge flows, utilization,* and *work division* of existing knowledge to members within the e-commerce community.

Knowledge dissemination as a knowledge management mode occurs frequently in Asia. In practice, the shared culture and language within an industry raise enthusiasm for cooperation and increase willingness of the members to innovate (Damanpour 1991, Yap and Souder 1994). Additionally, the intensive communication that occurs across an industry helps to build up interactive routines and makes knowledge utilization more effective. Nevertheless, knowledge dissemination is the most conservative one of the four, with finite change and protective knowledge activities that limits dramatic knowledge development (Lin et al. 2007, Wang 2000). We now state our first hypothesis regarding the effect of knowledge dissemination:

- Hypothesis 1 (The e-commerce community knowledge dissemination): E-commerce community knowledge dissemination helps members to raise innovation willingness and generate better innovation satisfaction.

3.2. Knowledge advancement

Knowledge advancement occurs when knowledge activities are carried out within the industry when the knowledge paradigm has been altered. The shoe manufacturing industry in Taiwan represents a good example. In the 1960s, firms in this industry manufactured shoes based OEM orders only and followed out-dated technologies from the U.S. and Japan. Most firms could not get any market-related information at all. To improve this, over 50 shoe manufacturers, with the support of Taiwan's government, pitched into set up the Shoe Designing and Manufacturing Association (SDMA). In the mid-1990s, the SDMA constructed a practical

and real-time manufacturing information system which not only shares market conditions, but also provides emerging products or process technologies, within and outside the industry, that fit members' needs. This lets them take advantage of product lifecycles and helps them enter a new knowledge domain (Bierly and Chakrabarti 1996, Sanchez and Heene 1997, Ruggles 1998, Teece 1998, Reimers et al. 2004, Martinsons 2008). The SDMA made an effort to join up with German-owned brand name firms to promote new products and ideas generated in Taiwan. Knowledge activities, such as extensive on-line negotiation, personal discussions, and face-to-face meetings, helped to build product knowledge. For over 30 years, SDMA has supported small and medium-sized shoe-makers who are willing to work together for knowledge integration, modification, and refinement through intensive e-commerce community knowledge management activities (Quinn 1992, Powell 1998, Zack 1998).

Most e-commerce community members had experience with long-term cooperation before and during the establishment of the SDMA. Knowledge advancement with members whose interests are aligned offers a good start to improve their existing knowledge level. It provides supportive colleagues and a familiar context that help to enhance cooperation and satisfaction (Robbins 1994). Moreover, according to Hedlund's (1994) T-form organizational knowledge, knowledge advancement may be divided into two types – extension and expansion (Quintas et al. 1997, Sanchez and Heene 1997, Zack 1998). Knowledge *extension* refers to stretching existing core knowledge in a *deeper* manner, while *expansion* happens when developing it in a *broader* manner. Both extension and expansion give new insights for modifying the existing process and products from different knowledge sources. We will report on knowledge advancement based on effective *knowledge extension* and *expansion* under a similar knowledge industry scope (Tarn 2006, Lin et al. 2007). Our next hypothesis addresses knowledge advancement:

- Hypothesis 2 (The e-commerce community knowledge advancement hypothesis): E-commerce community knowledge advancement helps members to perform better process and product innovation and raise innovation satisfaction.

3.3. Knowledge sharing deals

The third e-commerce community knowledge management mode, knowledge sharing deals, is conducted beyond industry borders under the existing knowledge paradigm. The literature and practical reports regarding integrated circuit-related manufacturers in China and Taiwan provide a critical norm for knowledge sharing deals. Their integrated circuit industries operative in a very competitive environment, suffer from rapid maturity of technology, and receive orders from diverse sources. They have to adapt their know-how and respond to the market conditions based on elaborate research and investigation. To survive these threats, Taiwan's government decided to start up an industrial cluster consisting of a major research institute (Industrial Technology Research Institute, ITRI), two science-driven universities near the ITRI (NCTU and NTHU), a related governmental organization (National Science Committee), many U.S. and Japanese experts, and numerous talented and well-trained workers. From circuit design, outsourcing, and manufacturing to testing and packaging, they employ a very deliberate division of work and assign their work using B2B e-commerce practices. With assistance from ICT and on-line facilities, the members of the e-commerce communities engage in knowledge licensing and strategic alliances across the industries (Prahalad and Hamel 1994, Streb 2003). They also integrate and coordinate existing skills (Quinn 1992, Powell 1998, Wang and Lihua 2006). Another activity is that they deal with the cross-industry knowledge trade and related exchange (Smith and Wolfe 1995, Fransman and Tanaka 1995, Hargadon 1998, Ruggles 1998, Ernst 2000). They further support knowledge cooperation among the parties (Mowery and Rosenberg 1989, Leonard-Barton 1995, Davenport and Klahr 1998, Dayasindhu 2003), and provide a learning culture, climate, and "guanxi" for knowledge cooperation (Nakata and Sivakumar 1996, Ottum and Moore 1997, Krogh 1998, Nonaka and Konno 1998, Dayasindhu 2003, Fu et al. 2006). Thus, this study defines *knowledge sharing deals* as *interfacial knowledge activities* across industries under an identical knowledge domain.

