European Journal of Business and Management
ISSN 2222-1905 (Paper) ISSN 2222-2839 (Online)
Vol.9, No.11, 2017

Innovative Affinity Spaces and Their Influence on Network Leadership in Open Innovation: a Dynamic Network Analysis of the Case of China

Prasad Siba Borah* Lulin Zhou Yinghua Chen Numair Nisar
School of Management, Jiangsu University, 301 Xuefu Road, Zhenjiang 212013, Jiangsu Province, P.R. China

Abstract
The intention in this paper is to present a conceptual framework developed as an evolution of the 'innovation communities' concept, called 'Innovative Affinity Spaces'. This new construct is applied in the context of Chinese firms to explore how it affects network leadership in open innovation projects. Using dynamic network analysis as the methodological tool, the research hypotheses were addressed through cross-checking data from a sample of 68 Chinese networks of companies and research institutions. Our study yields important conclusions on the notion of network competencies/capabilities as critical elements towards successful network leadership acting within innovative affinity spaces.
Keywords: Innovation networks, Network leadership, Network capabilities, Open innovation, Affinity spaces, Dynamic network analysis, China

1. Introduction

Whilst traditionally, industrial companies adhere to the use of relatively "closed" innovation strategies, in today's competitive markets closed innovation is no longer sustainable. Different global challenges require to collaborate with external partners and establish inter-organizational relationships. Within this innovative environment, the emergence of Open Innovation proposed by Chesbrough in 2003, has become one fashionable trend for innovation and management researchers who have strived to define its theoretical dimensions in acknowledgement of the lack of a distinct theoretical framework (e.g., Gianiodis *et al.* 2010; Lichtenthaler 2011). Chesbrough defines Open Innovation as "open innovation as a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model" (**Chesbrough & Bogers 2014, p.17**). The essence of the concept is found in the proposition that not all good ideas come from inside the firm or need to emerge in the particular firm. As a growing number of companies have integrated Open Innovation strategies in their innovation strategies processes, there has been substantial empirical research to explore the challenges associated with collaboration across organisational borders and the difficulties to reach joint goals (Boscherini *et al*. 2010; Buganza *et al*. 2011). Further to these, it has been empirically proven that strong organizational barriers and inertia need to be overcome to ensure a smooth transition of a firm's approach to technological innovation from Closed to Open Innovation (Chiaroni *et al*. 2010).

Nevertheless, it has been well established that the benefits of opening the innovation process to different sources of external information are significant. It is profound that synergies emerging from such network approaches are empowered as the number and diversity of external parties is increased (Becker & Dietz 2004; Belderbos *et al*. 2004; Miotti & Sachwald 2003; Nieto and Santamaria 2007; Tether 2002). Based on the latter, in the past two decades, a substantial proportion of innovation research has dealt with cooperation and network structures (Powell *et al*. 1996; Dhanaraj & Parkhe 2006). One especially interesting form of open innovation is the living labs approach, where technology is developed and tested in a physical or virtual real-life context. Users in this environment are knowledgeable informants and co-creators in the tests. Given the current global economic conditions, in particular for small and medium enterprises, forming cooperations appear as one possible way of gaining various advantages through synergies (Human & Provan 1997; Baier *et al*. 2006; Rese & Baier 2012). The latter have been investigated both in terms of theory and empirical research using primarily social network analysis.

In this research, we take a socio-cultural approach combined with dynamic network perspectives to narrow the unit of analysis to the new product development (NPD) project level. In respect to Open Innovation and how the dynamics of business networks influence this process, most of the empirical evidence suggests that collaboration on new product development (NPD) cannot guarantee improved commercial performance. In this sense, it has been suggested that firms embedded in networks require to develop a set of capabilities that will allow them to understand other actors, while also actively shape their networking position (Ford *et al*. 2003). These so called network competencies/capabilities (Ritter *et al*. 2002; Walter *et al*. 2006), although broadly defined in prior studies, have not explicitly dealt with the changeable nature of business networks. In addition, there has been scarce empirical evidence exploring the role of innovation communities as networks of promotors (Fichter 2009; Fichter & Beucker 2012; Rese & Baier 2012) which influence Open Innovation. The present study building on the work of other studies on dynamic capabilities, networks of promotors and dynamic network analysis (DNA), conceptualises a framework incorporating these understandings. The intention is to address the similarities and differences of how innovative affinity spaces impact Open Innovation in particular through addressing elements of network leadership such as network capacities.

The overarching aim in this research is to use a multidisciplinary network perspective pertaining to dynamic network analysis as the methodological tool to improve our fundamental understanding of leadership.

1.1 Contextual background of China

The pattern of open innovation internationally is characterised on one hand by the variant transnational corporations from developed economies who are globalising their innovation activities (Ernst 2006; Dunning, 2002; Cantwell & Odile 1999; UNCTAD 2007) and actively entering Chinese market to source low-end value chain activities; these firms aim for a wealth of R&D knowledge and human capital (OECD 2008; Fu & Gong 2010). On the other hand, more and more indigenous firms attempt to extend their activities and globalize themselves to acquire external R&D resources and improve innovation capabilities. Nevertheless, when considering the implementation of open innovation in a regional context, it is important to remember that economic systems and institutions differ in their support for open innovation practices (Nelson 1993).

This research examines in particular the case of China from an open innovation perspective to explore how Chinese firms opt for innovation (Wang *et al*. 2011). China, overcoming Japan, became the second-largest economy behind the United States in 2010 (Savitskaya *et al.*2010). During the process of China's growth as a result of the economic reforms and opening up in 1978, the country has experienced a significant transformation in the innovation landscape China has experienced a substantial transformation in the innovation landscape since the economic reforms and opening up in 1978. In particular Chinese firms have employed a number of open innovation models. Different policies introduced by Chinese government in regards to acquisition of foreign technology, collaborations between industries and universities, as well as a 'go global' strategy following the entry into WTO in 2001 (Fu & Xiong 2011), have encouraged both foreign and indigenous firms to adopt more internationalised types of innovation activities in China. More specifically, in the past three decades, Chinese S&D policy has gone through four important milestones in its development (Liu 2008). Starting from the catching-up strategy and closed innovation in planned economy before 1978, to the new paradigms of "economic development *relying on* S&D and S&D being oriented to economic development" around 1985, then to "revitalizing S&D and education, enhancing national innovation system" after 1995, finally to the most recent national strategy of "indigenous innovation". The most recent 'indigenous innovation' policy marking the "indigenous innovation in open era" as it is called, results from a global industrial restructuring and is can be traced in two revolutionary documents, i.e. "the Decision of the CCCPC and the State Council about Implementing the Outline of the Scientific and Technological Plan and Enhancing the Independent Innovation Capacity (No. 4 [2006] of the CCCPC)" and "the National Guideline for Medium and Long-term Plan for Science and Technology Development (2006-2020)" (Fang 2007; Liu 2008). The focus on "integrated innovation" and "innovations on the basis of introduction, digestion and absorption" described in the two documents above, are two basic forms of indigenous innovation. The emphasis in both is on the utilisation and integration of external R&D resources and commercial paths (Fu & Xiong 2011).

Open innovation has been embraced in China to build an innovation-oriented economy in the new Century as a means to tap the two main factors contributing to the capabilities of China's companies: customer and culture (Yip and McKern, 2016). Results from different studies and reports such as a firm-level national innovation survey carried out by the National Bureau of Statistics of China and Research Center for Technological Innovation of Tsinghua University indicate that in practice, apart from policy, Chinese firms widely implement an open innovation approach to develop their technology capabilities. Several research evidence suggests that there exist three characteristics of open innovation in China: the first refers to the high proportion of firms adopting outside-in process for acquiring advanced technology or knowledge exploration (Fu, 2015). Secondly, the proportion of inside-out process or technology exploitation is relatively low in China. This derives from the difficulty for domestic firms to adopt licensing or corporate venturing which does not facilitate the growth of new business models (Fu, 2015). Nevertheless, findings indicate that they succeed so by reaching out to different external technology sources. Instead of depending mainly on internal innovations, Chinese firms rely on licensing agreements with foreign companies to insource new technologies (Wang *et al*. 2011), pursuing in particular to establish long-term alliances with foreign partners (Wang *et al*. 2011). Third, there is an interesting pattern between sectors and firm size in China (Fu 2015). For the most part, fast and medium-level growth companies use the inside-out process actively. Nevertheless, a number of firms in traditional or low-growth sectors also use inside-out modes of innovation in China (Fu 2015). Finally, it has been proved that Chinese firms target collaborations with local universities and R&D institutes to broaden their technology strengths as well as collaborations with the local industrial community to deepen their existing technology competences (Wang *et al*. 2011).

Despite open innovation is a new paradigm and trend, it is apparent that open innovation is not a new phenomenon in China. In fact, it has been implemented across Chinese firms in the past three decades as part of a mix of old and new practices seeking to create and facilitate an open market environment and innovation atmosphere. Fu (2015) argues that that open innovation is an active response for latecomer firms in emerging economies looking to overcome internal rigidities and reinforce their innovation resources and capabilities. This hypothesised relationship has not been systematically addressed in the context of developing countries, or in the case of China in particular, which makes one more reason for carrying out this study.

There are different challenges related to cultivating open innovation in China, relating to internal factors of the firm such as R&D intensity and availability of surplus technologies, innovation system level as for instance influence of innovation policies and public funding on firm's involvement into open innovation processes and challenges or barriers at a cultural level, like for instance certain features of national and organisational culture creating an attitude towards the use of open innovation practices within the company (Savitskaya *et al,* 2010). In particular with regards to Chinese tradition cultures they are extremely intrinsic and unique for facilitating innovation processes. In this respect, research in the context of China could benefit from the psychological field, such as it was the case in this study. Nevertheless, it is expected that effective policy support could help most Chinese firms to overcome the most pressing obstacles to nurturing a climate and environment that promotes open conditions in the era of indigenous innovation in China. For instance, open innovation is thought of as a private-collective innovation model, which can replace the private investment model of innovation with Schumpeter's temporary monopolistic profits.

