

Assessing the Technological Development of Cloud Applications in China: A Patent Analysis

Honghua Qiu and Panbing Lu

Abstract—Cloud computing is one of the hot issues in recent years both in theory and practice. Patent information is considered an important mean of investigating the technological development. To assess the technological development of Chinese cloud applications, the patent information of cloud applications are searched from Shanghai Intellectual Property Information Platform and the technovation of Chinese cloud applications are analyzed by patent types, annual trend, main patentees/inventors, IPC distribution and technological life cycle, etc. The results of this study indicated that the patent number of cloud applications increased rapidly in recent years, nearly 90% of the patents were invention patents, most of the patents concentrated in the IPC of H04L29, G06F9 and G05B19, the domestic applicants such as INSPUR, HUAWEI and ZTE, would be challenged by the applicants from United States, South Korea and Japan.

Index Terms—Cloud computing, cloud application, patent analysis, technovation.

I. INTRODUCTION

Since the concept of Cloud computing was brought forward formally at the first time at the search engine conference in 2006 by Google's CEO Eric Schmidt, it became current one of the hot spot areas in the technological competition all round the world. Many countries, especially the developed countries, such as USA, UK, EU, JAPAN and South Korea and so on, have being deployed actively the NATIONAL CLOUD COMPUTING STRATEGY. It was translated from academic innovation to practical applications. According to the survey data provided by IDC (Internet Data Center), the cloud computing service discounted 10% of the whole IT expenses, its annual income approximated 44.2 billion US dollars, and the average annual growth rate reached as high as 26%, it is 6 times the growth rate of traditional IT industry. It is generally believed that the next five years would be the "golden period" for the development of cloud computing.

The industry of cloud computing in China has seen rapid development after 2010, the demonstration pilot project of the innovation development of cloud computing service confirmed by State Development and Reform Commission of China is carried out in Beijing, Shanghai, Shenzhen,

Hangzhou and Wuxi. The whole industry chain of cloud computing in Beijing would achieve at 200 billion during the period of 2013 to 2015, and Beijing would become a world class base.

The assessment of technological development is of increasing important for R&D activities and policy formulation. As one of the important protective measures for technological innovation, patent system requires the patent applicant to disclose the invention-creation in a manner sufficiently clear and complete, which allows patent information being an emerging as a possible alternative to assess the developing trend of a specific technology. It is believed that global events would have an effectiveness on technological development, and the technological innovation would then be reflected in the patent applications. According to the statistics of World Intellectual Property Organization (WIPO), in the global innovation activities, about 90-95 percent of the R&D achievements are covered in patent information. It is revealed that if the company makes full use of the patent information, the time employed in R&D would likely shorten 60% and the expenditure on R&D would likely save 40%. Moreover, the advantages of patent information also include that a relatively short publishing cycle and a standardized format, and so on. So much so, patent information analysis has become a feasible and effective way to identify or detect the technologies. Therefore, this paper will attempt to identify major trend changes and competitive situation of cloud applications in China.

The structure of this paper is arranged as follows. The previous studies about patent information analysis and patent protection for cloud computing would be summarized in the next section, which would be followed by an introduction of patent search and methodology, and then, the analysis and results would be presented. The conclusion would be discussed in the last part.

II. LITERATURE REVIEW

A. Empirical Studies on the Utilization of Patent Information

In the era of knowledge economy, intangible assets of a firm are often greater than tangible assets, and intangible assets has become one of the most important determinants for firm's competitive advantages [1]. The development situation and innovation activities of technologies would be discovered by patent bibliometric analysis, and the data contained in patent documents would be transferred into valuable and systematic information by means of patent analysis [2]. Patent analysis refers to methods of abstracting, indexing, counting, and analyzing used to study

Manuscript received February 14, 2017; revised April 15, 2017. This work was supported in part by National Social Science Foundation of China under Grant no. 15BTQ047.

Honghua Qiu is with the School of Intellectual Property, Northwest University, Xi'an, China (e-mail: honghuaqiu@163.com).

