Knowledge management in supporting collaborative innovation community capacity building

1. Introduction

Collaborative innovation is a trans-disciplinary approach for developing the wholeness synergy to improve the competitiveness of an organization through holistic, competitive and complementary interactions between and among innovation participants in a specific environment (Zhang et al., 1997; Swink, 2006; Bommert, 2010; Cai, 2012). It is becoming increasingly popular among governments, organizations, universities and research institutions in their active search for innovative ways to improve the effectiveness, efficiency and competitiveness of their operations in today's dynamic environment (Gloor, 2006; Karlsson, 2008; Niosi, 2010). The popularity of collaborative innovation in organizations is due to the benefits that it can bring with for individual organizations including obtaining more resources when facing competition for limited resources, gaining better recognition, and improving the competitiveness of individual organizations (Wagner, 2004; Chen, 2012).

The tremendous potential of collaborative innovation for improving the competiveness of individual organizations leads to an increasing amount of resources and efforts being spent for developing various collaborative innovation communities in organizations and for building the capacity of such communities (Gloor, 2006; Bommert, 2010; Cui, 2011). In this context, collaborative innovation community capacity building (CICCB) is about the development of social constructs to achieve the wholeness synergy on social innovation, science and technology innovation, economic and political reform and social changes through the engagement of various participants in collaborative problem solving and collective vision building (Miller, 2010; Ministry of Education of China, 2012). Much research has been done on the mechanisms, models and strategies for collaborative innovation and the demand for improving the performance of collaborative innovation (Cowan et al., 2007; Chen and Yang, 2012). There is, however, a lack of a systematic study of such a kind supported by empirical studies from the perspective of community capacity building (Fawcett, et al., 2011).

Knowledge management is one of the popular approaches for improving the performance of collaborative innovation in organizations (Clarke and Cooper, 2000; Chen and Wei, 2008; Füller et al, 2012; Kong et al., 2012; Luo et al., 2012). Effective knowledge management encourages and enhances the collaboration between and among employees in their pursuit of innovative business practices in an organization (Deng, 2006). Knowledge management itself, however, does not automatically increase collaboration in organizations. This is because knowledge management is a collaborative activity that depends on the creation of 'a shared context' between participants (Deng, 2008; Clarke and Cooper, 2000). The process of developing innovations depends on knowledge and how the knowledge is created and shared in an organization. There is a wide recognition that the management of knowledge is an essential element of running any types of business (Gloet and Terziovski, 2004; Plessis, 2007). There is, however, a lack of in-depth studies on the role of knowledge management in CICCB and the knowledge management approach for effective CICCB in organizations.

This paper aims to fill in this gap by addressing the following two questions: (a) what are the roles of knowledge management in CICCB, and (b) what are the knowledge management approaches for supporting CICCB? To effectively answer these two questions, this paper presents a comprehensive review of the related literature in both collaborative innovation and knowledge management from a trans-disciplinary perspective for CICCB. Such a review leads to the identification of the three demands for CICCB including (a) trust building for enhancing the effectiveness, (b) sustainability building for improving the efficiency, and (c) extensibility building for developing the competitiveness in organizations. Three roles of knowledge management in supporting CICCB are identified including (a) the reformation of knowledge management for convergence in collaboration, (b) the remediation of knowledge activities for synergy in communication, and (c) the reconfiguration of knowledge artifacts for the integration of knowledge management activities in connectivity. To adequately meet the three demands with respect to the role of knowledge management in CICCB as above, a holistic approach is proposed for effective CICCB including (a) the multi-dimensional convergence for trust building in collaboration, (b) the multi-directional synergy for sustainability building in communication, and (c) the multi-layer integration for extensibility building in connectivity in organizations.

In what follows, the related literature in collaborative innovation is first reviewed. This is followed by a critical analysis of the literature on CICCB from the perspective of knowledge management. Such an analysis leads to the development of a holistic approach for effective CICCB in organizations. Finally, the applicability of the proposed approach for effective CICCB is discussed, the limitation of the current study is presented, and the future research in this area is elaborated.

2. Collaborative innovation for organizational competitiveness

With the increasing globalization in today's dynamic environment, there is a sustained push to improve the efficiency,

effectiveness and competitiveness of individual organizations through innovation (Zhang and Deng, 2008; Baldwin and Von, 2011). Organizations need innovative processes and management that can drive down costs and improve productivity to be competitive (Baldwin and Von, 2011; Chen, 2012). In this context, innovation is the application of better solutions that meet new requirements, unarticulated needs, or existing market needs (Swink, 2006; Serrano and Fischer, 2007). Such an innovation is usually accomplished through more effective products, processes, services, technologies, or ideas that are readily available to markets, governments and societies (Chen, 2012).