Very similar to knowledge dissemination, working with an agreed-upon knowledge paradigm makes innovation much simpler, thereby raising the willingness of firms to participate together to achieve innovations, and to conduct different kinds of knowledge activities in the process (Yap and Souder 1994, Damanpour 1991, Wang 2000). It is often the case, however, that the dynamic and turbulent market environment makes knowledge less valuable and easier to imitate. So knowledge activities within the industry may be insufficient to sustain competitive advantage on a permanent basis, while new knowledge and competition are likely to occur across industrial borders. Thus, knowledge exchange, trade, and cooperation with other industries will be helpful strategies to extend the knowledge lifecycle and improve process performance (Streb 2003). We assert the following related hypothesis, as follows:

- Hypothesis 3 (E-commerce community knowledge dissemination and sharing deal hypothesis): E-commerce community knowledge dissemination and sharing deals help the members to perform better process innovation and raise innovation willingness and satisfaction.

3.4. Knowledge generation

Knowledge generation is the most sophisticated e-commerce community knowledge management mode that occurs beyond an industry arena under different knowledge paradigms. There have been many studies and practices concerning knowledge generation during the past two decades, with the automobile manufacturing industry in Taiwan showing a typical pattern. The engine industry acquires technology that is licensed from Japanese automobile makers. This makes engines costly and they are highly controlled and the firms in Taiwan are constrained by their Japan suppliers (Tarn 2006, Kao et al. 2006). For this, the Automobile Engine Manufacturing and Development Association (AEMDA) in Taiwan undertook to construct a "Standardized Engine Prototype" (SEP) that fits the demands of Taiwan's automobile market. With assistance from Japan, AEMDA called 11 domestic automobile makers together to investigate technology trends and consumer preferences in the automobile markets. They accordingly set the scales and standards of SEP (Bierly and Chakrabarti 1996, Nonaka and Konno 1998, Buckley and Tan 2004) and even sponsored firms to learn engine technology from abroad via e-commerce infrastructure and knowledge sharing deals (Lepkowski 1994, Nonaka and Takeuchi 1995, Nonaka and Konno 1998, Wu et al. 2000, Yang et al. 2006). They also organized a formal mechanism for cross-industrial cooperation (O'Connor 1998, iResearch 2008), established policies, priority, and rules (Mowery and Rosenberg 1989, Sapienza 1989, Conner and Prahalad 1996), and prospected for new ideas and knowledge domains (Germain et al. 2001, Li and Scullion 2006). These efforts not only have led them to develop their own automobile engines, but also helped them to create innovative ceramic engine technology beginning in the 1990s. The automobile industry in China

acts in a way that is similar to the e-commerce community knowledge management pattern in its global supply management (Reimers et al. 2004, Voelpel and Han 2005). Therefore, knowledge generation is viewed in terms of *initiatives to create knowledge activities* with a new knowledge paradigm across industrial borders.

Most knowledge generation requires anticipation, coordination, and creativity under unpredictable, risky, and chaotic conditions. Members put forth effort to adapt to changes from heterogeneous knowledge patterns and dissimilar knowledge origins. These may lead to high levels of cultural shock and resistance, and the members may lack motivation as a result. However, knowledge generation brings new ideas, vision, and encouragement to the members and creates the impetus for further development (Pisano and Wheelwright 1995, Schroeder et al. 1995, Ottum and Moore 1997, Song and Parry 1997, Wang 2000). This leads us to state the following hypothesis:

- Hypothesis 4 (The e-commerce community knowledge generation hypothesis): E-commerce community knowledge generation improves the process and product innovativeness of the members.

To evaluate the model and examine our hypotheses, this study develops instruments to measure e-commerce community knowledge management behavior, and conducts an empirical survey in China and Taiwan. We next discuss the method and results of the empirical study.

