Satellite Meeting - Knowledge Management Section
New Directions in Knowledge Management

Open Knowledge Management Model in Open Innovation Environment

Wang Zheng

Department of Public Information Resource Management, School of Public Management, Northwest University, Xi'an, China

School of Information Management, Nanjing University, Nanjing, China

E-mail address: libranger1203@gmail.com

Abstract:

Open innovation is the main trend of innovation theory and practice，which is core concept of future economic development strategy in China. In open innovation environment, a great amount of open content and open knowledge has been generated and accumulated constantly, and become into the new resource driving innovation. Open knowledge remoulds the knowledge environment for various types of organizations including library, and brings challenges and opportunities to organization knowledge management model. In traditional enterprise knowledge management theory and practice, internal knowledge is the primary target of operation and research, and stressing on knowledge accumulation and possession, ignoring eternal knowledge, open knowledge and flows of knowledge across the organizational boundary. The traditional model of knowledge management focuses on internal knowledge would lead organization into island in open environment.

In open innovation environment, open knowledge management model is supplement and complement to existed knowledge management model. Open knowledge is not only a knowledge attribution, but also a knowledge governance mechanism. Open knowledge theory is enrichment to firm knowledge theory. The thesis based on firm knowledge resource view, brings up with knowledge open regime in addition to appropriability regime.

Furthermore, the thesis raises open knowledge management model. Through grounded theory and case study, the research builds up the theory and pattern of organization open knowledge, and offers some specific implementation strategies. This model has adaptability and dynamic nature. The strategy selection depends on the knowledge circumstances where organization locates in.

The open knowledge management model raised by this thesis is complement to firm knowledge theory and open innovation theory. In practice, the model contributes to knowledge management and service design and implement, benefits for promoting status and efficiency of knowledge management in enterprise, government, public sector, knowledge service provider and even individual innovator.

Keywords: Open Innovation, Open Knowledge, Knowledge-based Theory of the Firm, Open Knowledge Management

Introduction

Open innovation has been the main trend of innovation theory and practice. In open innovation environment, amount of open content is accumulating. With the globalization in recent decades, capital, people and knowledge were flowing more smoothly in worldwide. In the flat world (Friedman, 2005), the new mode for production, consumption and innovation are forming gradually, and connotation the essential productive factor such as knowledge is reshaping. In China mainland, the Chinese economic growth mode is changing from energy-driven or labor-driven to "Innovation driven development strategy". From viewpoint of knowledge management practice, in last 5 years Chinese government launched an array of policies such as Internet plus initiative, Big data development initiative and mass entrepreneurship, which have a far-reaching influence on knowledge infrastructure, knowledge producer, knowledge manager, knowledge consumer and intellectual content itself. There is a common feature of these policy, that is emphasizing on open attribute of knowledge resource.

Background

Open innovation goes mainstream

The conception of innovation raised by Schumpeter refers to reconfiguration of productive factors within enterprise by entrepreneur. In traditional industrial age, innovation activities were mostly happened within enterprise, this type of innovation mode was called as Schumpeterian Innovation (Laursen and Salter, 2006).

The core of open innovation refers to a process based on purposively managed knowledge flows across organizational boundaries, utilizing both internal and external knowledge to realize innovation (Chesbrough, 2003). Nowadays open innovation is popular in the scene of problem-solving. In innovation practice, the Bain & Company survey of more than 200 senior executives around the globe found evidence of pent-up pressure to pursue open-market innovation (Rigby,2007). In theory, open innovation has been a valuable concept for so many firms and in so many contexts (Huizingh, 2010).

Open content goes main fact in open innovation environment

From the end of 20th century, there were two waves for open factors emerging(Table1). (1) The 1st wave started within 1980s to 1990s, the main content includes opening factors of policy, regimen and market, which provided foundation for open environment. The Chinese reform and opening-up progress begun in the same period. (2) The 2nd wave started in the first 10 years in 21st century, the main content refer to opening of technology factor, providing IT support for open environment. Stem from open source and Web2.0, various of open application and practicing were emerging, such as open collaboration, open community, open platform, open hardware, open tool, open access, open science and open government.

Based on above two waves, the 3rd wave may arise, we call it opening for content factor. Begin with 2010s, under the influence of previous open policy, open market, open infrastructure and open platform, massive open contents are producing incessantly. The representative forms are open linked data, open access article, open education resource, open patent and so on.