Towards this end, researchers and theorists like Fan (2006) and Chen and Qu (2003) are leading the way towards a new research stream where the traditional stages model is no longer feasible for firms in rapidly emerging countries like China. They suggest instead that innovation capabilities and self-developed technologies are implemented by domestic firms adhering to the use of operational, tactical, technological and strategic learning. This new technological development model and new technological learning has been labelled by Liu (2005) as the "open model" and is informed by new conceptualisations of leadership and innovation capabilities, which adhere to networking and globalisation and will be discussed in the following section.

2. Literature review

2.1 Developing Open Innovation projects

At the core of Open Innovation is the shift from internal R&D processes to external R&D partnerships as well as to explore how to innovate and sustain advances in the field of technology (West *et al*, 2014). It is essential as Chesbrough (2006) proposes to adopt a level of analysis focusing on R&D projects that will help understand the sources of innovation. Such project-level investigation will allow to review new aspects only available at a sub-firm level (Du *et al*. 2014; Felin *et al*. 2014). Open collaborative innovation projects involve multiple users; during the early studies investigating the experiences in these kinds of projects, open source software projects were mostly used whereas now the field has expanded (Elmquist *et al*. 2009). In respect to the characteristics of an Open Innovation project, the relevant literature suggests the following are critical: i) the project's players are peers rather than rivals, otherwise they do not collaborate (Chiaromonte 2006), and ii) the products or services including the innovation or IP rights connected to it are not for sale (Baldwin *et al*. 2009). In this respect, this study draws on Open Innovation projects where different partners like academia, industry and governmental authorities represent the collaborative context.

Two significant dimensions of Open Innovation paradigm as explored by Elmquist *et al.*(2009) involve the "locus of the innovation process" and the "extent of collaboration". The first relates to innovation process spread across different actors involved in the project instead of being controlled by the firm (Bergman *et al*, 2009). As a consequence, it appears that project management is affected by the interaction and the active participation of all partners in the project. Project management as it relates to Open Innovation has not be substantially addressed in the literature due to difficulties in coordinating knowledge and activities between different players (Matheis *et al*. 2014). The second stand relating to "extent of collaboration" places emphasis on the capability for collaboration among more than two parties in B2B markets. It is essential as Chesbrough and Teece (2002) cohort to coordinate and manage the innovation processes at this level, since there is an increasing likelihood for conflicts among participants due to the open share of knowledge. Subsequently, it seems that management and coordination of stakeholders involved in Open Innovation projects is one major issue in the literature. Towards this end, it has become profound that future research in the field should address the organisational side and human aspect of Open Innovation (Elmquist *et al*. 2009). In respect to the human side, the variant actors from different organisations operating in Open Innovation Projects is increasingly diverse, and as a result innovation processes have reached another level of complexity to manage (Munkongsujarit & Srivannaboon 2011). Dealing with different challenges such as creating trust, minimising power differences and reconciling dissimilar individual goals (Du Chatenier *et al*. 2009, 2010). On the other hand, this increasing level of complexity related to diverse backgrounds and experiences encourages creativity and promotes new knowledge (Melendez & Moreno 2012).

2.2 The construct of innovative communities

Of the most important advances in innovation studies, has been the acknowledgement of the importance of the role of communities within and outside the boundaries of firms which can lead to the formulation and dissemination of technological and social innovations. This role adhering to communities can fit within the discussion of how to extend the company-centric concept of Open Innovation (West & Lakhani 2008, p. 223). The majority of research on innovation communities has been conducted in the field of user innovation (Fichter 2009). In particular the concept is based on the vision of a group of key actors from one or several organizations who promote an innovation project (Fichter & Beucker 2012). In this conceptualisation of innovation communities, it is critical to first determine what a key factor is and therefore it is meaningful to examine the theories of promotor and champion (Figure 1).

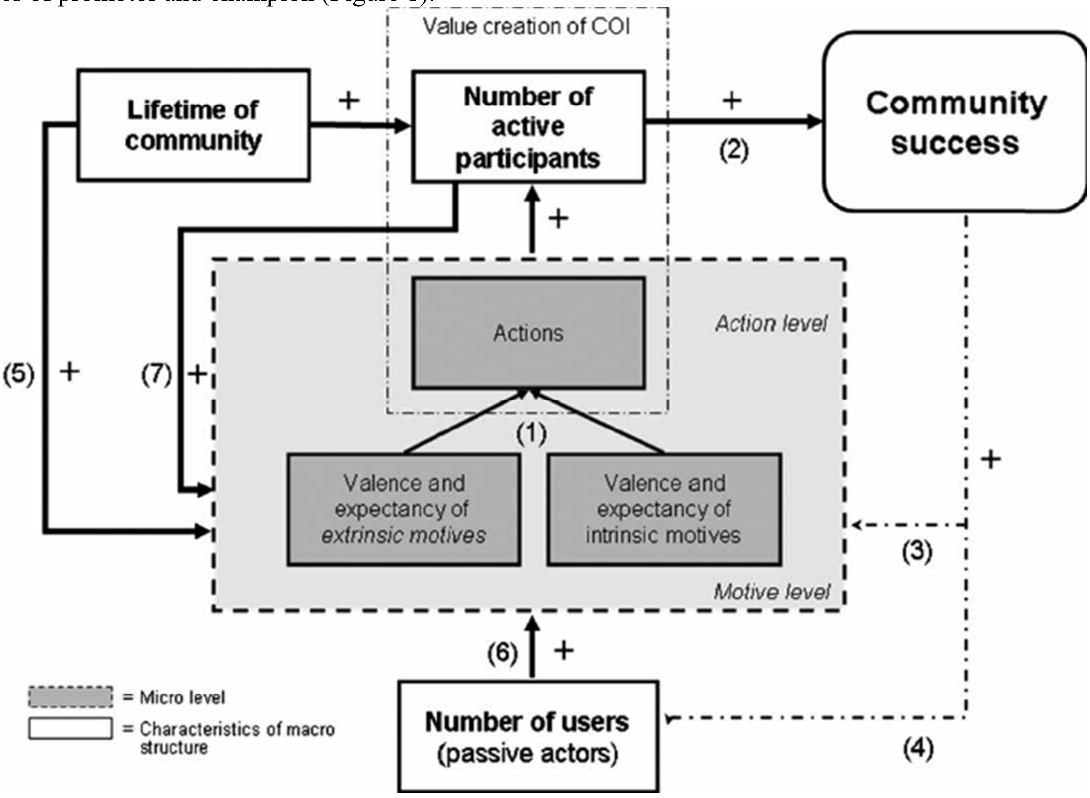

Figure 1. General explanatory model for the success of innovation communities
Source: Mühlhaus et al (2012).

There is also the need to address the concept of group as "a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and are seen by others as an intact social entity, embedded in one or more larger social systems (for example, business unit or the corporation), and who manage their relationships across organizational boundaries" (Cohen and Bailey 1997, p.141). To examine the relationship between this definition in regards to the innovation community concept, Rese and Baier (2012) suggest that two dimensions of inter-group relations are considered: group identity and group interaction.

There has been extensive empirical evidence in the field of innovation research suggesting that individuals have a vital role to play in promoting innovations. A person sustaining an important role attached to a status is a role player (Linton, 1936). Apart from expected duties, these roles include expected rights such as resource disposability (Turner 2002; Markham *et al*. 2010).

Innovation research has significantly addressed role-based models. Beginning with Schon (1963), an Anglo-Saxon research perspective of the champion concept discusses how a single person is being responsible for the innovation project. The emphasis is on individuals who play multiple roles in innovation processes. Importantly, Howell *et al* (2005, p. 641) cohort that champion behaviour consists of three facets: "expressing enthusiasm and confidence about the success of the innovation, persisting under adversity, and getting the right people involved".

Different researchers have identified a variant of champion roles existent within companies (Howell & Higgins 1990a, 1990b; Burgelman 1983; Kelley and Lee 2010; Markham *et al*. 2010). The previous roles have been derived through comparing successful and unsuccessful firms and projects. Yet there was an absence of theoretical concepts examined under this Anglo-Saxon research.

On the other hand, with regards to German speaking countries, the focus has been on more than one person promoting a single innovation project. In this respect, four roles were identified (for an overview Gemunden *et al*. 2007; Rost *et al*. 2007). Witte (1977) has developed a theoretical concept where promotors assist to overcome barriers by improving performance (Hauschildt 1999). There are certain key roles retrieved from these two strands of research. These include technical innovators or expert promotors, sponsor, organisational champion or power promotors, product champions, process promotors, relationship promotors and network champions.

3. Conceptual framework

3.1 Dynamic network theory and social network roles

In response to the queries for developing an understanding of how networks help individuals, organisations, and societies be more effective, new research on *dynamic network theory* (Westaby 2012)examines how social networks influence human goal pursuit (Westaby 2012). The theory postulates that there are eight social network roles in dynamic network systems which are distinct and relate to network motivation towards goals, network resistance and network reactance. Dynamic network systems are defined as "The totality of entities and social network roles directly or indirectly involved in targeted goal pursuits" (Westaby 2012, p. 5).The theory proposes the following: (1) network motivation toward goals (activated by goal strivers and system supporters in social networks) positively influences goal achievement and performance, (2) network resistance (activated by goal preventers and supportive resistors) negatively influences performance, and (3) network reactance roles (activated by system negators and system reactors) and peripheral roles (activated by interactants and observers) have variable effects on performance, depending on the situation (Figure 2).