There are several reasons why innovations are critical to the success of individual organizations (Plessis, 2007; Bueno and Balestrin, 2012). Although every organization has its own priorities and sector-specific issues to balance, businesses that fail to innovate run the risk of losing ground to competitors, losing key staff, or simply operating inefficiently (Coming, 1998; Chen, 2012). Innovation can be a key differentiator between market leaders and their rivals. In general the importance of innovation can be reflected in three perspectives. Firstly, innovation can help organizations discover what opportunities exist now, or are likely to emerge in future. Secondly, innovation is not only about designing a new product or service to sell, but can also focus on existing business processes and practices to improve the organizational efficiency, find new customers, cut down waste and increase profits. Thirdly, consumers often see innovation as something that adds value to a company or to its products (Baldwin and Von, 2011).

Collaboration is about working together, joining forces or teaming up in a specific situation for solving specific problems (Cowan et al., 2007; Tomas, 2009; Cai, 2012; Boehm and Hogan, 2013). It is the pooling of resources, talents and the best that a team has to offer. Collaborative innovation is a team working together to create new ideas (Li, 2011; Chen, 2012). The collective talent and resources of a group who are diverse yet focused on a common interest will inevitably lead to new paths within an organization. Innovations are the key to what drives organizations forward within today's global economy (Bommert, 2010; Chen, 2012).

Collaborative innovation is critical for the success of individual organizations due to the benefits that it can offer to individual organizations (Gloor, 2006; Fan, 2008; Cui, 2011; Chen, 2012). Firstly, collaborative innovation allows the sharing of new ideas in organizations. With teams working together and pooling intellectual revenue, more ideas will naturally be forthcoming. Secondly, collaborative innovation facilitates building on others ideas. With creative brain power from multiple individuals, new directions on the ideas can be improved upon. People with different expertise, diversity and backgrounds can elaborate in different ways, adding their take on how the idea can be developed and why. Thirdly, collaborative innovation encourages buying in ideas (Cai, 2012). When people invest a part of themselves into an innovation, their interest is peaked. They will strive to have their work a success as they will take ownership, pride and active interest in its success. Finally, collaborative innovation promotes engagement that translates into success. Even collaborative innovations that are not ultimately successful in the market will translate into raised engagement within the organization. Engagement translates to greater loyalty, quality and ultimately profitability when collaborative innovation's products achieve the desired outcome (Li, 2011; Greer and Lei, 2012).

Much research is done in collaborative innovation worldwide due to its huge potential to the success of individual organizations (Gloor, 2006; Cui, 2011; Chen, 2012; Fuller et al., 2012). A title search of 'collaborative innovation' in the Chinese literature found 479 studies from Chinese databases in which 119 studies are included in the Chinese Social Science Index. The same title search in the Web of Science database leads to the identification of 179 related studies. An analysis of the studies above reveals several major trends on the research in collaborative innovation discussed in the following.

There is an increasing recognition of the importance of collaborative innovation (Gloor, 2006; Fan, 2008; Li, 2011; Chen, 2012) in the literature exemplified by the increasing number of publications every year. A comprehensive title search in the Chinese literature shows that the concept of 'collaborative innovation' was firstly discussed in China in 1997. Since 2007, more than seven papers are published every year. Between 2011 and 2013, more than twenty papers are published each year. A similar title search in the English databases shows that the earliest English paper on 'collaborative innovation' available from the databases was in 1993. Since 2007, more than 20 papers are published every year related to collaborative innovation. The increasing number of publications in both the Chinese literature and the English literature shows that the study of 'collaborative innovation' is increasingly gaining attention worldwide.

The collaborative innovation research is increasingly becoming multi-disciplinary worldwide (Cui, 2011; Chen, 2012). The title search in the Chinese literature shows that collaborative innovation research has appeared in 27 disciplinary fields. There are 15 disciplinary fields that have more than two publications. The same title search in the English literature shows that collaborative innovation research has been discussed in 62 disciplinary fields, with 39 disciplinary fields having more than 2 papers. Such findings indicate that 'collaborative innovation' has become a common interest in multi-disciplinary research. Little attention, however, has been paid to the community capacity building in collaborative innovation in organizations.