Table1 the 3-open wave

Stage	Time	Content	Representative forms
Stage1	The end of 20th century	Opening of market and policy factor	The flow of knowledge worker; The mature of idea transaction; The improvement of outside supplier; The enhance of regional cooperation;
Stage2	The beginning of 21st century	Opening of technology factor	open source; open collaboration; open community; open tool; open platform; open access; open infrastructure;
Stage3	2009-2016	Opening of content factor	open access resource; open data; open education resource; open patent;

With the rapid development of big data technology and improvement of compute level, the mass isomerism open content could be converted to open knowledge, becoming new wave of factor driving innovation.

Globally, the governments and enterprises have realized the value of open content. Since 2009, UNESCO, world bank, G8, European Commission and other international organization released the policies to promote open content. Some countries have raised the open content policy up to the national strategy. In business field, Tesla lead the new trend to "open patent" in 2014, TOYOTA, Ford and other industrial domain are following in succession. These movements have brought huge influence to innovation environment and knowledge environment.

Challenge for knowledge management in open environment

There are some studies report that open access resource could offer significant benefits to enterprises, using open content, enterprises could reduce the R&D cycle, promote the innovation potential, and fill up the knowledge gap results from resource shortage, especially for SMEs (Salter and Martin, 2000; David et al.,2011; Houghton et al.,2011).

For using knowledge generated by open community and users to drive innovation, there are more practical cases and business mode, such as P&G organized tens of thousands of researchers worldwide to solve internal problem by InnoCentive. Apple brought innumerable developers into its development system by App Store. In China, the famous mobile phone maker Xiaomi builds fan forum to collect users' proposal and design in real time, to realize constantly update and innovate of its production.

For China and other developing countries, unlike mature large enterprise and state-owned enterprise, many start-up companies, entrepreneurial teams and individual creative makers have inborn limit knowledge storage. If connect their idea, creativity, design and proprietary knowledge with open knowledge resource, it could achieve the goal for enabling innovators. That is a new chance and significance of knowledge management practice in open environment.

However, in traditional knowledge management theory and practice, organizational internal knowledge is common research or operation target. This stereotype could result in filter or myopia for enterprise and other organizations (Ansoff, 1984). If organization concentrate on internal and familiar field for long term, they could turn a blind eye for growing point, or even impotent for new things. The knowledge management only focus on internal knowledge may lead organization into isolated island in open innovation.

Theoretical foundation

The above three backgrounds refer to three main theory foundations: open innovation, open knowledge and knowledge management (Figure1).

Figure 1 Theoretical foundation
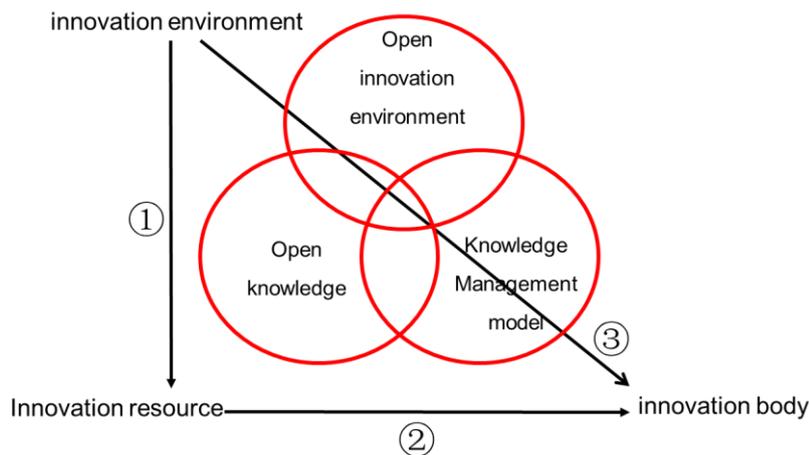
By literature review, could find the existing theory foundation and defeat. (1) For open innovation research (innovation environment): knowledge dimension is one of the main dimensions of open innovation research. From the viewpoint of knowledge, open innovation is defined as develop, utilize and retain knowledge both inside and outside the organization. Knowledge dimension connect open innovation theory with knowledge management theory (Lichtenthaler, 2009). However, existing open innovation theory lacks comprehensive consideration in external knowledge, especially for the knowledge which enterprises deliberately disclose. In addition, traditional open innovation research only pays attention on some certain knowledge pattern such as patent, and focus on knowledge transaction behavior, ignoring the new form of knowledge and related non-profit behavior. (2) For open knowledge (innovation resource): research on open knowledge shows the different standpoint between disciplines, but it cannot deny the fact that open knowledge is transboundary in utilizing end. For users, they don't intentional discriminate the source of open knowledge, they just consider their own scenario in most of time. Some researchers point out the open attribution on knowledge content, community and system, however, there seems to be a lack of consensus on open knowledge conception. (3) For knowledge management research (innovation body): as statements above, the traditional KM research mainly focus on internal knowledge, some limited research notices the external knowledge, but only focus on some certain knowledge source or carrier.