Network motivation roles

Westaby (2012) metaphorically describes network motivation as "the glue that holds social networks together in goal pursuit" (Westaby 2012, p. 11). It is thought of as imperative since it is technically defined as "a social network's general pursuit of goals, which is activated through goal striver (G) and system supporter roles (S)" (Westaby 2012, p. 33). *Goal strivers (G) are* entities that are directly trying to pursue the goal or behaviour. *System supporters (S)* is a term used to define entities that are supporting others in the goal pursuit. Through the actions of goal strivers and system supporters who demonstrate high system competency in the goal pursuit, then emerges *network power*(Westaby 2012, p. 88-90). This element represents "the strength of the glue that holds social networks together in goal pursuit" (Westaby 2012, p. 88). System competency also helps social networks from becoming overly dense and inefficient. Network power offers an alternative to the mainstream centrality" and "social capital" conceptualizations utilised to predict goal achievement and performance.

Network Resistance Roles

There are certain entities within different networks which through their behaviour work against goals and these are universally implemented through goal preventer and supportive resistor roles (Westaby 2012, p. 43). *Goal preventers (G`) described* entities that are trying to prevent or thwart the goal pursuit while s*upportive resistors (S`) refers to* entities that are supporting others in their network resistance efforts. Westaby suggests that these role activations negatively impact goal achievement and performance, through exhibited behaviours such as competition, rivalry mechanisms and conflict.

Network Reactance Roles

There are certain role activations which represent the negative interpersonal relations in regard to those involved with goal pursuit or resistance processes" (Westaby 2012, p. 46). Technically speaking, the entities generating these actions are system negators and system reactors: *System negators (R`) are the* entities that are negatively reacting to others that are pursuing the goal. *System reactors (R)* describes the entities that are negatively reacting to others that are showing network resistance or negativity toward the goal pursuit. These individuals' activities as Westaby (2012) posits can have variable/moderator effect on performance, depending on the situation. They can for instance implicitly or explicitly alert goal strivers about problems in their strategy. Nevertheless, on the other hand, goal strivers might get distracted by this negativity which results in reduced performance in the dynamic network system. It is therefore essential to be able to effectively manage negative feedback in the theory.

Peripheral Roles

Dynamin network theory postulates two last social network roles called peripheral, namely interactants and observers. The *interactants (I) are* entities that are encountering others involved in the goal pursuit. *Observers (O)* refers to entities that are "observing (or aware of) the people involved in the target behaviour/goal pursuit context or situation" (Westaby 2012, p. 5). These entities unintentionally affect the network and are expected to have variable/moderators effects on performance depending on the situation, such as when observers in a social network can motivate goal strivers that are highly experienced through social facilitation (and priming) effects, but distract other goal strivers that are just learning how to pursue the goal, such as by increasing their stress and anxiety (Westaby 2012, p. 55-58). Exclusive interactants may also inadvertently cause accidents in some settings, which can reduce a system's performance.

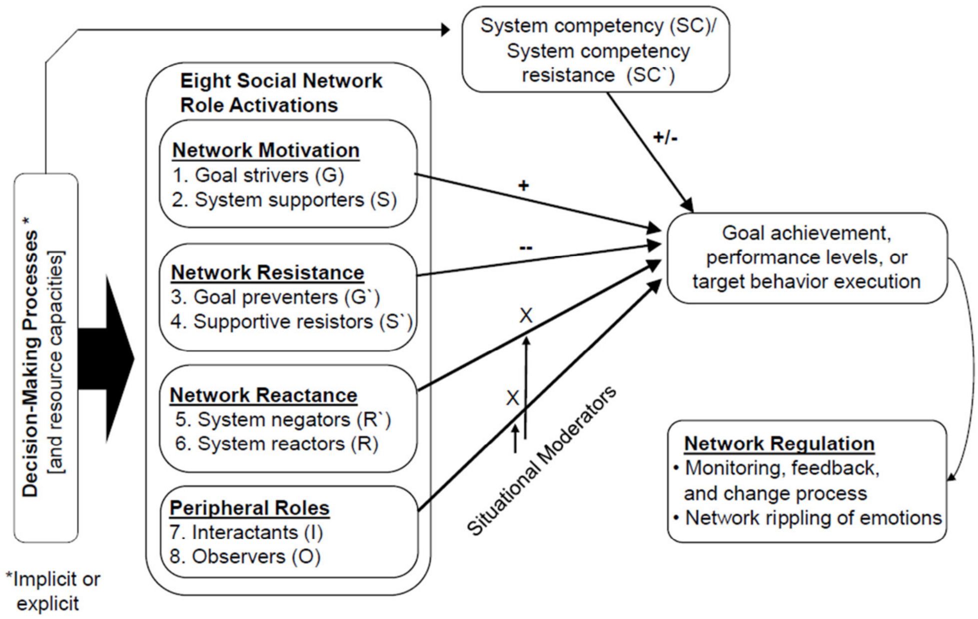

Figure 2.Key concepts in dynamic network theory
Source: Westaby (2012)

3.2 Network leadership in open innovation

One succinct issue in pursuing and achieving long-term sustainability of enterprises and the economy, is the absence of time to innovate; "a problem resulting from stripped out layers of management and running "lean" (Macnamara & Banff Executive Leadership, 2004). These challenges could potentially be dealt with by what it has been called network leadership. This study works within the grounds of re-conceptualisations of leadership from a dynamic network theory perspective in response to living and working in a networked world (Cullen *et al*. 2014). This understanding undertaking a networked perspective does not constitute another subset of leadership studies but rather urges researchers and practitioners to adopt the lens and science of networks to the topic of leadership. In this sense, network leadership is not a theory on its own, but rather a lens to evaluate existing theories (Cullen *et al*. 2014).

At its core, network leadership is a systems-thinking leadership far beyond traditional inward looking and autocratic management" (Macnamara & Banff Executive Leadership 2004). Instead, it embraces leadership as a shared process (Cullen *et al*, 2014) arising within dynamic web connections (Cullen *et al.*2013) among "communities of practice whenever people work together and make meaning of their experiences and when people participate in collaborative forms of action across the dividing lines of perspective, values, beliefs, and cultures" (Drath & Palus, 1994; Drath 2001) (McGonagill & Reinelt 2011, p.4).

3.3 The dynamics of network competencies

Dynamic network theory is part of knowledge management and dynamic capabilities research, which acknowledges knowledge as a process of know-how and information (Helfat *et al*. 2007; Kogut & Zander 1992). Based on these conceptualisations, this research proposes a capability-based framework for open innovation in accordance with other studies highlighting the possibility for organising knowledge processes outside a firm's boundaries (Cassiman & Veugelers 2006; Grant & Baden-Fuller2004; Gulati 1999), which appears to be an approach to which Chinese companies pertain to. According to Lichtenthaler and Lichtenthaler(2009), there are six knowledge capacities, namely inventive capacity, absorptive, transformative, connective, innovative, and disruptive capacity.

Network leadership reflects contemporary reality and the changing dynamics of the environment around us as opposed to the technical/analytical focus in the language and practice of traditional leadership. Within the grounds of this understanding, (Macnamara & Banff Executive Leadership 2004) have identified five dynamics in particular which are essential to adopt to move an organisation forward in terms of open innovation. The first dynamic, is referred to as market oriented "pull" dynamic and involves acknowledging how different dynamics influence major customers/funding decisions and the "pull" factor. There are both strategic and operational elements or leadership competencies which the executive must exercise, such as: to prioritise investment, projects, product development, define the organisation's value positioning, address capacity and capability-scalability to meet the needs and dynamics, drive brand integrity and follow-through consistency of experience, and engage front-line, real-time feedback mechanisms of perceived value and customer needs.

The second dynamic relates to the inherent capabilities that an organization possess and what are the areas to which the company can excel. This is called the innovation "push" dynamic and it is essential for executives in order to succeed the latter to develop and display different competencies such as personal networking, exploration, and curiosity, while also embrace employees, suppliers and partners for their creative and innovative efforts. In addition, it is considered crucial to allow for cross-boundary "permissions", such as flow of information like sharing ideas and insights, encouraging efforts among peers, issue resolution and consensus and partnership building. It is imperative also for network leaders to address innovation through effective utilisation of IT. Since the above are difficult for a leader to have to the maximum degree, it is important to address the next dynamic, which is knowledge and capital "leverage". The leadership competencies needed to be addressed in this area require to rethink traditional decision-making processes and consist of:

Engagement of multifaceted teams, a flexible approach to creating, leading and re-creating communities of practice, knowledge sharing, cross-connecting and networking, community engagement and clarifying common goals, measures, and outcomes. There is a need to redesign decision-making structures to engage the people with the insight needed.

It becomes evident that the role of community is important when operating at the network level of leadership and this is further exemplified when looking into the fourth dynamic proposed by (Macnamara & Banff Executive Leadership, 2004), which is community "transparency and accountability" dynamic. For the network leader, this area presupposes to have acquired competencies such as: the establishment of outcomes and impact measures, develop networks and relationships with key stakeholders, implement regular public reporting mechanisms and develop access to information mechanisms, seek government relations and facilitate community engagement. Although parts of these components could be allocated to specific departments or domains in larger organisations, when it comes to the network leaders, it is crucial to carry out most of them.

The final component proposed by Macnamara and Banff Executive Leadership (2004) requires to engage in regulatory, environment, competitive "constraint" dynamic. The latter pertains to a stewardship approach for sustainability of the whole, it requires awareness of the legal requirements and regulatory standards as well as understanding of community expectations. It is essential also to demonstrate awareness of the competitive landscape and engage in operational design techniques such as "waste=food" and finally exhibit philanthropy and corporate citizenship. One aim of this research was to examine the extent to which the aforementioned competencies were present during the workings of open innovation in the cases investigated.