There is an increasing support from various funding bodies worldwide to the collaborative innovation' research. A title search in the Chinese literature shows that 27 types of funding have been given to 'collaborative innovation' research, among which 6 types of funding have funded more than 4 projects. In the English literature, 15 types of funding are available to 'collaborative innovation' research projects. The analysis seems to show that China has paid more attention to the 'collaborative innovation' research in order to improve its global competitiveness. Furthermore, the types of funded projects indicate that 'collaborative innovation' research has been regarded as having multiple values with both academic and practical significance.

Collaborative innovation is very much dependent on the transfer, sharing and protection of knowledge in organizations (Cui, 2011; Chen, 2012). This is because Knowledge transferring improves the performance of collaborative innovation based on the community of practice and knowledge chains (Henttonen et al., 2004; Gertner et al., 2011). Knowledge sharing promotes economic development of collaborative innovation by new social constructs of value networks, wisdom of crowds, partnerships beyond organizational boundaries, integration of information and communication technologies and knowledge (Rosell and Akemond, 2012). Knowledge protection enhances the effectiveness of collaborative innovation through the development and implementation of appropriate intellectual property strategies and policies to solve the conflicts between the innovation participants (Luo et al., 2012; Zhang and Tan, 2013).

There is much research on the type of collaborative innovation through knowledge management including innovation ecosystems (Mercier-Laurent, 2011), science-to-business collaborations (Braun and Hadwiger, 2011; Boehm and Hogan, 2013), university-industry collaboration (Hanel and St-Pierre, 2006; Santoro and Bierly, 2006; Buerkner and Damm, 2011; Gertner et al., 2011), University-industry and research center collaboration (Nursall, 2003). In these collaborative innovations, virtual collaboration, open innovation, value networks, and dynamic and linked organizational boundaries are the key features of the collaborative innovation community. Complementary sharing of knowledge and a better use of talents, funds, information, knowledge and technology for the development of a win-win relationship are the goals of a collaborative innovation community (Mercier-Laurent, 2011). There is much attention in existing studies on the technology innovation (Gloor, 2006; Swink 2006; Davis, 2007; Serrano and Fischer, 2007; Wise et al., 2011; Retalis and slope, 2011; Fuller et al. 2012) and the economic innovation (Baldwin and Von, 2011; Greer and Lei, 2012; Pai et al., 2012; Wild et al., 2013) from the disparate disciplinary perspective. Little attention is paid to the inter-relationship and the interaction between various types of collaborative innovations from the perspective of community capacity building. This shows that there is a demand for studies on the social construct of CICCB for achieving shared goals and developing the whole community vision to societal innovation as well as identifying the steps to make such visions real. To adequately address this issue, a critical analysis of the existing literature on CICCB from the perspective of knowledge management is presented in the following.

3. Collaborative innovation community capacity building

Community capacity is the "interaction of human capital, organizational resources, and social capital within a given community that can be leveraged to solve collective problems and improve or maintain the well-being of that community" (Deorah, 2007; Chaskin et al., 2001; Kenny and Clarke, 2010). It can be operated through informal social processes and/or organized efforts by individuals, organizations, and social networks that exist among them and between them and the larger systems of which the community is a part (Deorah, 2007). There are four characteristics of community capacity (Chaskin et al., 2001) that provide a foundation for collective actions in organizations including:

- The degree of connectedness among members and the recognition of the mutuality of the circumstance including a threshold level on collectively held values, norms and visions for sharing and togetherness,
- The commitment to the community among its members, which describes the responsibility that particular individuals, groups or organizations take for what happens in the community, the obligations and the willingness of community members as stakeholders,
- The ability to solve problems, which refers to the ability to take charge of and make decisions as a collective group, to be able to endure or adapt over time, responding to or compensating for the impact of community change, and
- An access to resources, which refers to the capacity to access economic, human, physical, and political resources within and beyond the community, at different levels and from different types of external actors.

Community capacity building is "the process of developing and strengthening the skills, instincts, abilities, processes and resources that organizations and communities need to survive, adapt, and thrive in the fast-changing world" (Deorah, 2007; Kenny and Clarke, 2010; Miller, 2010). It is a conceptual approach that focuses on understanding the obstacles that inhibit people, governments, organizations and non-governmental organizations from realizing their developmental goals while enhancing their abilities for achieving measureable and sustainable results and improving and building their own collective commitments, resources and skills (Kenny and Clarke, 2010).