As for relationship between above three research foundation (see figure1), existing research have noticed that open innovation environment makes a new demand to innovation body (process③ in figure1). However, there was a lack of attention on knowledge pattern under open innovation environment affect (process①). In addition, how does open knowledge affect

innovation body's knowledge model and strategy, and what the effect is? (process ②). These questions were still in black box.

Conception of Open Knowledge
Open knowledge as knowledge pattern

Compared with open source or open content, open knowledge is a new terminology. According to existing research, could be classified as following by cognitive subject: (1) open knowledge in science and scientific exchange; (2) open knowledge in public affairs; (3) open knowledge in open movement; (4) open knowledge in enterprise and business. These four main domains are connecting with each other, and have convergence trend in open environment.

Table2 Typical open knowledge definition

Viewpoint	Typical definition	Sources	Description
Scientific exchange	Sun, 2013	Scientific open access; Internet	Convert open science and technology information into computable and machine-readable pattern, to support reuse and discover
Open movement	Open knowledge International	Open source movement; Public sector	Through open policy, open tool and open service, to promote utilize for open resource and upgrade public service level
Business	Pénin, 2007	Enterprise disclosure; Scientific open access;	Discover, identify and absorb external knowledge, knowledge integration

In some typical cases, Open Knowledge International is a global non-profit organization whose name after open knowledge. It gives the its official definition as open knowledge is what open data becomes when it's useful, usable and used. The key feature of openness are availability and access, reuse and redistribution, universal participation (Open Definition 2.1). In its Chinese Simplified definition version, open and knowledge are separately defined, knowledge refers to (1) content of music, movie and book; (2) data of science, history, geography and so on; (3) information about government and administration. The definition points out the open source software are excluded, because much previous studies have given the detailed definition. For scientist, open access content is not fully open knowledge, various types of open information should be structured, semantic and linked, to support combine and reuse, only then could call open knowledge. However, in some macro perspective, all the information released on Internet could be called as open knowledge (Cheng，2003).

In business and enterprise, there were four main sources of open knowledge: (1) scientific publish; (2) academic conference; (3) open source and internet; (4) patent disclose (Pénin, 2007). There is some overlay with scientific open knowledge. However, the research in company mainly focus on open source, user innovation based on visual community and crowdsourcing, and confined to several types of enterprise, especially for high-tech company, not reflect the whole meaning of open knowledge.

The definitions above reflect different field viewpoint, because in the history, open knowledge phenomenon came from several domains, mainly including:

- open access movement in scientific community

- open education practice

- open government movement

- open knowledge disclosure in business and open patent movement

Although in supply side, different field has its own specific opening motivation and strategy, but the result is the open knowledge from different fountainhead pour into one pool that is the public domain.

In addition, different field shared the similar philosophy: uphold the common properties of knowledge, promote knowledge sharing, and oppose to knowledge monopoly. Almost every field takes advantage of open source technology. Nowadays, every field shapes robust opening work flow. And in open innovation environment, different field's open chain is unblocked to each other.