Panbing Lu is with the School of Intellectual Property, Xiangtan University, Xiangtan, China (e-mail: 305554029@qq.com).

the patent information, based on searching of patent documents [3].

Patent information analysis has long been regarded as an important method of investigating various aspects of technological development or inventive activities of firms, industries, countries, or regions [4], [5]. Patent data has also served as a technology indicator to evaluate the situation of technology development in a particular sector [6], [7]. Because patent applications imply the R&D trends of competitor technology, prominent applicators and inventors, and the structure of innovation, and so on [8], patent analysis is used to estimate the technological strengths and weaknesses of competitors [9].

As to the empirical study, Heeyong Noh *et al.* [10] developed a method of patent analysis focusing on keyword strategies for applying text-mining. Michele Grimaldi *et al.* [11] examined the strategic technology planning from patent portfolio value analysis. Sebastien Lizin *et al.* [12] used patent landscape analysis to identify the technology value analysis. Sebastien Liovoltaic solar cells. Tugrul Daim *et al.* [13] demonstrated the patent information of wind energy technology using the patent alert system.

B. Patent Protection for Cloud Computing

The term cloud computing has been used increasingly in recent years and gained close attention of correlative fields. Cloud computing is defined as an architecture, a platform, an operating system, and a service, and from a certain point of view, it is all of above [14]. Meanwhile, it also refers to the applications delivered as services over the internet, as well as to the actual cloud infrastructure [15]. Cloud application is one of the most important areas in cloud computing [16], the market development of cloud computing would be hindered by the problem of cloud applications [17]. Cloud computing has become one of the fastest-growing segment of the IT market due to its ability to host applications from a range of domains, including scientific, engineering, gaming and social networking and so on [18]. However, few investigations have been done on patent information analysis of cloud computing.

Consequently, patent data has become an important resource of studying the innovation activities, it is necessary for a company to search and analyze the patent information to achieve an effective management of technologies. Therefore, the purpose of this paper is to employ patent information analysis to illustrate the development of Chinese cloud applications from the perspectives of annual trend, inventor, and applicator, countries/region, IPC and technology life cycle and so on.

III. PATENT SEARCH AND METHODOLOGY

The online Shanghai Intellectual Property Information Platform was used for retrieving the patent documents [19]. Some patent databases of several specific technologies/industries including cloud computing were created in real time on SIPIP. The patent information we collected from each patent documentation and the dimensions we analysed are detail in Table I.

TABLE I: THE CONTENTS OF ASSESSMENT

Dimension	Objective
Distribution of applications in each patent type	To estimate the innovation intensity of cloud applications
Annual trend of patent applications	To analyse the developing course of cloud applications
Patent activities of main patentees/inventors	To investigate the comparative advantage among the patentees/inventors
Distribution of patent applications in different areas	To present which foreign countries focused on the market of cloud applications
IPC item distribution	To note which technological section concentrated more patents
Technology life cycle	To understand the developing stage of Chinese cloud applications

IV. ANALYSIS AND FINDINGS

A. Distribution of Patent Applications in Different Patent Types

According to Patent Law of China, there are three kinds of patent rights: invention, utility model and design. Comparing to the utility model and design, invention patents not only have a longer protection period and a stricter condition of examination and approval, but also implies a higher innovation level. Therefore, the innovative intensity of a specific technology would be estimated by the statistics of patent applications in different patent types.

As is shown in Fig. 1, the total number of patent applications filed by Chinese cloud application industry come to 9737, all the patent applications were concentrated in inventions and utility models, and the applications for inventions and utility models are 8566 and 1171, and share 88% and 12% of the total patent applications separately. Consequently, it would be presumed that most of the patents of cloud applications in China were concentrated on invention, the reasons are that: on the one hand, it reflects the technovation level of Chinese cloud applications, on the other hand, it executes the characteristic of patent applications in cloud applications: because most of the innovative achievements are classed as computer software/business method-related inventions, they could be protected only by invention patent according to the Patent Law of P.R. China.