CICCB is a participative model for focusing on consensus building, sustaining multiple and diverse networks and relationships, identifying and celebrating community strengths and assets, generating broad-based community involvement toward mutual gains, developing whole community visions for the future, and identifying steps that can be taken to make such visions real (Miller, 2010; Chen, 2012). Such a way of thinking is important for increasing the success of innovation as the participants engage in collaborative problem solving with shared knowledge for mutual benefits and complementary advantages while sharing difficulties and obtaining greater resources and recognition when facing competition for finite resources (Wagner, 2004; Cui, 2012). Such an achievement depends only on the interaction with others, indispensable for the realization of one particularly important value, necessary for the realization of various goods (Mason, 2000). Having examined the domain of collaborative innovation and their patterns in research and practice, CICCB can be categorized into organization-based CICCB, location-based CICCB and clusters-based CICCB (Greer and Lei, 2012).

Organization-based CICCB is a process of collaboration within an organization (Zhang et al., 1997; Cai, 2012). It focuses on the influential factors including technological, organizational and cultural aspects and the technology and non-technology aspect for organizational innovations. Its purposes are to facilitate the interaction between multi-directional activities and practices within an organization. The typical application of organization-based CICCB is the integration of supply chains and working patterns for serving customers better and quicker, thus saving time and creating value (Coming, 1998; Heng et al., 2005; Bueno and Balestrin, 2012）

Location-based CICCB is a process of collaboration across organizations within a region (Meijers, 2005; Chen, 2012). It focuses on the coordination of key actors via networking within a region. The domain of collaborative innovation is at a local level since the participants are from multi-dimensional sectors and disciplinary fields. To make individual participants work together across various organizations, internal honesty, transparency, commitment and accountability are essential for the success of such collaboration (Chen, 2012). Location-based CICCB provides an open and innovative way to absorb creative ideas and integrate talent human resources and other resources to enhance the competitiveness of a region (Cowan et al, 2007).

Clusters-based CICCB is a process toward open collaboration across localities (Wang and Deng, 2007; Zhong, 2007; Fan, 2008; Retails and Sloep, 2011). This type of collaboration focuses on the coordination of key factors, participants and activities of a particular area for enhancing their effective interactions through Internet-based networks. The domain of collaborative innovation is at a societal level since the interactions between participants and activities are at multi-layers. Knowledge sharing and networks between participants and between organizations are the key for the success of such collaboration. Clusters-based CICCB provides organizations, regions and countries with a strategic plan to effectively integrate global and regional innovation resources and to promote the self-innovation of a particular industry (Gloor, 2006; Xie and Zeng, 2009; Berasated and Castellano, 2011).

Understanding the change and response of interactions in collaborative innovation and the obstacles that inhibit the interaction from realizing their collaborative innovation goals in the above three collaborative innovation domains, three demands for developing and improving collective commitments, resources and skills in CICCB are identified including (a) trust building for enhancing the organizational effectiveness, (b) sustainability building for improving the organizational efficiency, and (c) extensibility building for developing the organizational competitiveness.

Trust building among different innovation participants is crucial for enhancing the effectiveness in an organization (Cai, 2012). With multiple innovation participants from multiple disciplinary fields and sectors, collective vision building faces great challenges. For example, intellectual property protection and knowledge sharing depend on trust building for shared values in collaboration for the enhancement of organizational effectiveness (Niu, 2010; Fawcett, et al., 2011; Boehm and Hogan, 2012; Chen, 2012; Kong,et al., 2012; Luo, et al, 2012).

Sustainability building in different innovation practices is critical for improving the efficiency of organizational operations in the long term (Chen, 2012; Deng, 2014). With the multi-directional dynamic changes of the influential factors in the innovation process, maintaining a sustainable outcome in a specific situation in organizations becomes difficult (Zhang et al., 1997; Coming, 1998). There is a wide recognition that innovative ways for building consensus (Wibowo and Deng, 2013) and encouraging participation in a shared way of life rather than exerting controls through communication are important for the improvement of the organizational efficiency (Bueno and Balestrin, 2012; Cai, 2012).

Extensibility building along the life of different innovation projects is the key for developing the organizational competitiveness in an organization (Kong et al., 2012). With the multi-layers of systems and platforms in the innovation architecture, cutting costs and sharing resources through networks create mutual benefits for all the innovation programs. Building all-round connections across people, processes and technologies, inside and outside and identifying the group and mutual reorganizations in connectivity are critical for developing organizational competitiveness (Fuller, et al, 2012; He, 2012). Table 1 shows a summary of the discussion above.