Figure 2 Case on open knowledge chain cross different fields
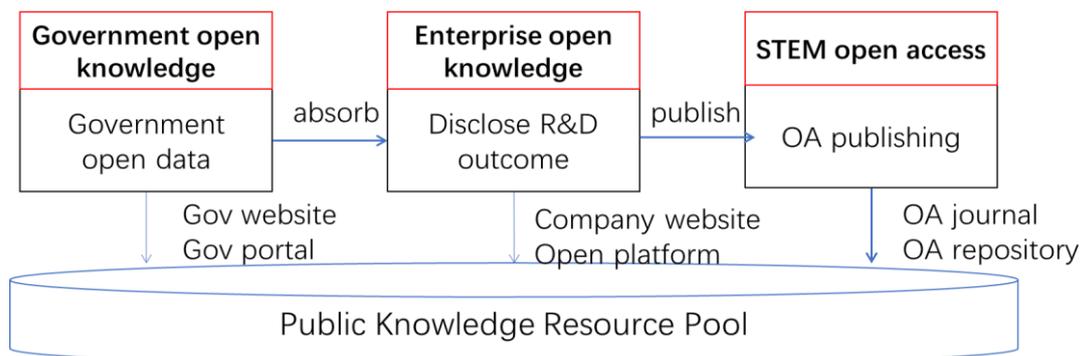
For instance, the enterprise and industry utilize open data from government and public sector into internal R&D, then its outcomes publish in OA journal, more public users could access the high-quality knowledge rather than only for scientists and research in labs.

However, the challenge now is, existing research mainly recognize open knowledge form supply side, lack of unified theoretical cognition form utilize side. What's more, when refers to definition of knowledge, there are many near-synonymy and ambiguity, such as data, information, content and work.

Base on above discussion, this study generalizes blowing main theoretical basis to define open knowledge:

- The epistemology, refers to open knowledge's philosophy base

- The intellectual property, refers to open knowledge's legal attributes

- The ontology technology, refers to open knowledge's operational technique

- The knowledge-based theory of the firm, refers to open knowledge's business value

From open knowledge phenomenon up to theoretical perspective, this study adopts two common dimensions to define open knowledge (Figure 3). (1) The vertical axis (open property) means openness is a changing process rather than binary status (Wiley,1998). It spins off two progressive subclasses, gratis and libre (Garrison, 2014), describing the extent of freedom to

use open knowledge (the less control, the more open). (2) The lateral axis (knowledge property) abides by DIKW pyramid, describing the extent of processing and investment. Particularly, in big data era, the value and readable in data side is ascent, changing the inherent value chain. Therefore, the lateral axis incorporate data into knowledge scope.

Figure 3 the property of open knowledge
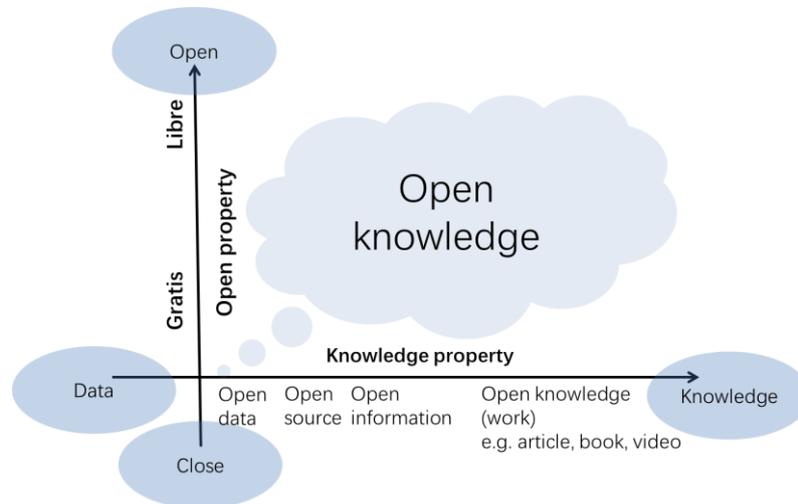
Combine the two property dimensions, the open knowledge locates in the dynamic matrix, means open knowledge as a knowledge pattern is keeping change, with variable openness and particle size. This study defines open knowledge as follows:

Open knowledge is generated in open innovation environment, abides by existing framework of intellectual property, with nature of public domain, supports reuse, revise, remix, and redistribute, is a public knowledge resource.

Open knowledge as governance mechanism

Traditional knowledge-based theory of the firm describes the relationship between knowledge attribute and firm governance mechanism. In old knowledge view, the core of governance mechanism is proprietary regime, realized by intellectual property protection. In the strong impact of this governance thought, from 1980s the commercial field constantly launched "enclosure movement" in public domain, to a certain extent, becomes fuse of later open movement and open innovation.