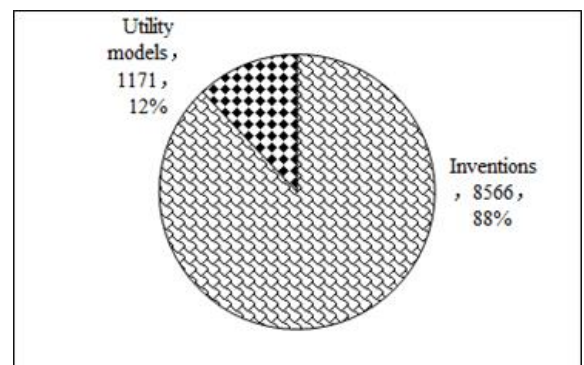


Fig. 1. Distribution of different kinds of patent applications.

B. Annual Developing Trend of Cloud Applications in China

The annual trend of patent applications reflects the development course of a specific technological field. Fig. 2 shows that patents for cloud applications increased rapidly after 2010, and the number of patent applications peaked in 2013 (2628 applications). Remarkably, the patent statistics in 2013 and 2014 are not complete, because the patent applications would be published after 18 months from the date of filing generally. Therefore, the patent applications would be anticipated to increase continuously. In view of the above, it could be argued that, with the support of government industry policy, the technological innovation of cloud applications in China have seen a rapid development in recent years.

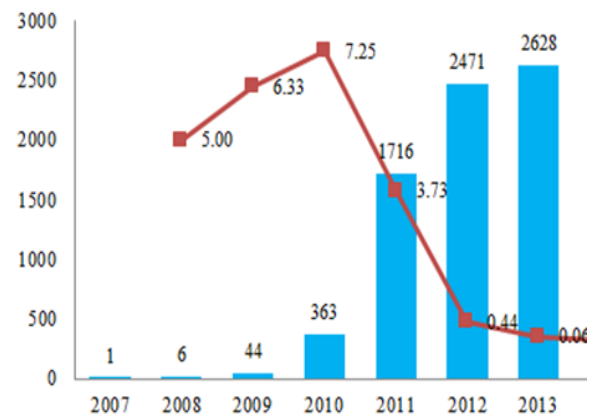


Fig. 2. The annual change and growth rate of patent application.

C. The Competitive Situation among Patent Applicants Inventors

TABLE II: KEY PATENT APPLICANTS OF CLOUD APPLICATIONS IN CHINA

Applicant	Total number	Rate of Invention	Rate of Grant	Cast of innovation
LI Zongcheng (Individual)	565	100%	0.00%	1
INSPUR	476	93.91%	4.62%	341
HUAWEI	188	100%	9.57%	308
ZTE	179	98.89%	3.35%	257
BAIDU	145	100%	0.00%	164
Qizhi	144	100%	3.47%	185
Qihoo	124	100%	2.42%	77
Microsoft	101	100%	6.93%	389
Tencent	92	97.83%	5.43%	204
NJUPT	89	98.88%	15.73%	209
G-Cloud	88	89.77%	4.55%	49

As is known that patent is an important legal measure to protect the innovative achievements, so that the competitive situation of innovation would be investigated by the statistical analysis of patent information.

Table II shows the patent activities of key applicants of cloud applications in China. It is found that LI Zongcheng, as an individual applicant, applied the largest number of patent applications with 565. INSPUR have the second most applications with 476, followed by HUAWEI with 188 applications. It could be considered that applicants listed in Table II could be the very important competitors in the technological sector of Chinese cloud applications, in other words, the applicants were concerned with the R&D of cloud applications, and lots of technology achievements have been made by them.

In addition, “Invention occupied” reflects the level of technological innovation. Therefore, as shown in Table II, it could be confirmed that most of the patents applied by the key applicants were invention for the reason that most innovative achievements in cloud applications were software/business method, while, according to the Patent Law of China, software/business method-related innovation could be applied for protection of invention patent only.