Insert Table 1 here

4. Knowledge management for collaborative innovation capacity building

Knowledge management is a systematic process of managing knowledge assets, processes, and organizational environments to facilitate the creation, organization, sharing, and utilization of knowledge for achieving the strategic aim of an organization (Song and Deng, 2005; Deng, 2010). It is a formal process that engages an organization's people, processes, and technologies in a solution that captures knowledge and delivers it to the right people at the right time (Duff, 2001; Jashapara, 2010). Knowledge management is an effective learning process with the exploration, exploitation and sharing of organizational knowledge using appropriate technologies in a specific environment for enhancing an organization's intellectual capital and learning capabilities (Japshapara, 2010). It is a multidisciplinary approach that takes a comprehensive and systematic view of the knowledge assets in an organization by identifying, capturing, collecting, organizing, indexing, storing, integrating, retrieving, and sharing organizational knowledge (Geisler and Wickramasinghe, 2009).

Knowledge management is increasingly gaining recognition as the determinant for improving the performance, competitive advantages and innovation through the sharing of lessons learned, integration of various resources and capacities, and continuous improvement of an organization (Geisler and Wickramasinghe, 2009; Xiong and Deng, 2008; Chen, 2012). In recent years, the significance of knowledge management for organizational competitiveness and better performance has been widely recognized around the world (Deng and Martin, 2003; Deng, 2010). This leads to the identification of various knowledge management strategies and practices for identifying, creating, representing, distributing, and enabling the adoption of organizational knowledge in order to develop the competitiveness of an organization.

From the perspective of collaborative innovation, knowledge management has provided a common language set for multidisciplinary projects that support people to access, create and share knowledge and leverage the knowledge for their competitive advantages (Deng, 2005; Geisler and Wickramasinghe, 2009). It provides organizations with networked architecture for community development and collaboration (Chen, 2012). Knowing how, when, why to collaborate involves community participants in innovation (Yahia et al., 2012). A critical analysis of existing literature on knowledge management in CICCB leads to the identification of the three roles of Knowledge management in CICCB. Table 2 presents an overview of the three roles including the reformation of knowledge management, the remediation of knowledge activities and the reconfiguration of knowledge artifacts for supporting CICCB.

The reformation of knowledge management for convergence in collaboration is to reformat the knowledge arrangement practice for the convergence of different knowledge stakeholders and knowledge innovation participants to build an alliance system for achieving collective visions and common goals in order to enhance the effectiveness of innovation (Chen, 2012). The knowledge center of a smart city project in an Australian city is a good example of such a role (An, 2013). The mechanism behind such a role is a social arrangement of multi-dimensional knowledge stakeholder partnerships to play the leadership role in harnessing complementary capacities and promoting a fair share of the costs and benefits of managing resources in a specific situation (An, 2013).

Insert Table 2 here

The remediation of knowledge activities for synergy in communication is to remediate knowledge activities for synergy between and among different knowledge management components and the degree of cohesiveness of knowledge in supporting the common interest and needs of individual participants by collective governance and interactions for improving the efficiency of innovation in organizations (Chen, 2012). It is a response to the complexity and multiplicity of the concerned innovation factors. The SECI knowledge conversion model proposed by Nonaka and Takeuchi (1995) in terms of the tacit knowledge to tacit knowledge transformation (socialization), the tacit knowledge to explicit knowledge transformation (externalization), the explicit knowledge to explicit knowledge transformation (combination), and the explicit knowledge to tacit knowledge transformation (internalization) has provided a framework for the management of relevant processes for the appreciation of the dynamic nature of knowledge and knowledge creation (Noaka and Takeuchi, 1995; Noaka et al., 2000). It has been used for examining knowledge activities during university-industry collaboration, which shows that a flexible structure works better for encouraging the transfer of knowledge than the traditional structure (Cheng and Wei, 2008).

The reconfiguration of knowledge artifacts for integration in connectivity is to reconfigurate knowledge artifacts for integration of knowledge innovation participants, actions and their interactions together by web 2.0 networks, platforms and infrastructure in support of shared ideas, information and work (Cai, 2012). Such an approach can develop

competitiveness, and enhance effectiveness and improve efficiency in organizations. A good example of this is the virtual world as a collaborative innovation and knowledge platform (Kong et al., 2012). Existing studies show that web 2.0 applications (Karunasena et al., 2012,; 2013) and virtual worlds bear the potential to connect organizational members as they provide media richness and facilitates social interactions, which enables gathering insights and knowledge from different departments and organizational backgrounds to engage in the generation of new innovative ideas and the access to distributed knowledge (Gloor, 2006; Serrano and Fischer, 2007; Füller et al, 2012).