4. Methodology

4.1. Scale construction and the measures

This study employs a questionnaire technique to collect observations. Item generation is primarily based on the descriptors from the six experts of the previous in-depth interviews. Two experts' codified description from the interviews resulted in 21 descriptors regarding the modes. Two additional academia experts modified the descriptors with terminology from the literature and generated 28 items. To capture additional information about the knowledge management practices, the author invited four chief knowledge officers (CKOs) from China's and Taiwan's information industry who understand the knowledge activities in the related e-commerce communities to appraise the face validity of the draft descriptors. After deleting 5 unsatisfactory items regarding e-commerce community knowledge management practices, 25 pilot questionnaires based on the remaining 23-item scale were used to survey the e-commerce community members. Due to a lack of internal consistency, another 3 items were dropped according to evidence from the pilot test. Consequently, our study used a four sub-construct, 20-item e-commerce community knowledge management scale. Table 1 presents the detailed descriptors of the scale, corresponding experts, and reference literature.

To examine criterion validity, this study employs e-commerce community performance as the criterion. Since this study concentrates on knowledge activities in e-commerce community, following similar efforts made by Lin et al. (2007), Damanpour (1991), and Yap and Souder (1994), this study employs a performance scale to measure innovativeness performance, which consists of 22 items that relate to four constructs: *Innovation Willingness*, *Product Innovativeness*, *Process Innovativeness*, and *Member Satisfaction*. The scales are measured with five-point Likert-type scales (1, strongly disagree; 5, strongly agree) and the detailed descriptors are listed in Tables 1 and 3.

4.2. Sampling and the samples

The survey targeted 107 members of the China E-Commerce Association (CECA) in Beijing, China and 48 members of the Taiwan Asia–Pacific Electronic Commerce Association (TAPECA) in Taiwan as the samples. This study selected leading e-commerce community organizations in China and Taiwan. The two countries have diverse economies in terms of market scale, economic development, e-commerce utilization, and the dominant industry sector. China is a large-scale, emergent, and secondary industry-based economy with a growing utilization on e-commerce, while Taiwan represents a smaller-sized, more mature, and higher service-based economy with steady e-commerce usage. These heterogeneities reflect different facets of the samples and raise external validity issues for the results. Additionally, an identical language, culture, and close industrial interaction between the two countries minimized the difficulty in making cross-cultural observations and comparisons.

The member lists of CECA and TAPECA suggest the leading roles of some of the e-commerce communities (as the leading organizations) and some other members that are involved too. We chose to focus on the leading organizations that the members were associated with. Based on the member lists, we sampled all of the 232 members with mailing questionnaires from a self-administered survey. These samples originate from different sectors; 36% are in the integrated circuit-related and 24% belong to the automobile industry.

We obtained responses from 107 member firms (46.1%). Detailed statistical analysis confirmed that the structure of the industry is well represented by the various industry ratios of the mailed samples ($p > 0.62$). As for the background of the leading organizations, many are firms that have their own-brand names, and that seek subcontractor partners (46%) and manufacturers with which to integrate resources via e-commerce communities (42%). Relatively few come from the academic institutes (8%) and government sectors (4%).

4.3. Statistical techniques for data analysis

This study employs multivariate statistical techniques to examine model construction and validity. Cronbach's α coefficient is useful for examining the internal consistency of the two scales. Subsequently, following Joreskog and Sorbom's (1989) and Baggozi and Yi's (1988) evaluation criteria, indices of LISREL's confirmatory factor analysis (CFA) are used to examine convergent and discriminate validity. Moreover, Pearson correlations and regression analysis are used to test the validity of e-commerce community knowledge management effects on performance. Finally, descriptive statistics are presented to investigate the knowledge management practices of e-commerce community in China and Taiwan.

5. Results

5.1. Internal consistency and construction validity

Table 1 exhibits the results of internal consistency. The α coefficients for the four modes (knowledge dissemination, knowledge advancement, knowledge sharing deals, and knowledge generation) are 0.753, 0.815, 0.642, and 0.833, respectively. The values all exceed or are very close to the threshold (0.70) suggested by Nunnally (1978), indicating e-commerce community knowledge management measurement is internally consistent.

Table 1 lists the item-to-total correlation coefficient results of the scale. The coefficients from 20 items are scattered from 0.357 (item 13) to 0.806 (item 15), all of which match the significance le-

Table 1
ECKM scale: descriptive statistics and internal consistency analysis.