Any invention or utility model for which patent right may be granted, by Patent Law of China, must possess novelty, inventiveness and practical applicability. Hence, “Grant rate” reflects the quality of technological innovation. Table II shows that NJUPT has the highest “Grant rate” with 15.73%,

followed by HUAWEI with 9.57%, Microsoft is the third with 6.93%. It becomes possible to think that the patent applicants who have higher “Grant rate” would make better or more valuable innovative achievements in quality.

The “Cast of innovation” represents the number of inventors of the patent applicants. As shown in Table II, Microsoft possesses 389 inventors, followed by INSPUR with 308 inventors, and HUAWEI has the third largest number of inventors. According to Implementing Regulations of the Patent Law of China (Rule 13), inventor means any person who makes creative contributions to the substantive features of an invention-creation. Consequently, it could be considered that the applicant who have larger “Cast of innovation”, to some extent, would have stronger innovative ability in cloud applications of China.

Similarly, Table III presents the patent information of key inventors of Chinese cloud applications. The key inventors in one specific technology and their patent activities would be disclosed by counting the number of patent applications accomplished by each inventor. It is found that the inventor who accomplished the most inventions is LI Zongcheng with 565 applications; JI Tongkai is close behind with 123, and YU Zhilou followed with 75. It could be argued that the key inventors listed in Table III show great concern for the R&D of Chinese cloud applications and make many achievements.

In other words, most of the key inventors might be the technical experts in the technological field of Chinese cloud applications, their invention-creation accelerate the development of the technological sector of cloud applications in China.

Likewise, “Granted number” represents the innovative quality of an inventor. From Table III, it could be seen that most of the patent applications have not been granted, one possible major reason would be a stricter provision on examination of invention application relating to software/business method were implemented by Chinese Patent Office.

“Entity belonged to” means the entity that the inventor is employed in. it could be seen in Table III that Soochow University possesses LI Zongcheng, who accomplished the most number patents in Chinese cloud application, besides, Wulian Group has 4 key inventors, G-Cloud has 3 key inventors, and INSPUR also has 2 key inventors. Generally speaking, the key inventor, as the persons who uppermost concern the R&D and development of Chinese cloud

applications, would be the most important innovators in that technological field. Hence, it could be considered that the entity listed in Table III, have a greater innovation capability in Chinese cloud applications.

The International Patent Classification (hereinafter “IPC”), established by Strasbourg Agreement 1971, provides a classification of patents and utility models according to the different areas of technology to which they pertain [20]. IPC has now become one of the most important tools available to classify the technological sector of a patent application. The universality and diversity of technological research among different inventors would be investigated by analysing the distribution of patents’ IPC. It could be seen from Table III that the most of the patent applications applied by the key inventors were mainly confined to the IPCs of H04L29, G07C9 and G05B, etc., thus the common aspects and differences of the innovative direction among the key inventors could be identified.

TABLE III: KEY INVENTORS OF CLOUD APPLICATIONS IN CHINA

Inventor	Total number	Granted number	Main IPC	Entity belonged to
LI Zongcheng	565	0	H04L29 (565)	Soochow University
JI Tongkai	123	4	H04L29 (55) H04L12 (15)	G-Cloud
YU Zhilou	75	0	H04L29 (23) G06Q10 (8)	INSPUR
MO zhanpeng	71	0	H04L29 (32) G06F9 (11)	G-Cloud
YANG Song	66	1	H04L29 (29) G06F9 (11)	G-Cloud
ZHU Feng	47	0	G07C9 (9) G05B19 (6)	Wulian Group
YU Jiangmei	46	0	G07C9 (9) G05B19 (6)	Wulian Group
ZHU Jungang	46	0	G07C9 (9) G05B19 (6)	Wulian Group
ZHU Junling	46	0	G07C9 (9) G05B19 (6)	Wulian Group
ZHU Bo	45	0	H04L29 (20) H04L12 (9)	INSPUR