The above studies show that there are demands for a holistic approach to make CICCB work effectively, efficiently and competitively in modern organizations. By 'holistic', this paper proposes the adoption of a trans-disciplinary perspective of knowledge management and community capacity building for improving the CICCB performance at a strategic level rather than the analysis of, treatment of, or dissection them into parts or assessment of them in isolation at an operational level. Such a holistic approach to CICCB is proposed in the following section.

5. A holistic approach for collaborative innovation community capacity building

Knowledge management is about the identification, creation, distributing, utilization, and maintenance of organizational knowledge for fulfilling organizational objectives (Deng, 2005; 2010). Effectively managing organizational knowledge becomes increasingly important for organizations to gain competitive advantages. Table 3 presents three knowledge management approaches for supporting CICCB in organizations (Chen and Wei, 2008). They are complementary with each other in supporting CICCB. The adequate adoption of such approaches can lead to the convergence, synergy and integration of various roles of knowledge management and embedding these roles into diverse CICCB processes for building complementary capacities and developing comparative advantages in today's dynamic environment (Chen and Yang, 2012).

Insert Table 3 here

The first knowledge management approach is the multi-dimensional convergence for trust building in collaboration (Plessis, 2007). With the adoption of such an approach, multi-dimensional knowledge stakeholder partnerships and a new alliance system can be developed for enhancing the effectiveness of collaborative innovation in organizations. Such a social arrangement promotes the reuse of knowledge asset and encourages the transferring of knowledge among different knowledge creators, owners, producers and users (Cowan and Jonard, 2004; Wang and Deng, 2007). It can explore the advantages of each participant and create a complementary new whole to benefit each other in knowledge innovation (Baldwin and Von, 2011; Xie and Zeng, 2008; Xiong et al, 2011; Cheng and Yang, 2012).

The travelling plan of the Smart Transportation Research Center in Brisbane, Australia (Smart Transportation Research Center, 2013) is a good example of the multi-dimensional convergence for trust building in collaboration. It operates as a neutral and trusted entity that advocates for the integration and sharing of transport data across stakeholder boundaries. The center can effectively deal with mobility challenges for improving the multimodal network operations in Australia. Such a reformation through the arrangement of knowledge from public, private and people helps building their interdependence for collaborative ways of thinking to understand each other's roles and to protect the rights and benefits of all the stakeholders, thus improving the efficiency and effectiveness of travelling in the city (An, 2013).

The second knowledge management approach is the multi-directional synergy for sustainability building in communication (Chen, 2012). The adoption of such an approach can lead to the development of the multi-directional knowledge governance mechanism in conformity with different types and different levels of collaborative innovation demands and requirements for the efficiency of collaborative innovation. Such remediation of knowledge activities and practices provides a knowledge continuum regime to improve the sustainability building in organizations (Zhang and Deng, 2008). The remediation of knowledge accumulation, sharing and transferring processes to interact with each other can produce a harmonious new whole to support each other in knowledge governance (Henttonen et al., 2004; Zong, 2007; Xiong et al, 2011).

Smart collective decision making in the Rio De Janeiro's Intelligent Operation Center (Hammin, 2012) is a good example of the multi-directional synergy for sustainability building in communication. It integrates all forms of intelligence into their administration with the ability to integrate all dimensions of human, collective, and artificial intelligence within the city to make city management a smooth operation. Such remediation of the knowledge activities and their interactions helps optimized processes, convergence of open data of government, and social media data of citizens to be adaptable to an intelligent analysis of the big data, thus improve the efficiency and effectiveness of collective decision making.

The third knowledge management approach is the multi-layer integration for extensibility building in connectivity (Chen,

2012). The application of this approach in CICCB facilitates building multi-layer ubiquitous knowledge networks for connecting people, processes, technology, and environment to achieve the competitiveness. Such reconfiguration of knowledge artifacts including knowledge resources, systems, platforms, infrastructure and architecture provides appropriate approaches for extensibility building (Geisler and Wickramasinghe, 2009; Li, 2011; Mercier-Laurent, 2011). The reconfiguration of knowledge networks improves the connectivity of the artifacts and enable actors, activities and their interactions working as an integral and green new whole (Gloor, 2006; Swink, 2006; Serrano and Fishcher, 2007; Wang and Deng, 2007; Tomas, 2009; Berasated, Arana and Castellano, 2011).

There are many examples of such multi-layer knowledge networks including the Living Lab at the Amsterdam Smart City Knowledge Center (Amsterdam Smart City Knowledge Center, 2014) and the Songdao futurist smart city in South Korea (Rijmenam, 2013). Such reconfiguration of knowledge artifacts provides innovative models to build interconnections and knowledge networks for optimized resources allocation, eliminating redundancy, consolidating assessments, establishing consistency and better performance and reducing maintenance, thus developing organizational competitiveness (Schaffer et al, 2011).