3.4 A new construct: 'Innovative Affinity Spaces'

This study revisits the concept of 'innovation communities' proposed by Fichter (2009, 2012) which was described earlier, by considering a conceptualisation adhering to the network perspective of leadership although it derives from the field of linguistics and is proposed by James Paul Gee (2006). According to Gee (2004), affinity spaces are virtual or physical sites of informal learning which often spread across many sites including face-to-face meetings, message boards, blogs, and websites. Affinity spaces offer multiple interest-driven trajectories, opportunities to learn with others, and paths toward becoming a participant (Squire, 2011). Jenkins *et al* (2006, p.6) identify *affinity spaces* as "highly generative environments, from which new aesthetic experiments and *innovations* emerge" (2006, p. 9). Whilst the concept has been primarily used in the field of education, here we propose that the concept is appropriate within the context of firms and their development as innovation communities as proposed by Fichter (2009) and further explored by Fichter and Beucker (2012) and Rese and Baier (2012). Gee, who first introduced the term affinity spaces referred to primarily online environments and the interactions between people in these spaces. According to Lammers *et al.*(2012), it is essential to update Gee's initial categorization of online affinity spaces with these nine defining features:

1) A common endeavour is primary;
2) Participation is self-directed, multi-faceted, and dynamic;
3) Portals are often multimodal;
4) Affinity spaces provide a passionate, public audience for content;
5) Socializing plays an important role in affinity space participation;
6) Leadership roles vary within and among portals;
7) Knowledge is distributed across the entire affinity space;
8) Many portals place a high value on cataloguing content and documenting practices; and
9) Affinity spaces encompass a variety of media-specific and social networking portals.

Affinity spaces are in simple terms new ways to think about group collaboration in an online connected modern world. In their essence, they take a step further and drift from the idea of 'community of practice' by embracing organic self-directed inquiry. Interestingly enough, although there has not been substantial empirical research in the corporate sector, the corporate structures of companies like Google and Valve adopt Affinity Spaces as engines to drive innovation.

Drawing on the concept of affinity spaces, Gee acknowledges how within the affinity space, people are not separated between novices and experienced but rather coexist (Gee & Hayes2009). The intention is to gain both intensive (experts or specialists) and extensive (broad knowledge shared with everyone) knowledge. Concurrently, the affinity space enables the use of dispersed knowledge (available outside the affinity space) and also tacit knowledge (knowledge built up in practice not able to express with words) (Gee & Hayes 2009). People who participate in these spaces, do it in varied ways and different levels, both peripherally and centrally. Affinity innovation spaces thus encompass a notion of leadership as porous activity where leaders are resources; different people lead in different days, different areas, and resourcing, mentoring, and advising people (Gee& Hayes 2009).

An affinity space consists of three concepts: portals, generators and content (Gee 2007, p.94). Portals refers to physical and digital places serving as entities used for the people to enter the space. Content refers to what the space is about, and it is important to note that all the participants produce content. The social learners produce content and supervise project processes. Generators are the entities giving content to the space, thus all the participants can uptake that role. When different partners work towards a mutual goal of successfully completing a project, the whole context is seen as an innovative affinity space. Jenkins describes affinity spaces as experimental, social, innovative, and dynamic, against conservative notions of learning. Through his arguments, Jenkins shifts the talk from participatory cultures to affinity spaces and the role and importance of community involvement. Yet, in this research, instead of looking at the 'innovative communities' construct, which is closer to the communities of practice concept proposed by Lave and Wenger (1990), we propose moving towards a reconceptualisation of innovative practice in corporate project management through use of the affinity spaces.

4. Research hypotheses

Based on the extensive review of the literature and the introduction of a new theory in the field of open innovation previously described, this paper has developed different general hypotheses which were tested through means of dynamic network analysis and concerned the role distribution of key actors in innovation affinity spaces pertaining to the open innovation paradigm specifically focusing on firms in China.

Based on these narratives, this research set out to explore the following questions within the Chinese context informed by the work of Westaby (2012) and Gee (2004, 2009) on dynamic network theory and affinity spaces.

Hypothesis 1: The goal striver is more frequent than the goal preventer role.
Hypothesis 2: The goal striver has a positive effect on project performance.
Hypothesis 3: More system supporters than goal strivers are present in innovative affinity spaces.
Hypothesis 4: Network power positively influences the performance of innovation affinity networks.
Hypothesis 5: System competency positively influences the performance of innovation affinity networks.
Hypothesis 6: Innovative affinity spaces appear more frequently when the following dynamics are present: the innovation "push" dynamic, knowledge and capital "leverage" and the community "transparency and accountability" dynamic.

5. Methodology

5.1 Research strategy

Dynamic network theory (Westaby 2012) links theory to method by offering a new language and syntax for creating the new dynamic network chart methodology. In this respect it claims to provide unique perspectives into explaining social structures, through an array of tools such as organisational charts, social network analyses and dynamic network charts (Westaby 2012). These tools show how social networks are accurately involved in specific goal pursuit cases. Importantly, in dynamic network theory, not all network connections promote function (reference); on the contrary, it depends on the type of social network roles being activated (reference). There are numerous implications of dynamic network theory (Westaby 2012). The theory's multidisciplinary capacity has contributed to developing the methodology and interpreting the findings of this research.

In particular, dynamic network analysis (DNA) was employed to examine the innovation process during 37 projects with 68 collaborating medium and small sized firms from China, a rather intuitive and widely applicable framework addressing both the theoretical and methodological concerns of network leadership (Schreiber & Carley 2008). It is essentially a combination of"the methods and techniques of SNA [Social Network Analysis] and link analysis with multi-agent simulation techniques" allowing for an in-depth look into networks (Carley, Diesner, Reminga, & Tsvetovat 2007, p. 1325). DNA was chosen as it allows to quantitatively assess how the general network structure and positioning of each organisation within the innovative affinity spaces influence the information that is conveyed through the network (Provan *et al*. 2007). It was expected that the results of the analysis would provide insights to the nature of network leadership and highlight key points of the usefulness of the network leadership concept in real-world organisations. DNA can handle large dynamic, multi-mode, multi-link networks with varying levels of uncertainty (Carley 2003). Multi-mode means that the socio-technical systems being analyzed can consist of a plurality of node types, such as people, organizations, resources and tasks. Any two nodes can have various types of connections; DNA is therefore well-suited to analyse the multi-link relations of socio-technical system (Carley *et al*. 2007). Such systems can be represented by these many different networks, e.g. a social network (actor by actor) or a task network (actor by task). The collection of these networks is referred to as a meta-matrix (Tsvetovat & Carley 2004). The added value of a 'network of networks' approach has also been acknowledged by others (cf. Salmon *et al*. 2011). The meta-matrix framework represents the network of relations connecting node entities. It is used to analyze the properties of the socio-technical system and its interactive complexity.

Another important attribute of DNA is that it is able to deal with longitudinal data series such as how the information flows are structured and how they change over time (Wolbers *et al*. 2013), as networks are not static in which case it would be meaningful to employ traditional SNA as it only provides with a static snapshot (Effken *et al*. 2011). In addition, DNA allows for the use of time stamps to the data and group them to create time slices (Wolbers *et al*. 2013). Time slices show the frequencies of information exchange in the network as it develops over time. The flow of information can then be analysed by comparing these time slices.

5.2 Sample

It was considered that the optimum approach in this research would be to conduct a multiple case study using dynamic network analysis. This was chosen to ensure a broader basis to test the above hypotheses and to generalise on the theoretical propositions of the 'innovative affinity spaces' construct. As defined in Section 2, there are particular units of analysis which are the 'innovative affinity spaces'. It was decided that four key sectors in China were selected to undertake the research. These were: the information and telecommunications sector, biotechnology, new energy and manufacturing sector. An imperative aspect of the theory of 'innovative affinity spaces' entails dealing with technologically advanced innovations, which determined in turn the selection of the cases based on the following criteria: (1) to involve highly complex technological solutions and (2) a high degree of innovativeness.

The population drawn for this research is based on the similar work conducted in Germany by Rese and Baier (2012) in order for comparison later on to be as accurate as possible. The decision was therefore to opt for purposive sampling focusing on active networks, whether newly formed or establishes ones belonging in highly innovative branches of industry, for instance nanotechnology, solar energy, information and communication technology. The sample included use of websites while the authors requested feedback from a group of available experts to inform the list of networks identified. This preliminary recruiting procedure yielded a complete sample of 134 identified networks in the Chinese industry focusing on the ones from small and medium enterprises (SME). The final sample following telephone contact with each company was 45 networks of companies.

5.3 Data collection and structuring

In general gathering complete network data for inter-organisational networks is challenging, even more when it comes to cross-organisational networks like in the case of open innovation projects. Obtaining real-time data normally requires an exceptionally big group of knowledgeable researchers, to be present at different locations in the network at the right moment. Innovation project can span over time depending on the product or service introduced, and as such gathering real-time data can be quite time-consuming and costly. Based on these factors, in this research, the procedures unfolded over the course of two years followed included a team of representatives from each collaborating firm involved in the process helped develop a map, using pen and paper at first, showing every step as it happens in reality. The process was broken down in to specific tasks and the flows of information were included in the map created. It was essential to take substantial time to create the value stream map so as to ensure a safe environment and a level of rapport among the participants. All companies gave permission to use the data from this value stream map for the DNA of this research.

The data was then converted into an edge list. Each row in the edge list represented a single tie in the network, and it was possible to attach variables, like the time of occurrence, to the ties. Every edge represented a generator x generator (who share information with whom?), generator x task (who does what task?) or task x task (how are tasks related?) tie. It is significant to note that there might be multiple interactions between two generators, since the edges are directed and valued, thereby the information flows in a certain direction and generator x generator ties represent the flow of information between generators. The focus of the analysis in this research was on the generators who. The edge list was then imported into ORA. A series of reports derived from

ORA, containing multiple metrics, both on a node and whole network level (Carley *et al*. 2007; Carley & Pfeffer 2012).