Item descriptors (the corresponding experts*)	Literature sources	Means	Cronbach's α	Item-to-total correlation
Knowledge dissemination	Richter and Vettel (1995) and Scheel (2002)			
1. We diffuse and assimilate the effective product knowledge to the members in our community (B, C)	Lindsay et al. (2003)	3.447	0.753	0.416
2. We bulletin practical market information via the Intranet and on-line tools to other firms/organizations within our community. (C, E, F)		3.748		0.573
3. We codify operational knowledge as documents and diffuse them to the members in the community (B, D)		3.585		0.520
4. We help the members in our community to effectively employ and utilize the knowledge (A, D, F)		3.423		0.582
5. The experienced experts in our community are assigned to transfer practical information regarding the technology, customers, and markets (B, C, D)		3.537		0.486
6. We construct a well-documented database and information system to preserve the relevant manufacturing information (A, D, F)		3.463		0.428
Knowledge advancement				0.576
7. Members in our community endeavor to modify and improve the existing products based on new consumer demand to prolong the lifecycle of products (B, C)	Hedlund (1994) and Sanchez and Heene (1997)	3.405	0.815	0.529
8. The leading firms in the community guide the members into new knowledge domains based on the market conditions (B, D)	Quintas et al. (1997) and Zack (1998)	3.785		0.632
9. We endeavor to integrate and transfer diversified production knowledge to improve our competitiveness (A, F)		3.314		0.574
10. We make efforts to improve and develop our products to catch up to the competitor's technology level (A, C, E, F)		3.442		0.712
11. We endeavor to apply new manufacturing knowledge to improve our business activities (C, F)		3.686		0.493
12. The members are used to following the demand shift of the market to adapt or modify the product or services (B, C)		3.770		
Knowledge sharing deals				
13. We are used to keeping in touch with partners outside of our industries to learn or purchase their marketing or technological knowledge (A, D, F)	Prahalad and Hamel (1994) and Ruggles (1998)	3.862	0.624	0.454
14. We integrate manufacturing knowledge from other fields and utilize it in our community to develop our products (B, D)	Davenport and Klahr (1998) and Streb (2003)	3.894		0.418
15. We keep up intensive interaction with academic, R&D, or government sectors to learn new production knowledge concerning marketplaces, customers, and competitors (D, E)		3.504		0.357
16. We are used to communicating and have meetings with partners outside of our industry to keep a good pace with their manufacturing knowledge (E)		3.724		0.427
Knowledge generation				
17. The members in our community jointly decide to set up knowledge/technology standards and prototypes when we endeavor to develop brand new products (D, E, F)	Lepkowski (1994) and Bierly and Chakrabarti (1996) and Nonaka and Konno (1998)	3.541	0.833	0.806
18. We jointly determine to set an R&D policy, priority, idea, domain, and rules of the alternatives when we conduct new products (B, C, F)	Germain et al. (2001)	3.438		0.680
19. We seek standardized and generalized knowledge from diversified knowledge sources, including our competitors, clients, and suppliers (A, D)		3.017		0.570
20. We decide how to assign duties and set the knowledge domains together when we develop new products (D, E)		3.355		0.603

Note: # All the item-to-total correlation coefficients are significant under the $p < 0.01$ level.
* The corresponding experts are those who mentioned the descriptors in the depth interviews.

vel requirement ($p < 0.05$). The evidence indicates good convergence and internal consistency on the four modes. The α coefficient for knowledge sharing deals (0.642) is somewhat lower, but still very close to 0.70, and all the item-total correlation coefficients are statistically significant. Hence, the measure remains as it was constructed. The measurement literature, as a rule of thumb, argues for a reliability of 0.70 or higher before employing an instrument. In practice, the appropriate reliability degree depends upon the use of the instrument. For example, a scale with less items will lead to lower internal consistency. The measure that this study uses is an exploratory scale with four items to represent a knowledge sharing deal. This might be the reason for the lower coefficient estimate, and it indicates that future refinement of the measurement is essential.

Table 2 presents out empirical results concerning the construct validity of the e-commerce community knowledge management scale appraised by LISREL. As for the CFA results, due to sample size ($N = 107$), both the chi-square value and NCI (normed chi-square index) somewhat fail to satisfy Baggozi and Yi's (1988) evaluation standards. However, the RMSR (root mean squared residual) value is lower than the less-than-0.05 standard, as both GFI and AGFI exceed the 0.90 thresholds. The total coefficient of determinants (TCD) approaches 1.00 (TCD = 0.945), and SMC (square multiple correlation) and the levels are higher than the 0.50 standards, indicating good convergence validity. These results exhibit good construct validity and goodness-of-fit for the model.

Table 2 presents the inter-construct Pearson correlation coefficients. Standardized cross-factor correlation coefficients (ranging from 0.184 to 0.326) reveal that these constructs may be correlated, representing that the scale fails to satisfy the inter-factor independence rule. However, the coefficients are still very distant from 1.00, signifying fair discriminant validity. To sum up, it is reasonable to conclude from the results of convergence and discriminate validity that the e-commerce community knowledge management scale exhibits good construct validity.

Table 2
ECKM construct validity test results.