To effectively support CICCB, the three approaches discussed above need to be integrated in a holistic manner for improving the efficiency, effectiveness and competitiveness of an organization. Such an integration of the three knowledge management approaches leads to the development of a holistic approach to effective CICCB in organizations as shown in Figure 1.

Insert Figure 1 here

The proposed holistic approach can be effectively adopted for supporting CICCB in organizations. It adequately addresses the problems of trust building in collaboration, sustainability building in communication, and connectivity building in connectivity which are critical for the development of collaborative innovation through community capacity building in organizations (Chen, 2012). Such an approach provides a lens for seeing models, approaches and mechanisms of changes and responses in the real world by the reformation of knowledge management arrangements, the remediation of knowledge activities and the reconfiguration of knowledge artifacts from the trans-disciplinary perspective of both knowledge management and community capacity building. It provides organizations with an effective tool for investigating the active engagement of various participants in collaborative problem solving and collective vision building in developing CICCB. The adoption of this holistic approach in organizations provides practical recommendations on how to enhance the total effectiveness, efficiency and competitiveness of an organization through collaborative innovation at a strategic level, thus leading to effective CICCB in a dynamic environment nowadays.

6. Conclusion

The importance of collaborative innovation in developing the organizational effectiveness, efficiency and competitiveness in today's dynamic environment is increasingly being recognized in both theory and practice worldwide. Collaborative innovation, however, is still under-explored from the trans-disciplinary perspective of knowledge management and community capacity building. To adequately address this issue, this paper investigates the role of knowledge management in collaborative innovation and identifies the knowledge management approaches for supporting CICCB in organizations as an integrated whole at a strategic level in organizations.

A comprehensive review of the related literature in collaborative innovation and knowledge management is conducted. Three demands for CICCB in organizations including (a) trust building for enhancing the organizational effectiveness, (b) sustainability building for improving the organizational efficiency, and (c) extensibility building for developing the organizational competitiveness are identified. An examination of collaborative innovation and their patterns from the perspectives of community capacity building leads to the classification of CICCB into organization-based CICCB, location-based CICCB, and clusters-based CICCB. An analysis of current literature in knowledge management and community capacity building shows that knowledge management can provide organizations with a holistic approach for effective CICCB. Such an approach is built on the integration of three knowledge management approaches including (a) the multi-dimensional convergence for trust building in collaboration, (b) the multi-directional synergy for sustainability building in communication, and (c) the multi-layer integration for extensibility building in connectivity. The integration of the three knowledge management approach for CICCB is based on a better understanding of the three roles of knowledge management in supporting CICCB including (a) the reformation of knowledge arrangement for convergence in collaboration, (b) the remediation of knowledge activities for synergy in communication, and (c) the reconfiguration of knowledge art facts for integration in connectivity.

The contribution of this study is mainly reflected in three ways. Firstly, it provides insights into the way in which the collaborative innovation literature currently lacks attention but crucial for its success. Secondly, this paper identifies the

demand for CICCB in supporting collaborative innovation and the role of knowledge management in CICCB. Thirdly, this paper proposes a holistic approach for effective CICCB. Furthermore, Insights about how organizations can better support CICCB through effective knowledge management for improving their competitiveness are provided based on the identification of the demand for CICCB and the role of knowledge management in collaborative innovation. The development of a holistic approach to effective CICCB can help organizations better utilize their limited resources for developing their competitiveness in today's dynamic environment.

This paper is the first step of a more comprehensive study on the role of knowledge management in supporting CICCB in organizations. It provides a solid foundation for the investigation of the models, approaches and mechanisms for effective CICCB through effective knowledge management in organizations. It paves the way for the exploration of the assessment of the performance of knowledge management in collaborative innovation and the critical factors that support the implementation of knowledge management approaches in collaborative innovation in organizations. Such studies would be of practical significance for the development of appropriate strategies and policies towards the building and improvement of CICCB in organizations.

Acknowledgments

This work is partly supported by the National Social Science Foundation of China Major Project (Project number: 13 &ZD 184), National Natural Science Key Project (Project number: 71133006/ G0314) and the China-US Fulbright Program.