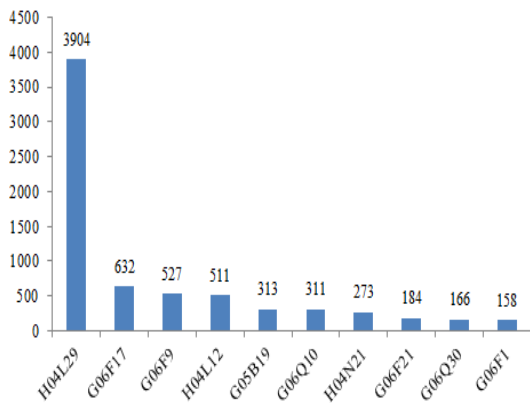


Fig. 3. The distribution of the patents by International Patent Classification (IPC).

As stated above, IPC is a useful system to classify the applications of inventions and utility models, according to the technological field to which the patents relate. Fig. 3 shows the top 10 IPCs based on the patent information searched in this study. Most patents were coded as H04L29 (3904 patents), which is related to “Arrangements, apparatus, circuits or systems, not covered by a single one of groups from H04L1/00 to H04L27/00”, which is followed by G06F17 (632 patents),

which is related to “Digital computing or data processing equipment or methods, specially adapted for specific functions”, and G06F9 (527 patents), which is related to “Arrangements for program control, e.g. control unit”. Moreover, the code of H04L12 also concentrated 511 patents, which is related to “Data switching networks”. It could be recognized that, as to the industry of Chinese cloud applications, the technological areas related to the IPC listed in Fig. 3 would be the dense sector of the research and development (R&D)/innovation.

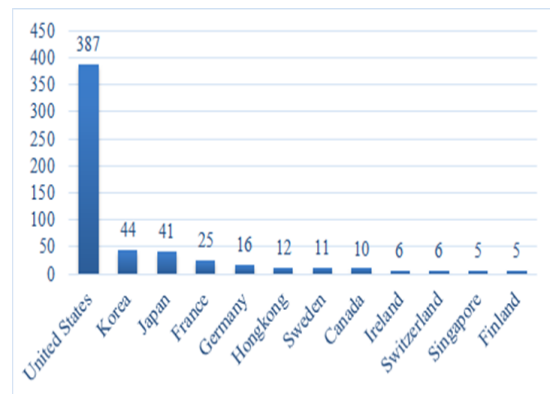


Fig. 4. Number of patents by countries.

The number of patents by countries could be found out according to the nationality of patent applicants. The top 10 foreign countries and their patent application number were shown in Fig. 4. It could be seen that US, KR, JP, FR, and DE, etc., possess more patents in Chinese cloud applications, and the countries listed in Fig. 4 would have a stronger competitive advantage in the patent activities of Chinese cloud application.

Patent Law is a domestic law, thus the patent rights have the typical characteristic of regional. If a patent applicant want to protect his innovative achievements by the way of patent abroad, he would be asked to file the patent application in the particular country according to its patent system. Therefore, the market of a specific technological sector is important or not for the applicant would decide his decision of applying patent protection or not. In other words, the strategic important or market attractiveness of a specific industry in a particular country could be investigated by the statistics about the number of foreign patentees and their patent applications. The main foreign patentees and their patent number were listed in Table IV. The top 2 patentees, Microsoft and IBM, account for up to 100 and 75 patents respectively. It is also shown that the main patentees of cloud applications in China are from US, JP and KR. It could be revealed that the patentees listed in Table IV would attach more attention to the innovation of cloud applications, they are active in the patent activities, and play emphasis on applying patents in China. It also could be considered that, as to Chinese domestic companies, these foreign patentees would be the main competitors in Chinese cloud applications.