Dissemination	Advancement	Deal	Generation
SMC(ξ1) = 0.631	SMC(ξ2) = 0.512	SMC(ξ4) = 0.632	SMC(ξ3) = 0.657
α = 0.841	α = 0.810	α = 0.833	α = 0.879
λ11 Fixed	λ72 Fixed	λ13.3 = Fixed	λ17.4 Fixed
λ21 = 0.931*	λ82 = 0.711*	λ14.3 = 0.633*	λ18.4 = 0.901*
λ31 = 0.858*	λ92 = 0.719*	λ15.3 = 0.557*	λ19.4 = 0.888*
λ41 = 0.832*	λ10.2 = 0.627*	λ16.3 = 0.521	λ20.4 = 0.754*
λ51 = 0.761*	λ11.2 = 0.589		
λ61 = 0.777	λ12.2 = 0.602		

Inter-factor correlation	ξ1	ξ2	ξ3	ξ4
ξ1	1.000			
ξ2	0.201*	1.000		
ξ3	0.308*	0.184*	1.000	
ξ4	0.212*	0.231*	0.326*	1.000
χ^2 (p value)			101.75 (<0.001)	
NCI			3.185	
GFI			0.905	
AGFI			0.898	
RMSR			0.045	
TCD (X)			0.994	

*The coefficient is significant under the $p < 0.01$ level.

Tables 3 and 4 present related statistical evidence of the innovativeness performance indicators. The statistics disclose that the items within the four dimensions are highly internally consistent (Cronbach's α is spread from 0.7409 to 0.8204), while the inter-construct correlations are distributed from 0.184 to 0.528 (with high coefficient correlation between product and process innovativeness) and have high model goodness (GFI = 0.901, AGFI = 0.897). The statistics exhibit good construction for the innovativeness performance indicators.

5.2. Criterion validity

To evaluate validity, this study employs correlation analysis and multivariate regression analysis to examine e-commerce community knowledge management effects on performance (as seen in Tables 5 and 6). All 16 correlation coefficients ($4 \times 4 = 16$) are statistically significant under the $p < 0.05$ standard. The empirical evidence indicates that e-commerce community knowledge management influences innovativeness performance, with most of the coefficients ranging from 0.40 to 0.50, revealing that e-commerce community knowledge management offers a fair to good explanation (criterion validity) of innovation.

Table 6 exhibits the results from multivariate regression analysis. The e-commerce community knowledge management modes perform well on all four criteria with high R squares, ranging from 0.340 to 0.931 and having significant model statistics ($p < 0.0001$). As for the βs, the *Dissemination* variable for knowledge dissemination shows positive effects on willingness (0.555, $p < 0.01$) and satisfaction (0.319, $p < 0.001$). The variable *Advancement* for knowledge advancement is correlated with satisfaction, and product and process innovativeness (0.277–0.552, $p < 0.01$). The *Deal* variable for knowledge sharing deals exhibits a modest impact on willingness, satisfaction, and process innovativeness (0.168–0.258, $p < 0.05$). *Generation*, the variable for knowledge generation, has milder and stronger effects on process and product innovativeness (0.126 and 0.439, $p < 0.05$). The statistics confirm all four hypotheses.

To sum up, the empirical results from the Pearson correlation and regression analysis indicate that the four e-commerce community knowledge management constructs contribute to the explanation of innovativeness performance. Among the four modes, the coefficients signify that knowledge advancement and knowledge sharing deals have a grater effect on the knowledge management outcomes.

5.3. Some descriptive statistics results

Table 1 lists the mean values of the 20 e-commerce community knowledge management items, which represent e-commerce community knowledge management tendency in China and Taiwan.

Table 3
Innovativeness performance indicator scale: descriptive statistics and internal consistency analysis.