Given the properties of open innovation in China, the interest was specifically in the centrality of generators. Centrality is a fundamental characteristic to node-level metrics and represents the relative importance of individual nodes (Kim *et al*. 2011). The method is primarily used to gain insights into the flow of information in a network and estimate potential levels of coordination (Hossain *et al*. 2006). The analysis draws in particular on three distinct facets of network centrality: degree, betweenness and closeness, with each of these measures having different implications for coordination (Freeman 1979). Degree centrality explains the activity in communication of every node, whereby nodes with a high amount of information feature high-in and out- degree centrality. When matching the degree centrality of nodes with the generator by task relationships, it is possible to reveal the extent of the workload of every node.

With regards to the second characteristic, betweeness centrality indicates which nodes are most likely to have pass along information for information to disperse parts of the network, which in turn can negatively affect the process as they distort information or can no longer process it. Finally, closeness centrality can help evaluate the extent to which the nodes that distribute the most information can actually do this within minimum amount of time, given their position in the network.

Network level metrics were used informed by the work of Stanton *et al* (2012), to define as they declare a network of organisations: network density (distribution of information or how sparse or fragmented the network is), diameter (patterns of interaction, such as the maximum number of steps needed to reach from one node to another), and centralisation (allocation of decision rights on a centralised or decentralised basis).

6. Results

The results from the cross-case analysis of all 37 projects and 68 firms involved in the management of the innovation project among the different firms revealed some interesting facts. All the generators (round nodes) and the tasks that these generators performed in this process are presented in Figure 3. Task by task relationships are represented using the dotted lines. It is apparent that a relatively small number of generators are involved in the process, although numerous other perform specific tasks which leads to a complex network of dependent generators and tasks. The graph suggests an asymmetrical distribution of the tasks and communication activity among the nodes.

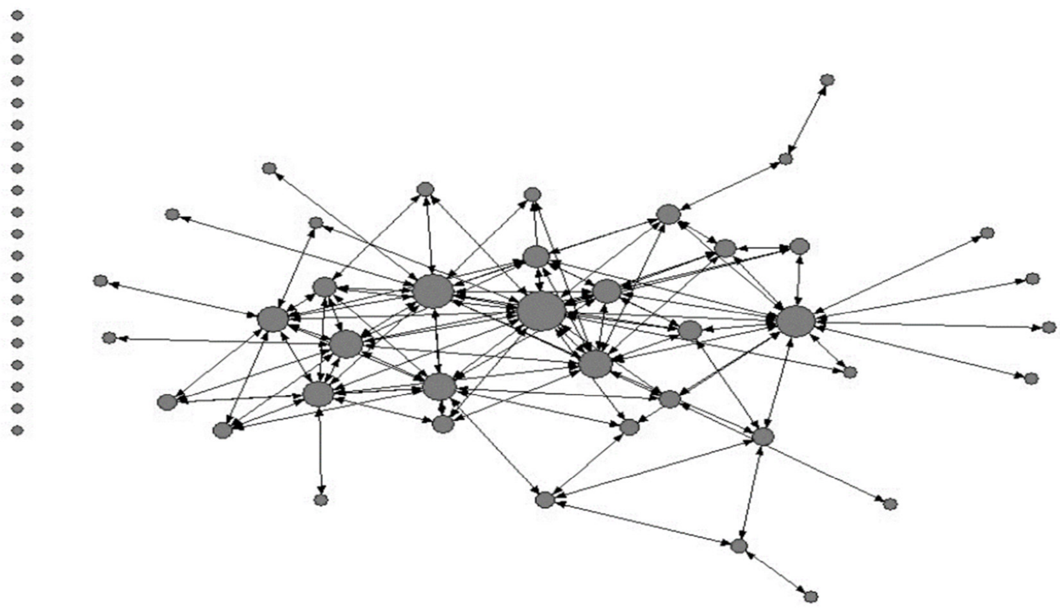

Figure 3. Overview of the overall network of generators and tasks during the management of the innovation process.

Table 1 indicates the centrality measures applied to the nodes in the innovative affinity network space. The nodes with an asterisk share a higher than normal value, which suggest the value is more than one standard deviation above the mean. Given that this was a directed graph the measurement was both on the indegree (number of ties directed to the node) and outdegree (the number of outgoing ties of a node).

Table 1.The most central nodes based on degree, closeness and betweenness centrality measures

	Total degree centrality	*Indegree centrality*	*Outdegree centrality*	*Closeness centrality*	*Betweenness centrality*
1	Goal Strivers (20)*	System resistors (5)*	Goal Strivers (12)*	Goal Strivers (0,342)*	Goal Strivers (0,321)*
2	System supporters (14)*	Goal Strivers (7)*	System supporters (11)*	System Supporters (0,311)*	System Supporters (0,271)*
3	Observers (11)*	System supporters (5)*	Node operations control (7)*	System resistors (0,121)*	System resistors (0,071)*
4	Node Operations Control (11)*	Interactants (6)*	System resistors (6)*	Node operations control (0,313)*	Interactants (0,231)
5	Interactants (10)*	Observers (4)	System negators (5)	Interactants (0,278)*	Node operations control (0,113)*

The links have been intentionally inverted (1/w) when measuring betweenness and closeness centrality to take into account the valued data. The latter was imperative as ORA treats line weight as distance whilst in this research it is treated as the number of interaction between nodes. In this respect, tie strength only indicates a potential of information to pass along and inverting the links maintains the interpretation of line weight as similarity information. Goal strivers have the highest centrality score for all measures, except for that of indegree centrality, followed by the system supporter. The goal striver (total degree score 20) is also the generator that communicates most frequently with other generators. It is evident from the large number of outgoing ties that the goal striver has a central role in distributing the information in the network. This is backed up by the high closeness centrality score, as the central position of the goal strivers makes it possible for them to distribute the information in the least amount of time and more effectively. Concurrently, the high betweeness centrality of the goal striver (Figure 4) suggests that he operates as the key motivator in transmitting information between disparate parts of the network. It is therefore confirmed that the goal striver has a specialised role in the innovative affinity space as he, together with other goal strivers ensure the smooth operation of the innovation process.

Figure 4. Sociogram of Innovation Network Betweeness Centrality

Interpretation of the scores in Table 1 indicate there is no diagonal communication between the actors, so as to avoid miscommunications. This supposedly influences the rate of flow of information, as it is expected that in more sparse networks there will be less communication linkages. Due to the fact that there are no direct ties between nodes, it appears that multiple steps are necessary in order to have information flow throughout the network.

The centrality scores indicate how tight the network is organised around the most central node, the goal striver (Figure 5). It is apparent that the degree centralisation scores are relatively high so there are particular nodes dominant in the network, i.e. the network are closely coupled with information distribution (out-degree) being more dominated by information receiving (in-degree). The betweenness Centralisation is of similar levels, with a dominant node that controls the flow of information. Closeness though has the highest centralisation score. The overall accessibility of information is moderately high.

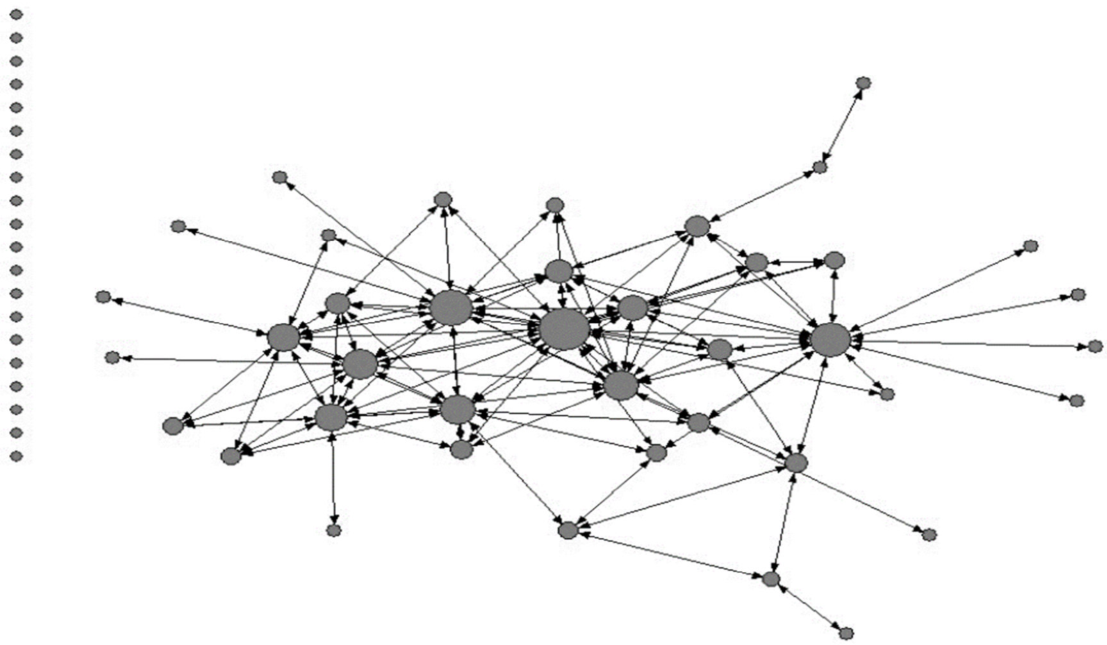

Figure 5. Sociogram of Innovation Network Degree Centrality

It is critical in order to determine the importance of a node in a network with reference to the dynamic patterns of communication during the different phases of the innovation management process (Table 2). In this sense six time slices were created to reveal how the network develops over time and how the position of nodes changes. The first time slice demonstrates that four goal strivers have a critical role to play and collect accurate and detailed information which they communicate to the rest and inform them of their decisions and actions. In addition, together with system supporters, these generators motivate the overall activities in the affinity space.