In open innovation environment, the old intellectual property regime was corrupted, and be regard as "anti-innovation" or cause of "tragedy of the anti-commons". To address this situation, the various open movements adopt the philosophy in the opposite of intellectual property, meanwhile, in practice adjust to the intellectual property framework, making the balance between public domain and private province. This trend appears in the enterprise, some companies try to weaken the proprietary regime, and to explore the new regime in open environment. The emerging of open knowledge is a moment for this exploration. Therefore, open knowledge is not only a name of knowledge pattern, not also governance mechanism.

Figure 4 open knowledge theory evolution
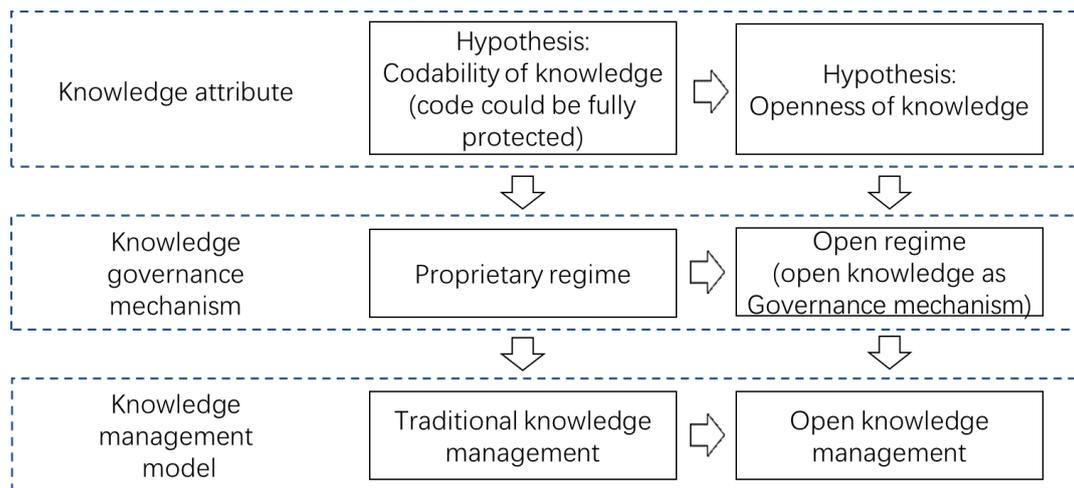
Review the history of firm knowledge theory, could find out it is a way that new attribute of knowledge was continually discovered, new hypothesis was continually built and busted (figure 4). In traditional economics, knowledge was assumed to be total public goods, but results in opportunism dilemma. Then the tacit attribute of knowledge was raised, and bring up with knowledge transaction cost, so people begun to be keen on knowledge explicitation and coding, but facing disclosure dilemma. It results in the proprietary regime rising. With the openness attribute was recognized, the new knowledge governance mechanism and open management model may be the emerging trend. To sum up, the theory about open knowledge may include bellowing things:
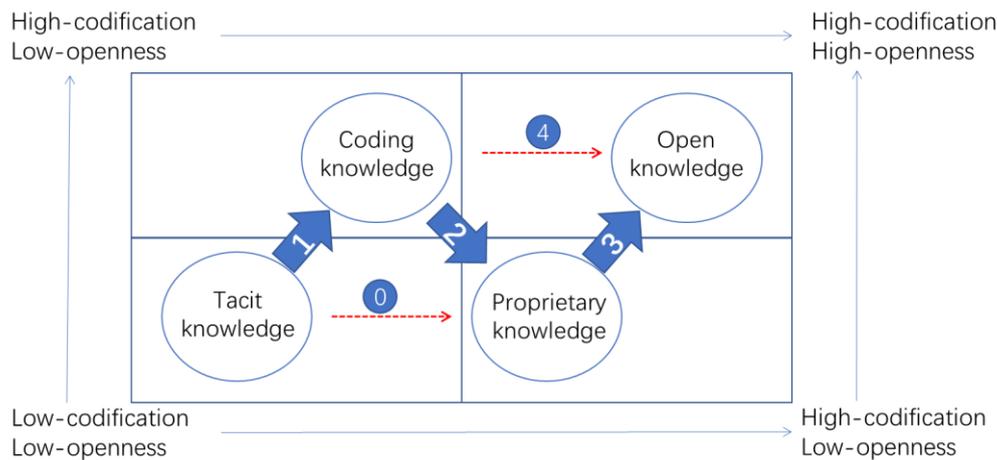
- Open knowledge as knowledge attribute
- Open knowledge as knowledge pattern
- Open knowledge as governance mechanism
- Open knowledge as management model
- Open knowledge as actionable strategy