Item descriptors	Means	Cronbach's α	Item-to-total correlation
Innovation willing			
16. The members in our B2B system are used to learning new technology and knowledge	3.813	0.7409	0.557
17. The members in our B2B system are willing to spend time to learn new knowledge	3.358		0.659
18. The members in our B2B system are willing to invest in the new technology/knowledge	3.756		0.489
Product innovativeness			
1. We rapidly recognize the market demand to develop new product ideas	3.541	0.8204	0.631
2. We can form new and effective product ideas to develop new products	3.438		0.704
3. We can generate brand new products in a very short time-span	3.017		0.587
4. We can quickly modify the design of the existing products	3.405		0.673
5. We can renew the old-fashioned products to improve their value	3.785		0.429
6. We are good at developing products with diversified fashions	3.314		0.610
Process innovativeness			
7. We can develop more efficient production processes on our own	3.443	0.7923	0.386
8. The costs of our products are lower than our competitors	3.131		0.364
9. We can more effectively distribute our products than our competitors	3.355		0.387
10. Our manufacturing processes can improve the product quality	3.687		0.582
11. Our manufacturing processes can decrease the failure ratio of the production	3.770		0.633
12 We are good at providing just-in-time orders	3.639		0.565
13. We can produce urgent orders in very short time-span	3.570		0.431
14. We can flexibly supply the products according to the needs of our customers	3.752		0.555
15. We can take urgent orders and supply the products rapidly	3.512		0.428
Member satisfaction			
19. The members in our B2B system feel learning new knowledge is beneficial for their work	3.691	0.7667	0.612
20. The members in our B2B system can apply what they have learned to their jobs	3.634		0.622
21. The members in our B2B system feel that the learning activities can get their jobs better accomplished	3.618		0.498
22. The members in our B2B system feel that the new technology and knowledge are good to them	3.439		0.485

Note: # All the item-to-total correlation coefficients are significant under the $p < 0.01$ level.

Table 4
Performance construct validity test: LISREL results.

Product innovativeness	Process innovativeness	Innovation willing	Member satisfaction
SMC(ξ1) = 0.598	SMC(ξ2) = 0.612	SMC(ξ3) = 0.583	SMC(ξ4) = 0.611
α = 0.820	α = 0.792	α = 0.741	α = 0.767
λ11 Fixed	λ72 Fixed	λ16.3 = Fixed	λ19.4 Fixed
λ21 = 0.902*	λ82 = 0.911*	λ17.3 = 0.777*	λ20.4 = 0.852*
λ31 = 0.851*	λ92 = 0.849*	λ19.3 = 0.654*	λ21.4 = 0.808*
λ41 = 0.844*	λ10.2 = 0.828*		λ22.4 = 0.724*
λ51 = 0.751*	λ11.2 = 0.783		
λ61 = 0.677	λ12.2 = 0.716		
	λ13.2 = 0.701		
	λ14.2 = 0.658*		
	λ15.2 = 0.652*		

Inter-factor correlation	ξ1	ξ2	ξ3	ξ4
ξ1	1.000			
ξ2	0.528*	1.000		
ξ3	0.218*	0.184*	1.000	
ξ4	0.301*	0.271*	0.426*	1.000
χ^2 (p value)				131.75 (<0.001)
NCI				3.015
GFI				0.901
AGFI				0.897
RMSR				0.055
TCD (X)				0.992

*The coefficient is significant under the $p < 0.01$ level.

Table 5
ECKM's criterion validity on performance indicators: correlation analysis.

PerformanceECKM	Innovation willingness	Product innovativeness	Process innovativeness	Member satisfaction
Dissemination	0.55**	0.20*	0.40**	0.48**
Advancement	0.28**	0.85**	0.70**	0.44**
Deal	0.42**	0.19*	0.41**	0.46**
Generation	0.20**	0.90**	0.57**	0.31**

* $p < 0.05$.
** $p < 0.01$.

Table 6
ECKM's criterion validity on performance indicators: regression analysis.

PerformanceECKM	Innovation willingness	Product innovativeness	Process innovativeness	Member satisfaction
Intercept	−1.377*	0.494*	−0.044	−0.538
Dissemination	0.555**	−0.084	0.142	0.319**
Advancement	0.130	0.552**	0.443**	0.277**
Deal	0.224*	−0.034	0.168*	0.258**
Generation	−0.015	0.493**	0.126*	0.004
F value	14.88	385.94	37.89	17.32
p-Value	0.0001	0.0001	0.0001	0.0001
R-square	0.340	0.931	0.571	0.378

* $p < 0.05$.
** $p < 0.01$.

The item means of dissemination range from 3.423 to 3.748, indicating a fair level of knowledge dissemination. Since knowledge dissemination is the simplest and most essential e-commerce community knowledge management mode of the four, this might imply that the efforts on knowledge diffusion and transfer are insufficient for e-commerce communities in the two economies. Additionally, the means for advancement items are spread between 3.314 and 3.770, representing a higher tendency toward extension and expansion behaviors. As for knowledge sharing deals, the item means are from 3.504 to 3.894, suggesting that trade, interchange, and cooperative behaviors are common in e-commerce community knowledge management. Finally, the means of knowledge generation range from 3.017 to 3.541, indicating the lowest tendency of the four. This finding conforms to knowledge management practices there. To summarize, the descriptive statistics representing e-commerce communities in China and Taiwan represent a middle level of e-commerce community knowledge management.