TABLE IV: MAIN FOREIGN PATENTEES OF CHINESE CLOUD APPLICATIONS

Patentee	Nationality	Number of patents
Microsoft Corporation	USA	100
International Business Machines Corporation	USA	75
Intel Corporation	USA	26
Samsung Electronics	KOR	25
Hewlett-Packard Development Company, L.P.	USA	18
Alcatel-Lucent Enterprise	FRA	16
Rockwell Automation, Inc.	USA	12
Apple Inc.	USA	8
Cisco Systems, Inc.	USA	8
Sony Pictures Home Entertainment	USA	8
Sony Corporation	JPN	8
Empire Technology Development LLC	USA	8

To be the same with products, technologies also have its life cycle. As is well known, as an important protection way for the technological innovation, patent information is used frequently to investigate the developing stage of a specific technological sector [21]. It is generally assumed that, the same as the product, the technological life cycle could be divided into following four stages: Introduction (Research and Development), Growth, Maturity and Declining

(Revitalization). At the first stage, the technological sector is being converted from idea into promotion, only a limited number of technical innovators who are of foresight and vision prosecute their research in this technology field, therefore, both patentees and patent applications seem smaller in number. At the second stage, as the market prospect of a specific technology sector is confirmed, more and more market entities, including the research institutes, were attracted and engaged in the activities of innovation and applying patents. So, the number of patentees and patent applications seems increased rapidly in this stage. At the third stage, as the technology continued to mature, the market competition potential is shifted from Blue Ocean to Red Ocean, the number of patent applications and applicants would fluctuates within a certain range. At the last stage, as a obsolescent technology, the number of patent applications and applicants have shown a trend of decline.

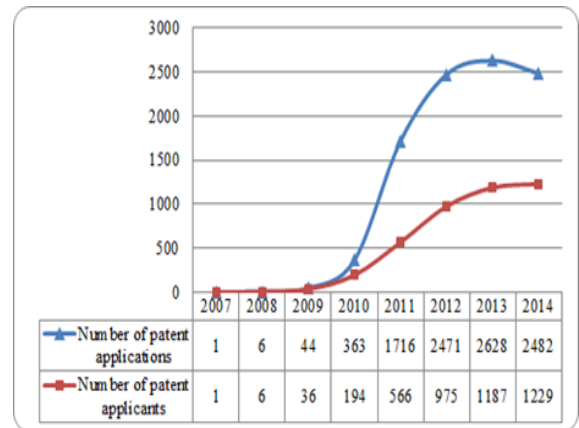


Fig. 5. Technology life cycle of Chinese cloud applications.

Fig. 5 shows the evolution of the number of patent application relative to the applicants (patentees), which is a typical value for judging the life cycle of a specific technological sector. The figure shows that both patent applications and patentees are small in number before 2009, indicating that Chinese cloud application industry was being the life cycle of introduction stage, which implies that few inventor and institution would engage in the R&D activities of cloud applications in China. By contrast, it could be seen that the number of patents and assignees increased rapidly after 2009. Specially, the number of patent applications (patentees) increased from 44 (36) in 2009 to 2628 (1187) in 2013, which means that Chinese cloud application industry has entered the life cycle stage of growth. During the growth stage, the technical problems are solved and market uncertainty is removed gradually, more and more products are developed for commercialization [22]. Currently, many products of cloud applications, such as cloud storage, are acceptable and available commercially.

V. CONCLUSIONS AND DISCUSSES

As an important legal protection way for technovation achievements, patent system plays a strategic role in encouraging invention-creation, promoting the application

of invention-creation, enhancing innovation capability and promoting the advancement of science and technology. It is confirmed by the theory and practice of Intellectual Property, that patent information analysis has become an important aspect and core index in assessing the technovation abilities of a specific technological sector.