Open Knowledge Management Model
During 2015-2016, this study made a survey on more than 20 companies in China mainland, mainly locate in the central city such as Beijing, Tianjin, Shanghai, Guangzhou, Xi'an and Shenzhen. The sample derives from two Chinese domestic knowledge management trade association directory: China Knowledge Management Alliance and Chinese Knowledge Manager Community. Sampling method adopts snowball sampling and purposive sampling. The samples cover IT company, consulting corporation, training company, manufacturer, financial institution, design agency, public sector and small entrepreneurial team.

By case study, form the open knowledge management model (Figure 5). This model refers to SECI model (Nonaka, 1995) in form. Then extend the knowledge classification and knowledge conversion thought in SECI model. Based on tacit-explicit dimension previously, this model adds proprietary-open dimension, form the new matrix to describe the knowledge pattern and convert strategy. This model includes: (1) 2 kinds of dimension; (2) 4 knowledge types; (3) 5 convert forms.

Figure 5 open knowledge management model

High-codification
Low-openness

High-codification
High-openness

Coding knowledge

Open knowledge

Tacit knowledge

Proprietary knowledge

Low-codification
Low-openness

High-codification
Low-openness

For four knowledge types in the model and five convert forms

The implication of tacit knowledge follows previous research. In an organization, tacit knowledge includes skills, ideas and experiences imbedded in people's mind. The tacit knowledge is most valuable knowledge in organization. Exploit and disseminate tacit knowledge is always priority for knowledge management. With the technology and knowledge management practice develops, the coding knowledge in organization increases rapidly, such as document, standard, report, record, manual and so on. In the proprietary regime, most of coding knowledge generated in organization be seen as organization's knowledge assets especially for enterprise. The coding knowledge is protected comprehensively in old knowledge management fashion as proprietary knowledge. So far, the above three knowledge type domain has form mature knowledge management methods and tools respectively.

The covert form between knowledge types are key element in model. At first, check two extreme cases: (see figure 5)

(1) personal proprietary (see no.0 in figure 5)

The best way to keep a secret, is to keep it in your mind. Tacit is ultimate proprietary. Once been coding, there was a chance to open. Therefore, the ultimate proprietary is no coding operation.

(2) born open (no.4 in figure5)

It is ideal condition for open. Once been coding, knowledge is open for all. Organization's knowledge base is on Internet.

(3) coding strategy (see no.1 in figure5)

According to codification mode for knowledge management (Hansen et al.,1999), this strategy includes construct intranet, optimize IT infrastructure, enrich enterprise repository, launch knowledge management system and so on.

(4) proprietary strategy (see no.2 in figure 5)

Based on coding strategy, performance as stress on network security and privacy, focus on rights management, the knowledge with high classification level and so on. The main feature of this strategy is paying attention to intellectual property.

(5) open strategy

It is core of open knowledge management model. Under the influence if proprietary regime, most organizations have formed above knowledge type domain and strategy, open strategy is supplement and complement. And it could be a new trend. By cases study, could summarize blowing major open strategy:

- Set open inventory and roadmap
- Integrate internal repository and extranet
- Extend the function of knowledge management section
- Construct common knowledge base cross-discipline
- Open platform
- Datifying
- Ontologizing
- Utilize social media
- Run user community
- Open patent
- Default open

Case Study
To illustrate the open knowledge management model especially for different knowledge strategy choice and implement, in this part presents three companies' cases in China.

Huawei, Lenovo and Xiaomi are specimens and model of Chinese high-tech company. They were all listed in the most innovative companies TOP 50 released by BCG group in 2014 (there were only 4 Chinese companies on the list) (table 3). Most important of all, they are different type of companies (Lenovo is multinational corporation since purchased IBM PC, Huawei is domestic enterprise with self-owned brand, Xiaomi is relative newly established Internet company), however, they have same business line: smart phone. It is suitable for cross-case study. According to IDC report, in 2015 these 3 companies' market share list No.3, No.4, No.5 in worldwide (the TOP 2 are Samsung and Apple).