Table 2.The results of the network-level metrics

Network-level metrics	*Results*
Network density	0.07
Network diameter	12
Centralisation, Indegree	0,269
Centralisation, Outdegree	0.343
Centralisation, Betweenness	0,447
Centralisation, Closeness	0,445

Each generator has been attributed a specific task in the network, which is demonstrated in Table 3. The table shows the most central generator for each time slice in regards to degree-centrality and betweenness-centrality. Following the guidelines by Borgatti *et al*. (2013), closeness centrality isn't calculated as in most time slices the networks are disconnected, rendering closeness centrality problematic to calculate. Although there exists a high correlation between both measures, both indicate that the most central generator is the same and is the goal striver in each time slice. This confirms the centralised and sparse nature of the network. The various (connected) sub-networks act following the instructions of a central core (Wolbers *et al*. 2013).

Table 3.Most central actors per time slice across cases

Time	*Nodes (Generators)*	*Nodes (Tasks)*	*Ties (Generator x Generator)*	*Total degree centrality*	*Betweenness centrality*
T1	Goal Strivers	4	10	Goal Strivers	Goal Strivers
T2	10	3	9	Goal Strivers, System resistors	Goal strivers, System negators
T3	15	8	14	System supporters/Goal strivers	System supporters/Goal Strivers
T4	12	8	12	Node Operations Control	Node Operations Control
T5	11	6	5	System supporters	System supporters
T6	5	6	3	Interactants, Observers	Interactants, Observers

7. Discussion

To assess the role of the generators in the innovation process within the portals of the affinity space, three centrality measures (degree, betweenness and closeness) were used. For all measures, the goal striver and system supporters were the highest in centrality. This demonstrates their importance in the processing and distribution of information during the innovation. Given their role, it is crucial that the goal striver and the system supporters across all teams in the affinity space provide others with appropriate support and system competency. However, sharing this sort of system competency requires to possess certain dynamics like innovation push dynamic and knowledge and capital "leverage" which adhere to network leadership and are difficult at times to find especially when confronted with information overload and high workload. In addition, there were moment when the efforts of goals strivers and system supporters were counterbalanced by the attempts of goal preventers and supportive resistors to thwart the goal pursuit, meaning the innovation. Still the enthusiasm and capabilities by the goal strivers working as the network leaders in the affinity space proved efficient and promoted a sense of network power in the innovation project. Importantly, the goal strivers and system supporters enhancing network motivation appeared to have the most tasks assigned to them besides being the most active communicating node. Although at the middle stages of the project it becomes challenging to deal with every team and generator, a goal striver positively influences the capacity of the affinity space through the portal to share information.

Another interesting finding was with regards to the low centrality scores of generators in social networking roles such as goal preventers, system resistors as well as network reactance roles including system negators and system reactors. Closeness centrality can also be seen as indicating the independence of nodes. This feature suggests nodes with a high closeness centrality can act autonomously and navigate freely across the affinity space to access information in a timely manner (Kim *et al*. 2011).

Calculating the density, diameter and centralisation in order to define the overall network structure suggested a high density score and a low diameter meaning that the network is relatively closely coupled. It was evident that information does not have to pass many generators before reaching the intended recipients and generators will therefore have increased access to information. Given the small amount of nodes on the line of communication it is rather unlikely that the information gets distorted, since there is little risk of errors in the absence of many retellings. In addition the network of affinity space proves to be more beneficial due to dense communication structure, since information reaches generators in time. It is not always easy to decide upon the right amount of integration in a network since more ties result in higher complexity and thus higher communication needs. However, the dynamics of network leadership are evident in the capabilities exhibited in this case and thus despite certain coordination problems, these were limited as goal strivers undertook substantial load to smoother coordination.

Finally, it appeared based on the time slices that information is shared within disconnected parts of the affinity network in the middle of the implementation of the innovation, deriving from the roles of goal preventers and supportive resistors. In these moments which did not have a direct link to the source of the information, it was also obvious that system negators and system reactors, as a consequence of the negative entities in the innovative affinity space were contributing towards a negative overall performance. These generators' worked based on previous experiences and proceeded to certain assumptions without having full knowledge on the situation. This phenomenon is linked with the community "transparency and accountability" dynamic, which presupposes the quality competencies of outcomes and impact measures, to have developed networks and relationships with key stakeholders, implement regular public reporting mechanisms and access to information mechanisms, seek government relations and facilitate community engagement. Such network capabilities appeared to be evident only among the goal strivers and system supporters, which in turn positively influenced the progress of the project.

8. Conclusions

This research set out to test the utility of Dynamic Network Analysis (DNA) as a network tool in order to investigate the communication patterns during participation in an innovative affinity space in the Chinese industrial system and how this construct might influence network leadership based on the observed network capabilities. The Chinese industrial system is a networked system in which several organisations and teams, physically remoted and with different organisational boundaries, manage innovations. In this perspective it is important to understand how these generators connect and share information while taking part in innovative affinity spaces. The methodology for this research suggested that it is possible to effectively employ DNA to capture the irregular flows of information during the innovation process. The tool using specifically dynamic network charts was applied to a simulated case of innovation process in a specific network collaboration to visualise and analyse the network of independent generators and tasks over time.

Different hypotheses were formed, tested and analysed via means of the DNA. The method appeared to perform well in describing and structuring the complex information flows during project management. Even the initial, still static, overview of the overall affinity network has provided with a systematic overview of the communication patterns and tasks during the progress of the innovation project. It was possible to define key actors using the centrality values and the overall structure was delineated using network-level measures. This process revealed the central roles of the goal strivers and system supporters, and the decentralised structure of the network along with the long lines of communication stemming from the dynamics of innovation "push" dynamic, knowledge and capital "leverage" and the community "transparency and accountability".

The dynamic nature of the network leadership and network capabilities was captured through the time slices. The network changes shape over time and to understand the change it is important to develop such time slices. The analysis suggested a considerable variation in the centrality of actors per time slice. For instance, at the very beginning of the project, the goal striver is more actively communicating. In addition, the time slices indicate an emergent character of the network of innovative affinity space. It is evident that during the first stages of the project when the goals and other information are communicated in the portals, the generators in the network are active making it highly connected, whereas as the time passes by, the network quickly becomes more fragmented when individuals return to their own specific task. It was also evident that network power positively influenced the innovation process when the goal strivers and system supporters exhibited high system competency confirming Westaby's (2012, p. 88-90) theoretical propositions. There was evidence of disconnected parts of the network during the middle of the implementation of the innovation, stemming from the role of goal preventers and supportive resistors. In these moments, it was also obvious that system negators and system reactors, opposing negative entities in the innovative affinity space were contributing towards a negative overall performance. Nevertheless, it was found that this influence was scarce and did not relate with the source of the information. It was not possible to trace these dynamics in the static image of the network at the very beginning, yet it was important to retrieve and interpret later time slices as this understanding informs the conceptualisations of the innovative affinity network space.

The previous finding confirms other studies like Wolbers *et al* (2013) and Schipper *et al*'s (2015) that employing only static analysis of networks prevents from revealing the real dynamics of communication and potential problems or success competencies. It is significant however to point out one limitation of the DNA which was how while the analysis allowed to structure the information flows, it did not help to reveal details on the content of the information that flows through the ties, or how the generators through their roles respond to this information as such work would require huge gathering of data. DNA demonstrates whether information is flowing between generators or not. It could be possible to add an attribute such as information quality to classify the ties between generators, nevertheless such an action would only visually enhance the analysis. One potential alternative would be to combine a DNA with a qualitative analysis (Crossley 2010).

Although there were limitations on the data used for this analysis and in terms of the data collection methods, such as how process mapping might not give an exact representation of how generators behave during real-time operations, still process mapping made it possible to create a detailed representation of the process and the information flows, supported by the meta-matrix. Given that participants were chosen to represent typical teams of different firms working on innovation projects in China, it is possible to generalise to some extend and consider some of their activities as routine tasks. It can be expected that non-standardised actions are employed to enable creativity during open innovation projects, however, certain network competencies prevail across all innovative affinity spaces. In this sense, it is not unlikely to witness similar network structures and information flows and dynamics in other countries, yet this remains to be seen with future research.

It is presumed that employing the framework of innovative affinity spaces using a dynamic network analysis in a more systematic way, could further provide with insights on how to integrate the approaches of mapping networks and building networks. A more systematic investigation into the underpinnings of leaders within innovative affinity spaces could also ensure that they and future leaders are trained and fluent in a network perspective.

Acknowledgment
The authors would like to thank anonymous reviewers for their valuable comments. We are grateful to the financial support provided by the major project of the National Social Science of China (no.15BGL200). We wish to thank The Overseas Education College of Jiangsu University for their valuable support especially the Dean Prof. Jing Gao and PhD supervisor Dr. Yong Cui. We are also very thankful to PhD scholar Mr.Henry Asante Antwi and Miss.Tehzeeb Mustafa for their valuable suggestions.

References

Baier, D., Queitsch, M.& Freund, S. (2006)."Erfolgsfaktoren f€ur das Innovations management in Netzwerken aus KMU und Forschungseinrichtungen: Eine empirische Untersuchung", in: Meyer J-A (Hrsg.) (ed) "Kleine und mittlere Unternehmen in neuen M€arkten – Aufbruch und Wachstum – Jahrbuch der KMU-Forschung und -Praxis 2006". Josef Eul, Lohmar, pp. S197–S214.