6. Conclusion

6.1. Main findings

There is a growing number of firms starting to organize and participate in e-commerce communities to improve their capability and knowledge. Most studies in the literature have investigated knowledge management issues at the *firm and organizational* level. They view the firm as a knowledge base (Conner and Prahalad 1996, Grant 1996, Kogut and Zander 1998), while neglecting the emerging reality that many knowledge activities are conducted at the level of e-commerce community, particularly in Asian NIEs. This study attempts to explore Asia's e-commerce community

knowledge management through in-depth interviews, model construction, and an empirical survey in China and Taiwan. This study provides an e-commerce community-level insight into the knowledge management issue that gives an alternative view on Asia. After reviewing related articles, this study defines e-commerce community knowledge management and concludes that four modes – knowledge dissemination, advancement, sharing deals, and generation – are appropriate to form the e-commerce community knowledge management model.

Our 107-observation empirical survey, which samples the leading e-commerce community organizations in China and Taiwan as respondents, confirms that the e-commerce community knowledge management scale matches the requirements of face validity, internal consistency, and construct validity. Empirical evidence indicates knowledge activities in e-commerce communities are involved in product planning, R&D, prototype initiation, manufacturing, and marketing. The results suggest that, of the four modes, e-commerce communities in China and Taiwan that perform better in knowledge advancement operate at the lowest end in knowledge sharing deals.

As for the validity of e-commerce community knowledge management modes, our statistical evidence indicates that the four modes positively correlate with innovativeness-related performance, signifying appropriate validity. Knowledge advancement and sharing deal show higher effects on the criterion than other modes. Additionally, the results suggest that e-commerce community knowledge management loads on all of the performance indicators, particularly process innovativeness and member satisfaction. The R squares for the explained variance range from 0.340 to 0.931 signifies good explanation of the innovation indicators.

6.2. Discussion

Evidence collected with in-depth interviews indicate that e-commerce community knowledge management in China and Taiwan is specific and different from the western context. Many knowledge activities in China are conducted with cooperation between partners within and outside the industry rather than developed on their own. The partners include suppliers, distribution channels, customers, people in academic sectors, and even competitors. The evidence and literature (Burrows et al. 2005, Geng et al. 2005, Lu et al. 2006, Tarn 2006, Lin et al. 2007) indicate the nature of knowledge activities in China and Taiwan.

The empirical results reveal some of the e-commerce community knowledge management practices in China and Taiwan. The mean values of e-commerce community knowledge management items range from 3.017 to 3.894, most of which are located around 3.50, showing a medium level of e-commerce community knowledge management (Tarn 2006, Voelpel and Han 2005) relative to the findings from the firm-level literature. Due to the over-emphasis on manufacturing, firms in many NIEs in Asia pay the most attention to process improvement, quality, and cost reduction, while neglecting the importance of knowledge. In reality, e-commerce community partners primarily help firms in knowledge activities regarding competition, marketplace, and international trade. The evidence verifies the kinds of e-commerce community conditions that occur in China, Taiwan, and many other Asian NIEs (Yang et al. 2006).

Our observation of four e-commerce community knowledge management modes suggests some differences from firm-level studies. Of the four modes, e-commerce communities in China and Taiwan first act as a lower level of knowledge dissemination (means from 3.423 to 3.748). Since knowledge dissemination is the simplest and most essential mode, the efforts on knowledge diffusion and transfer seem to be insufficient. Second, the means of knowledge advancement are range from the medium to high level, suggesting that those knowledge activities differ from what the studies in the firm-level literature show (Quintas et al. 1997, Sanchez and Heene 1997). Based on the mean values, e-commerce communities behave on a higher level of knowledge domain guidance (item 8, 3.785), and knowledge adaptation and modification (item 12, 3.770), while performing on a lower level of knowledge integration (item 9, 3.314), and catching up to the knowledge level of the competitors (item 10, 3.442). As for knowledge sharing deals, the means are located on a divergent scale as well, exhibiting a higher magnitude on knowledge convergence and utilization (item 14, 3.894) and interaction activities (item 13, 3.862), but a lower magnitude on connection with research and academic institutes (item 15, 3.504). Finally, since knowledge generation is the most complicated and costly mode, the results also indicate the lowest tendency of the four relative to past studies. The previous conditions roughly portray e-commerce community knowledge management scenarios in China and Taiwan and confirm the literature (Pisano and Wheelwright 1995, Kao et al. 2006). Interestingly, the respondents tend to perform at lower on the modes regarding competition, that is, items 1–6, 10, and 13. The lower tendency may be attributable to the delicate competition relationship among the e-commerce community members: they are co-workers and competitors simultaneously. It forces the members to decrease knowledge activities to protect their own proprietary information.