Table 3 Three case companies in BCG global innovation survey

	1 to 10		11 to 20		21 to 30		31 to 40		41 to 50
1	Apple	11	Hewlett-Packard	21	Volkswagen	31	Procter & Gamble	41	Fast Retailing
2	Google	12	General Electric	22	3M	32	Fiat	42	Wal-Mart
3	Samsung[1]	13	Intel	23	Lenovo Group	33	Airbus	43	Tata Group
4	Microsoft[2]	14	Cisco Systems	24	Nike	34	Boeing	44	Nestlé
5	IBM	15	Siemens	25	Daimler[3]	35	Xiaomi Technology	45	Bayer
6	Amazon	16	Coca-Cola	26	General Motors	36	Yahoo	46	Starbucks
7	Tesla Motors	17	LG Electronics	27	Shell	37	Hitachi	47	Tencent Holdings
8	Toyota Motor	18	BMW	28	Audi	38	McDonald's	48	BASF
9	Facebook	19	Ford Motor	29	Philips	39	Oracle	49	Unilever
10	Sony	20	Dell	30	SoftBank	40	Salesforce.com	50	Huawei Technologies

Source: 2014 BCG Global Innovators survey.
[1]Includes all Samsung business groups (including electronics and heavy industry).
[2]Includes Nokia.
[3]Includes Mercedes-Benz.

By case study, there are some interesting findings: Lenovo prefers to coding strategy, Huawei prefers to proprietary strategy, and Xiaomi prefers to open strategy. (Figure 6)

Figure 6 case study findings
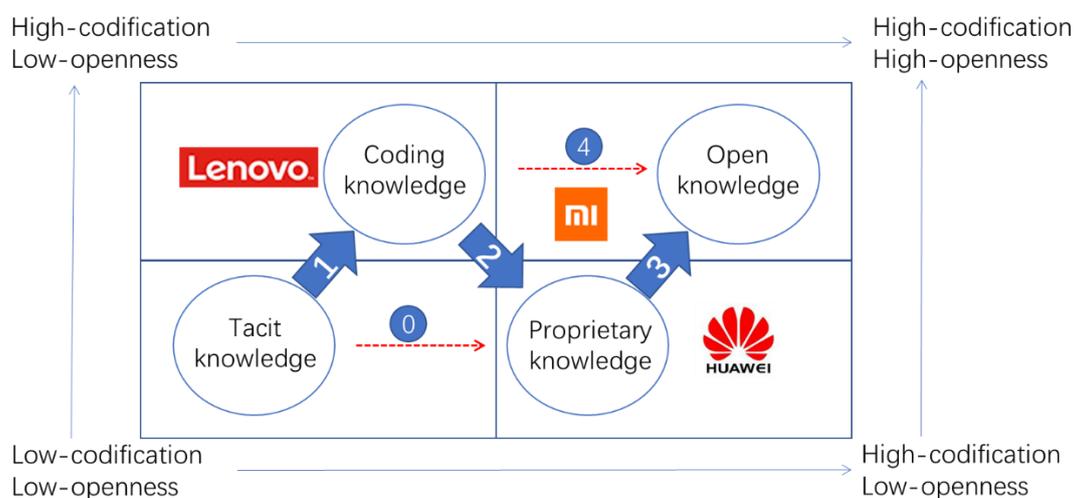
(1) Lenovo-coding strategy

Adopt Activity Based Knowledge Management (ABKM) method, identify every action in work flow, then record in knowledge article, save in Knowledge Base. Mobilizing workers and engineers writing knowledge article.

(2) Huawei- proprietary strategy

Stress on patent application keenly. In 2014, Huawei has become the champion in patent application number in the world. Adopt Employee Stock Ownership to control talent wastage rate. Strong intellectual property administration.

(3) Xiaomi-open strategy

Technic socializing, to introduce the technical knowledge to the public. Adopt mature on-line community to collect users' voice. Cultivate fans culture, involve fans into research and development. Set open level, Gated Launch.

Discussion and conclusion

Take the organization's knowledge environment into consideration, could understand the tendency for knowledge strategy choice. For above case, Huawei comes from telecom industry, it is a relative closed area, the core technology and standard were monopolized by a handle of western company, when Huawei attempted to get the market in Europe and America in 2003, it was sued by Cisco immediately. It was famous as 1st lawsuit in intellectual property between China and US. Which shows the closure property of environment where Huawei grew up.