Baldwin, J.R., W. Gu, Lafrance, A.& Macdonald, R. (2009). Investment in Intangible Assets in Canada: R&D,

Innovation, Brand, and Mining, Oil and Gas Exploration Expenditures. *Research Paper: The Canadian Productivity Review*, Statistics Canada, Ottawa, December.

Becker, W.& Dietz, J. R. (2004).“R&D cooperation and innovation activities of firms: evidence for the German manufacturing industry”,*Research Policy*33(2), 209.

Belderbos, R.& Carree, M. (2004).“Heterogeneity in R&D cooperation strategies”,*International Journal of Industrial Organization* 22(8/9), 1237 - 1263.

Bergman, J., Jantunen, A. & Saksa, J.M. (2009).“Enabling open innovation process through interactive methods: Scenarios and group decision support system”,*International Journal of Innovation Management*13(1), 139-156.

Borgatti, S.P., Everett, M. G.& Johnson, J.C. (2013).*Analyzing social networks.* SAGE Publications Limited.

Boscherini, L., Chiaroni, D., Chiesa, V. & Frattinni, F. (2010).“How to use pilot projects to implement open innovation”,*International Journal of Innovation Management*14(6), 1065-1097.

Buganza, T., Chiaroni, D., Colombo, G. & Frattini, F. (2011).“Organizational implications of open innovation: An analysis of inter-industry patterns”,*International Journal of Innovation Management*15(2), 423-455.

Burgelman, R.A. (1983).“A process model of internal corporate venturing in the diversified major firm”,*Administrative Science Quarterly* 28, 223-244.

Cantwell, J. &Odile, J. (1999).“Technological globalization and innovative centres: the role of corporate technological leadership and locational hierarchy. *Research Policy*28(2-3), 119-144.

Carley, K.M. & Pfeffer, J. (2012).“Dynamic network analysis (DNA) and ORA”,*in Proceedings of the 2nd International Conference on Cross-Cultural Decision Making: Focus July 21-25, 2012,* San Francisco, CA.

Carley, K.M. (2003).“Dynamic network analysis”,*Dynamic Social Network Modeling and Analysis: Workshop Summary and Papers,* 133-145.

Carley, K.M., Diesner, J., Reminga, J. & Tsvetovat, M. (2007).“Toward an interoperable dynamic network analysis toolkit”,*Decision Support Systems* 43(4), 1324-1347.

Cassiman, B. & Veugelers, R. (2006).“In search of complementarity in innovation strategy”, *Management Science*52(1), 68 - 82.

Chen, J. & Qu, W.Q. (2003).“A new technological learning in China”,*Technovation*23(11), 861-867.

Chesbrough, H. (2006).“Open innovation: A new paradigm for understanding industrial innovation”, in H. Chesbrough, W., Van haverbeke, & J. West, (ed.)*Open innovation: Researching a new paradigm*, pp.1–12. Oxford: Oxford University Press.

Chesbrough, H. & Bogers, M. (2014).“Explicating Open Innovation: Clarifying an Emerging Paradigm for Understanding Innovation”, in H. Chesbrough, W. Vanhaverbeke & J. West (Eds.), *New Frontiers in Open Innovation,* Oxford: Oxford University Press, pp. 3-28.

Chesbrough, H. (2003).*Open innovation: The new imperative for creating and profiting from technology*. Boston, MA: Harvard Business School Press.

Chesbrough, H.W. & Teece, D.J. (2002).“Organizing for innovation: When is virtual virtuous?”*Harvard Business Review* (August), 80(8), 127–135.

Chesbrough, H., Vanhaverbeke, W. & West, J. (2006) *Open innovation: Researching a new paradigm*. London: Oxford University Press.

Chiaromonte, F. (2006).“Open Innovation through Alliances and Partnership: Theory and Practice”*International Journal of Technology Management*33(2-3), 111-114.

Chiaroni, D., Chiesa, V. & Frattini, F. (2010).“Unravelling the process from Closed to Open Innovation: evidence from mature, asset intensive industries”,*R&D Management*40, 222-245.

Cohen, S.G. & Bailey, D.E. (1997).“What makes teams work: group effectiveness research from the shop floor to the executive suite”,*J Manage*23(3), 239–290

Crossley, N. (2010).“The social world of the network: Combining qualitative and quantitative elements in social network analysis”,*Sociologica*1.

Cullen, K., Willburn, P. Chrobot-Mason, D. & Palus, C. (2014).*Networks: How Collective Leadership Really Works.* WHITE PAPER—Cutting-edge Thought Forum Insights.

Cullen, K.L., Palus, C.J. & Appaneal, C. (2013).*Developing Network Perspective: Understanding the Basics of Social Networks and their Role in Leadership.* Center for Creative Leadership White Paper (March 2013).

Dhanaraj, C. & Parkhe, A. (2006).“Orchestrating innovation networks”,*Academy of Management Review*31(3), 659-669.

Drath, W. (2001). The Deep Blue Sea: Rethinking the Source of Leadership, San Francisco: Jossey-Bass.

Drath, W. H. & Palus, C. P. (1994).*Making common sense: Leadership as meaning making in a community of practice* (Report No. 156). Greensboro, NC: Center for Creative Leadership.

du Chatenier, E., Verstegen, J.A.A. M., Biemans, H. J. A., Mulder, M. & Omta, O. (2009).“The Challenges of

Collaborative Knowledge Creation in Open Innovation Teams",*Human Resource Development Review*8 (3), 350-381.
du Chatenier, E., Vertegan, J., Biemans, H., Mulder, M., Omta, O. (2010)."Identification competencies for professional in open innovation teams",*R&D Management*40(3), 271-280.
Jingshu, D., Leten, B. &Vanhaverbeke, W. (2014)."Does Open Innovation Improve the Performance of R&D Projects?", *Research Policy* 43(5), 828-840. DOI: 10.1016/j.respol.2013.12.008
Dunning, J.H. (2002).G*lobal Capitalism, FDI and Competitiveness. The Selected Essays of John H. Dunning* (2nd ed.) The late John H. Dunning OBE.
Effken, J. A., Carley, K. M., Gephart, S., Verran, J. A., Bianchi, D., Reminga, J. et al. (2011)."Using ORA to explore the relationship of nursing unit communication to patient safety and quality outcomes",*International Journal of Medical Informatics*80(7), 507–517.
Elmquist, M., Fredberg, T., &Ollila, S. (2009)."Exploring the field of open innovation: a review of research publications and expert opinions",*European Journal of Innovation Management*12(3), 326-345.
Ernst, D. (2006)."Innovation off-shoring: Asia's emerging role in global innovation networks",*East-West Center Special Reports*10, 1–50.
Fan, P. (*2006*)."Catching up through developing *innovation* capability: Evidence from China's telecom-equipment industry",*Technovation*26(3), 359-368.
Fang, X. (2007)."*Formation*, *evolution and reform* of the Chinese S&T system", in Fang X., *Chinese technological innovation and sustainable development* (Chinese), Science Press.
Felin, T., &Zenger, T. R. (2014)."Closed or open innovation? Problem solving and the governance choice",*Research Policy*43(5), 914-925.
Fichter, K. (2009)."Innovation communities: the role of networks of promotors in open innovation",*R&D Manage*39(4), 357–371.
Fichter, K. (2012)."Innovation communities: A new concept for new challenges", in K. Fichter & S. Beuckert (Eds.).*Innovation communities: Teamworking of keyPersons as a Success Factor in Radical Innovation*. Berlin, Heidelberg: Springer.
Fichter, K. &*Beucker,* S. (Eds.). (*2012*). *Innovation Communities*. *Teamworking of Key Persons as a Success Factor in Radical Innovation*. Berlin, Heidelberg: Springer.
Ford, D., Gadde, L.E., Håkansson, H. & Snehota, I. (2003).*Managing Business Relation‐ships* (2nd ed.) England: John Wiley & Sons Ltd.
Freeman, L. C. (1979)."Centrality in social networks conceptual clarification",*Social Networks*1(3), 215-239.
Fu, X. & Gong, Y. (2010).*Indigenous and foreign innovation efforts and drivers of technological upgrading: evidence from China*. World Development.
Fu, X. (2015) *China's Path to Innovation*. Cambridge University Press.
Fu, X.&Xiong, H.(2011)."Open innovation in China: policies and practices", *Journal of Science and Technology Policy in China*2(3), 196 – 218.
Gee, J. P. (2004).*Situated language and learning: A critique of traditional Schooling*, London: Routledge.
Gee, J. P. (2006).*An introduction to discourse analysis.* New York: Routledge.
Gee, J. P. (2007). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.
Gee, J. P. & Hayes, E. (2009). *Public pedagogy through video games: Design, resources and affinity spaces.* Game Based Learning. http://www.gamebasedlearning.org.uk/content/view/59/
Gemünden, H. G., Salomo, S. & Hölzle, K. (2007)."Role Models for Radical Innovations in Times of Open Innovation",*Creativity and Innovation Management*16, 408-421.
Gianiodis, P., Ellis, S.C. and Secchi, E. (2010)."Advancing a typology of open innovation",*International Journal of Innovation Management*14(4), 531-572.
Grant, R.M. & Baden-Fuller, C. (2014)."A knowledge accessing theory of strategic alliances", *J Manage Stud* 41, 61–84.
Gulati, R. (1999). "Where Do Interorganizational Networks Come From?",*American Journal of Sociology*104(5), 1439–93.
Hauschildt, J. (1999)."Projektleiter als Prozesspromoteren", in Hauschildt, J. & Gemünden, H.G. (eds.), *Promoteren. Champions der Innovation* (2nd ed.) Gabler, Wiesbaden, Germany, pp. 211– 31.
Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J. & Winter, S.G. (2007) *Dynamic capabilities: understanding strategic change in organizations*. London: Blackwell.
Hossain, L., Wu, A., & Chung, K.K. (2006)."Actor centrality correlates to project based coordination",*Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work,* 363-372.
Howell, J.M. & Higgins, C.A. (1990a)."2Champions of technological innovation",*Administrative Science Quarterly* 35, 317-341.