The technological development of Chinese cloud applications is assessed by using the patent data in this paper. The industrial policies and market scale reflect that cloud computing has become one of the most fast-growing emerging industries in many countries, which brought a rapid growth of the patent number. It is shown by the patent information analysis in this paper that the patent activities of Chinese cloud applications, either the number of patent applicants or the number of patent applications, represent an active tendency in the past 10 years; because the great majority patents of cloud computing belong to the software or business method, which could only be protected by invention patent, there were nearly 90% of cloud applications patent in China were invention patents; the domestic applicants, such as Li Zongcheng, INSPUR, HUAWEI and ZTE, and so on, who applied relative more patents, would have a stronger innovation capability in cloud applications; the technological fields represented by the IPC of H04L29, G06F17, G06F9 and G05B19, etc., which concentrated more patent applications, would be the intensive areas of research and development of Chinese cloud computing; the foreign applicants, such as Microsoft, IBM, Intel, and Samsung, and so forth, who came from United States, South Korea and Japan, pay more attention to carry out the strategy of patent portfolio in Chinese cloud computing industry, and these applicants might become the major competitors to the relevant entities in China.

Currently, the industry of Chinese cloud computing has been changed from the stage of technological introduction to flourish development and rapid popularization. According to the report released by IDC (International Data Corporation), one of the most important trends for cloud computing is high-speed developing. According to the statistical data of relevant government department, the market scale of Chinese cloud computing has been increased from 35 billion Yuan 2010 to 100 billion Yuan during the period of 2010-2014. Meanwhile, with the development of cloud computing, the electronic information manufacture industry, software and IT service industry in China have been promoted and grown rapidly. In January, 2015, Commons on promoting the innovation and development of cloud computing and cultivating a new industry pattern of IT has been promulgated and implemented by China's State Council, which would be the most important developing policy to Chinese cloud computing. Furthermore, since the Outline of the National Intellectual Property Strategy is formulated and issued by the State Council of P.R. C in 2008, not only the patent legal system is further improved, but also the whole society's consciousness of patent protection is enhanced greatly. The patent competitiveness of companies and enterprises is improved vastly through the guidance of market forces and policy. Predictably, the technovation and patent activities would continue to remain a rapid growth trend over the next several years.