As start-up, Xiaomi was born in Web 2.0 age in 2011. From beginning, it produces smart phone, unlike Lenovo and Huawei who once made traditional cell phone. Smart phone's most characteristic is software operation system, where open movement began. So, Xiaomi had open blood when it born. More important, Xiaomi lack enough funds to purchase patents and technology, unlike its predecessor once did, therefore chose open knowledge supply for Xiaomi is a sound choice.

More noteworthy is Lenovo, which is a PC producer. PC industry locates between telecom and Internet, it is a middleman. Its knowledge environment is semi-open, since 1982 IBM launched compatible machine (the IBM's action is open strategy, to open technical data except BIOS). Therefore, Lenovo's coding strategy is in the middle way, if head for open, it is Xiaomi way, if head for proprietary and intellectual property, it is Huawei way.

In conclusion, the open knowledge management model is dynamics, the choice for strategy is changing with environment. We could see when Huawei produces smart phone, it adopts Xiaomi way sometime, when Xiaomi goes into overseas market especially for western world, it adopts Huawei way.

In this study, we start from open knowledge phenomenon, and up to theoretical perspective. In open innovation environment, the openness attribute of knowledge is raising. Bring with the new open knowledge pattern. As result, the knowledge governance mechanism and management model may evolve consequently. In future study, could attention to open knowledge management practice for different kind of organization such as government, institution and library in different context. And track the effect of open knowledge strategy.

References

Chesbrough, H. (2003), Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press, Boston, MA.

David,P.,Dick,W.and Jane,H.(2011)Benefits to the private sector of open access to higher education and scholarly research, avaliable at:http://wiki.lib.sun.ac.za/images/5/5c/Report-to-oauk-benefits-of-open-access.pdf(accessed 20 May 2017).

Friedman,T.(2005),The World Is Flat.Farrar, Straus and Giroux, New York.

Garrison,J.(2014),What Does "Free as in Speech" or "Free as in Beer" Really Mean? avaliable at:http://www.howtogeek.com/howto/31717/what-do-the-phrases-free-speech-vs.-free-beer-really-mean/.(accessed 20 May 2017).

Hansen,M.,Nohria,N.and Tierney,T.(1999),What's Your Strategy For Managing Knowledge,Harvard Business Review,March-April,pp 106-116.

Hua jun cheng（2003）,OKSA: an open knowledge service architecture for building large scale knowledge system in semantic Web,Systems, Man and Cybernetics, IEEE International Conference.

Huizingh,E.(2010),Open innovation: State of the art and future perspectives,Technovation,Vol.31, Issue1,pp.2-9.

Houghton,J.,Swan, A.and Brown, S.(2011),The Danish Agency for Science, Technology and Innovation, avaliable at:http://wiki.lib.sun.ac.za/images/5/5c/Report-to-oauk-benefits-of-open-access.pdf(accessed 20 May 2017).

Laursen, K. and Salter, A. (2006), Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms, Strategic Management Journal, Vol. 27 No. 2, pp. 131-150.

Lichtenthaler, U. and Lichtenthaler, E. (2009), A capability-based framework for open innovation: complementing absorptive capacity, Journal of Management Studies, Vol. 46 No. 8, pp. 1315-1338.

Nonaka.I.,Takeuchi.H.(1995),The knowledge creating company: how Japanese companies create the dynamics of innovation,Oxford University Press,New York.

Pénin J.(2007),Open knowledge disclosure：An overview of the empirical evidences and the economic motivations,Journal of Economic Surveys,Vol.21（2）,pp.326-348．

Rigby,D.(2007),Open Market Innovation,Harvard Business Review,Vol.10,pp.68.

Salter,A.and Martin,B. The economic benefits of publicly funded basic research:
a critical review,Research Policy,Vol.30,pp.509-532.

Sun,T.(2013),Open information environment:remoled of academy library information resource development, Chinese Library Journal,Vol5,pp.9-17.

Wiley,D.(1998),Defining the "Open" in Open Contentand Open Educational Resources,avaliable at:http://opencontent.org/definition/(accessed 20 May 2017).

开放知识基金会，「开放知识」的定义，
avaliable at:http://opendefinition.org/od/1.1/zh/(accessed 20 May 2017).