Howell, J.M., & Higgins, C.A. (1990b).“Champions of change: Identifying, understanding, and supporting champions of technological innovation”,*Organizational Dynamics*19, 40 - 55.

Howell, J.M., Shea, C.M.,& Higgins, C.A.(2005).“Champions of Product Innovations: Defi ning, Developing, and Validating a Measure of Champion Behaviour”, *Journal of Business Venturing* 20, 641-661.

Human, S.E. & Provan, K.G. (1997).“An emerging theory of structure and outcomes in small-firm strategic manufacturing networks”,*Acad Manage J*40, 368–403.

Jenkins, H. et al. (2006).*Confronting the Challenges of Participatory Culture: Media Education for the 21st Century*, Cambridge and London: The MIT Press.

Kelley, D. & Lee, H. (2010).“Managing Innovation Champions: The Impact of Project Characteristics on the Direct Manager Role”,*Journal of Product Innovation Management*27, 1007–1019. doi:10.1111/j.1540-5885.2010.00767.x

Kim, Y., Choi, T. Y., Yan, T. & Dooley, K. (2011).“Structural investigation of supply networks: A social network analysis approach”,*Journal of Operations Management* 29(3), 194-211.

Kogut, B. & Zander, U. (1992).“Knowledge of the Firm, Combinative Capabilities and the Replication of Technology”,*Organization Science*3, 383-397.

Lammers, J.C., Curwood, J.S. & Magnifico, A.M. (2012).“Toward an affinity space methodology: Considerations for literacy research.”, *English Teaching: Practice and Critique*, 11(2), 44-58. Available http://education.waikato.ac.nz/research/files/etpc/files/2012v11n2art3.pdf accessed 14 November 2016.

Lave, J. & Wenger, E. (1990).“Situated Learning: Legitimate Peripheral Participation”,*IRL report 90-0013*, Palo Alto, CA: Institute for Research on Learning.

Lichtenthaler, U. (2011).“Open innovation: past research, current debates, and future directions”, *Academy of Management Perspectives*25(1), 75–93.

Lichtenthaler, U. & Lichtenthaler, E. (2009).“A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity”,*Journal of Management Studies* 46(8) doi: 10.1111/j.1467-6486.2009.00854.x

Linton, R. (1936). *The Study of Man*. New York: Appleton Century Crofts.

Liu, X. (2005).“China's development model: an alternative strategy for technological catch-up”,*Working Paper*. Hitotsubashi University.

Liu, Li. (2008).“The Evolution of China’s Science and Technology Policy”(1975-2007).*OECD Review of Innovation Policy:China*, 381-393.

Markham, S. K., Ward, S. J., Aiman-Smith, L. & Kingon, A. (2010).“The valley of death as context for role theory in product innovation”, *The Journal of Product Innovation Management*27, 402–417.

Matheis, H., Tilebein, M., Hirsch, M. & Lau, A. (2014).*Managing Diversity of Collaborative Innovation Projects.*

Macnamara, D. & Banff Executive Leadership Inc. (2004).“5 Dynamics of Network Leadership”,*Leadership Acumen*19.

McGonagill, G. & Reinelt, C. (2011).“Leadership Development in the Social Sector: A Framework for Supporting Strategic Investments”,*The Foundation Review*2(4), 57-72. doi:10.4087/ FOUNDATIONREVIEW-D-10-00030.

Padilla-Meléndez, A. & Garrido-Moreno, A. (2012).“Open innovation in universities: What motivates researchers to engage in knowledge transfer exchanges?”*International Journal of Entrepreneurial Behavior and Research*18(4), 417-439. DOI: 10.1108/13552551211239474.

Miotti, L. & Sachwald, F. (2003),“Co-operative R&D: Why and With Whom? An Integrated Framework of Analysis”,*Research Policy* 32, 1481–1499.

Mühlhaus, D., Weiber, R., Kim, J.S. & Hyun, J.H. (2012). “A conceptual approach to modelling the success of communities of innovation”, *Total Quality Management & Business Excellence* DOI:10.1080/14783363.2012.6695 Available https://www.researchgate.net/publication/254348582_A_conceptual_approach_to_modelling_the_success_of_communities_of_innovation.

Munkongsujarit, S. & Srivannaboon, S. (2011). “Key Success Factors for Open Innovation Intermediaries for SMEs: A Case Study Of Itap In Thailand”,*Technology Management in the Energy Smart World* 1-8.

Nelson, R. R. (1993). (ed.). *National Innovation Systems: A Comparative Study*. Oxford: Oxford University Press.

Nieto, M.J. & Santamaria, L. (2007).“The importance of diverse collaborative networks for the novelty of product innovation”,*Technovation*, 27(6), 367-377.

OECD (2008) *Open innovation in global networks*. OECD Publishing, Paris.

Powell, W.W., K. Koput, L. & Smith-Doerr. (1996).“Interorganization collaboration and the locus of innovation: Networks of learning in biotechnology”,*Admin. Sci. Quart.* 41, 116–145.

Provan, K.G., Fish, A. and Sydow, J. (2007) "Interorganizational networks at the network level: A review of the empirical literature on whole networks",*Journal of Management* 33(3), 479-516.

Rese, A. & Baier, D. (2012)."Networks of Promotors as Success Factor for Radical Innovations: Theoretical Considerations and Empirical Findings", in K. Fichter & S. Beuckert (Eds.), *Innovation communities: Teamworking of keyPersons as a Success Factor in Radical Innovation*. Berlin, Heidelberg: Springer.

Ritter, T., Wilkinson, I. F. & Johnston, W. J. (2002)."Measuring Network Competence: Some International Evidence",*Journal of Business and Industrial Marketing*17, 119-138.

Rost, K., Hölzle, K. and Gemünden, H.G. (2007)."Promotors or champions? Pros and cons of role specialisation for economic process",*Schmalenbach Business Review(SBR)*59(4), 340–363.

Salmon, P., Stanton, N., Jenkins, D. & Walker, G. (2011)."Coordination during multi-agency emergency response: Issues and solutions",*Disaster Prevention and Management*20(2), 140-158.

Savitskaya, I., Salmi, P., & Torkkeli, M. (2010)."Barriers to Open Innovation: Case China",*Journal of Technology Management & Innovation*5(4), 10-21.

Schipper, G., Gerrits, L. & Koppenjan, J. F.M. (2015)."A dynamic network analysis of the information flows during the management of a railway disruption"*, EJTIR*15(4), 442-464.

Schon, D.A. (1963)."Champions for radical new inventions",*Harvard Business Review*41(2), 77-86.

Schreiber, C. & Carley, K. (2008)."Leading for innovation and adaptability: Toward a dynamic network analytic theory of knowledge era leadership", in M. Uhl-Bien & R. Marion (Eds.) *Complexity leadership, Part 1: Conceptual foundations* (pp. 291−332). Charlotte, NC: Information Age Publishing.

Squire, K. (2011).*Video games and learning: Teaching and participatory culture in the digital age.* New York, NY: Teachers College Press.

Stanton, N.A., Walker, G.H., & Sorensen, L.J. (2012)."It's a small world after all: Contrasting hierarchical and edge networks in a simulated intelligence analysis task",*Ergonomics* 55(3), 265-281.

Tether, B.S. (2002). "Who co-operates for innovation, and why An Empirical analysis", *Research Policy*31(6), 948.

Tsvetovat, M. & Carley, K.M. (2004)."Modeling complex socio-technical systems using multi-agent simulation methods", *KI 18*(2), 23-28.

Turner, L. (2002). *Translation of a health policy innovation: An analysis of the actors, factors and processes that enabled the emergence and translation of Diagnosis Related Groups into and within Australia*, 1970-2000, unpublished PhD thesis, UNSW.

UNCTAD (2007).*The Least Developed Countries Report, 2007 - Knowledge, technological learning and innovation for development* (UNCTAD/LDC/2007). New York and Geneva. United Nations. Available http://unctad.org/en/pages/PublicationArchive.aspx?publicationid=158.

Walter, A., Parboteeah, K. P., Riesenhuber, F. & Hoegl, M. (2011)."Championship Behaviors and Innovations Success: An Empirical Investigation of University Spin-Offs",*Journal of Product Innovation Management*28(4), 586–598.

Wang, Y., Vanhaverbeke, W., Roijakkers, N.& Chen, J. (2011)."How Chinese firms employ open innovation to accelerate the development of their technological capability", *International Journal of Technology Management* DOI: 10.2139/ssrn.1925149, 1-23.

West, J. & Lakhani, K.R. (2008)."Getting Clear About Communities in Open Innovation",*Industry and Innovation*15(2), 223-231, DOI: 10.1080/13662710802033734

West, J. & Bogers, M. (2014)."Leveraging External Sources of Innovation: A Review of Research on Open Innovation",*J Prod Innovation Management*31(4), 814–831. DOI: 10.1111/jpim.12125.

Westaby, J. D. (2012).*Dynamic network theory: How social networks influence goal pursuit.* Washington, DC: American Psychological Association.

Witte, E. (1977)."Power and Innovation: A Two-Center Theory",*International Studies of Management and Organization* 7, 47-70.

Wolbers, J., Groenewegen, P., Mollee, J. & Bím, J. (2013)."Incorporating time dynamics in the analysis of social networks in emergency management", *Journal of Homeland Security and Emergency Management* 10(2).

Yip, G.S. & McKern, B. (2016).*China's Next Strategic Advantage: From Imitation to Innovation*. MIT Press.