REFERENCES

- [1] Y. S. Chen, M. J. Lin, and C. H. Chang, "The influence of intellectual capital on new product development performance-the manufacturing companies of Taiwan as an example," *Total Quality Management and Business Excellence*, vol. 17, pp. 1323-1339, 2006.
- [2] P. L. Chang, C. C. Wu, and H. J. Leu, "Using patent analysis to monitor the technological trends in an emerging field of technology: A case of carbon nanotube field emission display," *Scientometrics*, vol. 82, no.1, pp. 5-19, 2010.
- [3] K. L. R. Pavitt, *World Patent Information*, 1st ed. Amsterdam, North Holland: Elsevier Science Publishers, 1988, pp. 340-342.
- [4] B. P. Abraham and S. D. Moitra, "Innovation assessment through patent analysis," *Technovation*, vol. 21, no. 4, pp. 245-252, 2001.
- [5] Z. Griliches, "Patent statistics as economic indicators: A survey," *Journal of Economic Literature*, vol. 28, pp. 1661-1701, 1990.
- [6] M. E. Mogege, "Using patent data for technology analysis and planning," *Research-Technology Management*, vol. 34, pp. 43-49.
- [7] S. Liu and J. Shyu, "Strategic planning for technology development with patent analysis," *International Journal of Technology Management*, vol. 13, pp. 661-680, 1997.
- [8] S. P. Ju, M. F. Lai, and C. Y. Fan, "Using patent analysis to analyze the technological development of virtualization," *Procedia-Social Behavioral Sciences*, vol. 57, pp. 146-154, 2012.
- [9] G. Narin and E. Noma, "Patents as indicators of corporate technological strength," *Research Policy*, vol. 16, pp. 143-155, 1987.
- [10] N. Heeyong, J. Yeongran, and L. Sungjoo, "Keyword selection and processing strategy for applying text mining to patent analysis," *Expert Systems with Applications*, vol. 9, pp. 4348-4360, 2015.
- [11] G. Michele, C. Livio, D. G. Martina, and R. Francesco, "The patent portfolio value analysis: A new framework to leverage patent information for strategic technology planning," *Technological Forecasting and Social Change*, vol. 5, pp. 286-302, 2015.
- [12] L. Sebastien, L. Julie, D. Catherine, and V. P. Steven, "A patent landscape analysis for organic photovoltaic solar cells: Identifying the technology's development phase," *Renewable Energy*, vol. 9, pp. 5-11, 2013.
- [13] T. Daim and I. Iskin, "Patent analysis of wind energy technology using the patent alert system," *World Patent Information*, vol. 1, pp. 37-47, 2012.
- [14] P. A. Katherine and K. Ramin, "Cloud computing: What is it and could it be useful?" *Journal of the American College of Radiology*, vol. 4, pp. 252-254, 2010.
- [15] A. A. Faisal, A. A. Abdullah, and M. A. Ali, "Effective use of cloud computing services in education," *Journal of Next Generation Information Technology*, vol. 4, pp. 62-77, 2012.
- [16] K. Narander and S. Swati, "Migration performance of cloud applications- A quantitative analysis," *Procedia Computer Science*, vol. 45, pp. 823-831, 2015.
- [17] P. Dana, M. Georgiana, P. Silviu, and C. Craciun, "Portable cloud applications-from theory to practice," *Future Generation Computer Systems*, vol. 6, pp. 1417-1430, 2013.
- [18] B. Rajkumar and V. Christian, *Mastering Cloud Computing-Technologies and Applications Programming*, Waltham, USA: Morgan Kaufmann, 2013, pp. 353-371.
- [19] The source of patent information. [Online]. Available: <http://www.shanghaiip.cn/Search/login.do>
- [20] An introduction to International Patent Classification. [Online]. Available: <http://www.wipo.int/classifications/ipc/en/>
- [21] R. Huaupt and M. Kloyer, "Patent indicators for the technology life cycle developments," *Research Policy*, vol. 36, pp. 387-398, 2007.
- [22] C. V. Trappey, A. J. C Trappey, and C. Y. Wu, "Clustering patents using non-exhaustive overlaps," *Journal of Systems Science and Systems Engineering*, vol. 19, no. 2, pp. 162-181, 2010.



Honghua Qiu was born in Guangxi province, China, In 2002, he got the bachelor degree in economic law in Anhui University of Finance and Trade, in Bengbu city, Anhui province, China. In 2007, he received the master degree in economic law in Huazhong University of Science and Technology in Wuhan city, Hubei province, China. At the same university, he earned the doctoral degree in intellectual property management in

2011.

He worked in School of Intellectual Property, Xiangtan university during 2011 to 2015, and now he work in School of Intellectual Property, Northwest University, Xi'an city, Shaanxi province as an associate professor. His refereed journal articles include: "A study on the promotion mechanism of IP education for constructing an IP strengthened China" (published in Intellectual Property, 2016, in Chinese), "A Study on the technology environment carbon capture and storage in US and its enlightenments based on pest model" (published in Journal of Intelligence, 2014, in Chinese) and "Comprehensive evaluation on the innovative capabilities of chinese domestic and foreign banks based on analytic hierarchy process model" (published in R&D management, 2012, in Chinese), and so on. His research interests include: patent information search and analysis, technovation and its patent protection, patent strategy, etc.

QIU is a candidate of national patent information talent selected by state intellectual property office of China, and also a managing council

member of intellectual property law research society, Shaanxi province, China.



Panbing Lu was born in Jiangsu province, China. In 2013, he got the bachelor degree in mechanical engineering in Xiangtan University, in Xiangtan city, Hunan province, China. And at the same University, he earned the master degree in intellectual property law in 2017.

He is now being a apprentice lawyer in a law office at Shenzhen city, Guangdong province. His refereed journal article include: "A Study on the management tactics for the patent activities of enterprises based on the assessment of influential factors of patent value", Published in library and information service, in Chinese in 2006.