Evidence from regression analysis (Table 6) for the four hypotheses deserves our attention. Knowledge advancement and sharing deals have higher effects on innovativeness than knowledge dissemination and generation (with significant coefficients up to 0.552 and 0.258). Based on our model's construction, dissemination and generation are the most conservative (identical knowledge in the same industry) and the most radical (heterogeneous knowledge from different industry) modes, while knowledge advancement and sharing deals have effects that are in the middle of the extremes. This result suggests that modest aggressiveness on e-commerce community knowledge management performs better than conservative and enthusiastic modes, which corresponds to what Lin et al. (2007) find.

Additionally, the results show that the two modes of knowledge management within an identical industry, knowledge dissemination and sharing deals, have greater impacts on willingness and satisfaction, while beyond industry boundaries, the two are more beneficial for process and product innovativeness. This may imply that working with the same industry members can raise psychological safety issues and motivate members to commence new knowledge management activities (Wang 2000, Lin et al. 2007). Nevertheless, knowledge resources from different fields can nurture new directions for radical improvement on process and product development (Pisano and Wheelwright 1995, Schroeder et al. 1995, Song and Parry 1997, Ottum and Moore 1997, Wang 2000).

6.3. Contributions and future work

This study provides new insights into knowledge management issues from an e-commerce perspective. We next point out some contributions and suggestions for future researchers and practitioners. First, even though it is flourishing in practice, the e-commerce perspective of knowledge management has been seriously neglected. It seems that now is the time to target and work for e-commerce community knowledge management. The items in Table 1 can be treated as a checklist to start e-commerce community knowledge management efforts.

Second, this study constructs an e-commerce community knowledge management scale. However, refinement of the scale may be essential for any follow-up research. Some feasible direc-

tions include investigating new e-commerce community knowledge management activities aside from the contents mentioned in this study, modifying the descriptors, and making replication studies.

Third, this study samples leading organizations in China and Taiwan as respondents for the empirical survey. Since e-commerce communities are technology-based, the findings may only reflect e-commerce community knowledge management's effects for hi-tech or high-capital industries, while they may fail to generalize to ordinary manufacturers and service providers. Future studies may target more industries from more economies as samples and conduct comprehensive and comparative studies to explore the differences of e-commerce community knowledge management with competing industries. These efforts can raise the external validity of the model.

Fourth, this study explores how Asian economies conduct e-commerce community knowledge management. Due to time and budget limitations, this study only concentrates on the e-commerce community knowledge management context of these two economies. Both China and Taiwan play key manufacturing roles in Asia. China is the world's factory today, while Taiwan has developed very robust e-commerce communities linking related firms around the world. Thus, the experiences in these two economies are representative of e-commerce community knowledge management in Asia. It is essential to sample more economies in this area to examine external validity further though. This study explores e-commerce community knowledge management model in Asia, while the model may be also satisfactory for other cultures.

Due to small scale of individual firms and markets, e-commerce community knowledge management in Asia may exhibit a particular knowledge management model based on inter-organizational communities of practice. In larger-scale firms in the U.S., Europe, and Japan, the analogous knowledge activities may be conducted within the firms by means of intranet and internal information systems rather than inter-organizational modes (Stahle and Hong 2003, Lin et al. 2007). Nevertheless, the growing globalization has forced them to outsource from and cooperate with external partners. Thus, the e-commerce community knowledge management model, derived for Asia, may be suitable for other cultures. Therefore, the comparative effect between the cultures is a potential issue for further research efforts.

Fifth, the primary purpose of this study is to conduct an exploratory empirical survey to test the proposed e-commerce community knowledge management scale. This study has only sampled the leading organizations for observations, making all the observations perceptual. Since each e-commerce community consists of members from diversified sectors, it is reasonable to sample more members for each e-commerce community, including the leading and partnering members, so as to collect comprehensive e-commerce community knowledge management information. This not only can alleviate common method bias, but will also help in conducting a multi-level analysis. Additionally, B2B e-commerce is a business activity, but the stakeholders involved are not in the business sector only. In previous cases, SDMA (in knowledge advancement), ITRI and NSC (in knowledge sharing deals), and AEMDA (in knowledge generation) have been established under cooperation among governmental, academic, and business sectors. Thus, governmental and academic sectors are not just observers, and any future study can include these other parties to clarify their functions.

Finally, this study focuses on the conditions in e-commerce community knowledge management, but does not report on the antecedents of e-commerce community knowledge management. Solely understanding e-commerce community knowledge management in a particular industry does not make any sense, but exploring why e-commerce community knowledge management is enacted is certainly essential. Future studies can work to investigate e-commerce community knowledge management determinants, such as industrial characteristics, knowledge features, and market conditions.

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