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Table 1 Demands for CICCB

Demands for CICCB	Driving forces for CICCB	References
trust building for enhancing the effectiveness	participants engagement and commitment	(Niu, 2010; Fawcett, et al; Boehm, Hogan, 2012; Chen, 2012; Kong, et al, 2012; Luo, et al, 2012).
sustainability building for improving the efficiency	integration of key influential factors and corporate governance	(Zhang, et al, 1997; Coming, 1998; Bueno, Balestrin, 2012 , Cai,2012)
extensibility building for developing the competitiveness	networks, cutting cost and sharing resources	(Chen, 2012; Fuller, et al, 2012; He, 2012; Kong, et al, 2012).

Table 2 Roles of knowledge management in collaborative innovation

Roles of knowledge management	Description	knowledge management contributions to CICCB	References
Collaboration	reformation of arrangement, people oriented effectiveness enhancing	Knowledge stakeholders partnerships and alliance system building	An, 2013
Communication	remediation of activities, process focused efficiency improving	SECI model; knowledge continuum regime and collective governance	Chen and Wei, 2008; Chen, 2012
Connectivity	reconfiguration of art facts, technology based competitiveness developing	Web 2.0 applications; virtual worlds; knowledge resources, platform, infrastructure and architecture integration	Gloor, 2006; Serrano, Fischer, 2007; Cai, 2012; Füller et al, 2012; Kong et al., 2012

Table 3 Knowledge management approaches for effective CICCB

Knowledge management approaches	Knowledge management contributions to CICCB	Changes and responses	Examples
multi-dimensional convergence: reformation	effectiveness enhancement: trust building in collaboration	arrangement of different knowledge stakeholders; reformation of their relationships; knowledge innovation	Traveling plans of Smart Transportation Research Center (Smart Transportation Research Center, 2013)
multi-directional synergy: remediation	efficiency improvement: sustainability building in communication	activities of different knowledge practices; remediation of their interactions; knowledge governance	Smart collective decision making of Rio De Janeiro Intelligent Operation Center (Hammin, 2012)
multi-layer integration: reconfiguration	competitiveness development: extensibility building in connectivity	art facts of different knowledge resources; reconfiguration of their technologies networks; knowledge networks	Living Lab Projects of Amsterdam Smart City Knowledge Center (Amsterdam Smart City Knowledge Center, 2014) , Songdao futurist smart city of South Korea (Rijmenam, 2013)

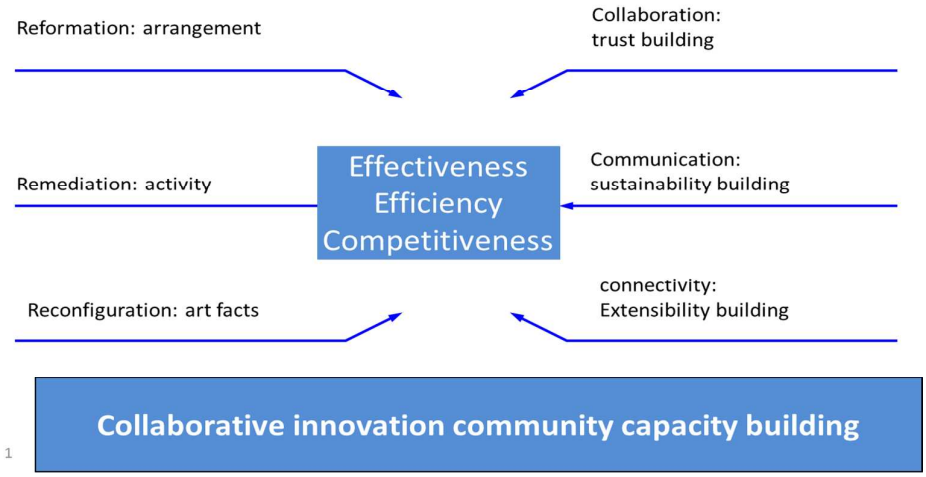
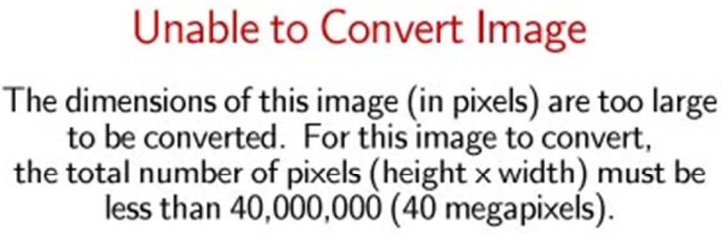


Figure 1: A holistic Approach for effective CICCB

33x48mm (400 x 400 DPI)



271x379mm (360 x 360 DPI)

25x31mm (300 x 300 DPI)