

Characteristics of Industry-Academia-Research Cooperation Based on Local Undergraduate Universities of Yunnan Province from the Perspective of Patent

Lina She¹, Li Zhang^{2,*} and Yujiao Wang³

¹ *Science and Technology Department, Kunming University, Kunming, 650214, China*

² *Novelty Search Center, Yunnan Institute of Science and Technology Information, Kunming, 650051, China*

³ *School of Education, Kunming University, Kunming, 650214, China*

**Corresponding author*

ABSTRACT

This work studied the patent output and social network characteristics of local undergraduate universities in Yunnan Province in terms of cooperation with outside scientific research institutes and enterprises in scientific and technological innovation. Through analyzing the cooperation mode, technical field and other quantitative distribution characteristics of Industry-Academia-Research cooperation patent, the invention patent overall network and central social network indicators, and the patent efficiency, it is found that the university-enterprise model is the most, accounting for 63%; the category A01 technology field obtains the most patents. All colleges and universities need to increase the innovation and diffusion of network cooperation technology. Kunming University, Qujing Normal University, Honghe College and Wenshan College are in an important position in the network of Industry-Academia-Research cooperation technology innovation, which can control more innovative resources. The patent efficiency of university-research institute model is the highest, which is 75-100%. Kunming University, Qujing Normal University, Pu'er University and West Yunnan University have the highest invention efficiency.

Keywords: *Local undergraduate universities; Industry-Academia-Research; Patent; Characteristics*

1. INTRODUCTION

The Industry-Academia-Research cooperation refers to the exchange and cooperation activities carried out between enterprises, universities and scientific research institutes to carry out innovation activities, mainly to achieve the goal of innovation. Freeman's Theory of "National Innovation System" tells that the Industry-Academia-Research cooperation mode is an important bridge between universities that master "core technology" and enterprises that build "core competence", and the innovation power of colleges and universities has become the guide of social progress[1]. The position of the main body in the cooperative network influences the innovation performance of the Industry-Academia-Research cooperation[2]. The patent of Industry-Academia-Research cooperation is the embodiment of the achievements of the joint technology research and development activities among the main partners, and the change of quantity and quality can indirectly reflect the adjustment effect of the cooperation policy of Industry-Academia-Research cooperation. Main parties of the Industry-Academia-Research conduct knowledge exchange and innovation through formal or informal cooperation such as strategic alliance, joint research, and personnel exchange, forming a complex network

containing a variety of relations. The method of social network analysis provides an important means to clarify the complex relations between different actors in the parties of industry, education and research, and has developed into a mature method of scientific measurement and intelligence analysis[3].

In recent years, some world-class universities in China have carried out patent cooperation in the process of Industry-Academia-Research. In 2017, Hu Cheng took 7 world-class universities in Shanghai as the research object, used the social network analysis method to draw the visual network of the patent cooperation between 7 universities and enterprises, and focused on the macro characteristics, micro characteristics and cooperation mode of patent cooperation[4]. In 2017, Zhang Yupeng analyzed the cooperation of patent application, patent field, inventor and Industry-Academia-Research in Guangdong science and technology colleges and universities, and carried out the competitive analysis of the subject which effectively docked with the strategic emerging industries in Guangdong Province[5]. In 2018, Jia Xiaoxia studied the influence path of patent data accumulation on innovation performance of 34 world-class universities in China from 2006 to 2015, combining knowledge base and social network theory with cooperation breadth and depth as intermediary variables[6].

Local colleges and universities are also an organic part of the university system in China, and the number of patent

achievements also represents the scientific prowess. However, local colleges and universities are the "birthplace" of technological progress and invention and creation, but also the "disaster area" with idle and lost patents. The number of technology market transactions in local colleges and universities is less than 20% in world-class universities[7-8]. However, there are few researches on patent cooperation in local colleges and universities, particularly, they lack cooperation analysis and in-depth exploration of laws in the aspects of cooperative mode, cooperative field and cooperative network attributes. As representative universities in the southwest of Yunnan Province, local colleges and universities in Yunnan Province have outdated research on patent transformation. Taking local colleges and universities in Yunnan Province as the research object, this work studies the characteristics of patent output index and social network in the Industry-Academia-Research cooperation, which can reflect the cooperation level between local universities in Yunnan Province and external research institutes and enterprises in scientific and technological innovation, as well as the long-term dynamic process of knowledge transfer in collaborative innovation. It is of theoretical significance for colleges and universities in Yunnan Province to carry out Industry-Academia-Research cooperation from the perspective of patent output and to integrate innovation resources and improve innovation efficiency.

2. RESEARCH METHOD

In November 2014, Yunnan Province issued *Implementation Opinions of Yunnan Provincial Department of Education on Promoting the Transformation and Development of Some Undergraduate Universities*, and took Kunming University, Chuxiong Normal University, Baoshan University and other local undergraduate universities as the first batch of pilot universities [9]. This group of colleges and universities are distributed in all prefectural level cities in Yunnan. This work took 12 local undergraduate universities in Yunnan Province as the research object, which are Kunming University, Dali University, Qujing Normal University, Honghe University, Yuxi Normal University, Chuxiong

Normal University, Baoshan University, Wenshan University, Zhaotong University, Pu'er University, Western Yunnan Normal University, and West Yunnan University of Applied Sciences. A total of 3,156 patents can be obtained from each school from 2000 to February 2020 by searching "Applicant equals to current or former name of each school" on the website of National Intellectual Property Administration. On this basis, the patents cooperated by each institution and other institutions can be retrieved for re-examination (including the same patent application PCT patent as the combination of duplicate patents), totaling 97 cooperative patents.

In this work, the author first analyzed the quantitative distribution characteristics of patent application cooperation mode, cooperation intensity, cooperation frequency and cooperation technology field in each university for 20 years, then used social network software to identify the key nodes in the cooperation network and describe the relationship model between nodes, analyzed the structure of the relationship model and its influence on the node and even the whole network, analyzed the characteristics of the patent cooperation network and network structure, and finally analyzed the efficiency of invention patent evaluation patent quality, and analyzed the interrelation or trend consistency of each block analysis result.

3. RESEARCH RESULTS

3.1. Patent cooperation mode, frequency and intensity of the Industry-Academia-Research cooperation

This work obtained patent data from each university as the applicant and analyzed the top ten cooperative applicants of each university. Then it deleted the patent applied by the university and the individual in the name of cooperation, and sorted out the patent applied jointly with the research institute or enterprise. There are a total of 46 cooperative institutions (Table 1), all of which are domestic institutions, among which only 11 institutions have cooperative institutions. Baoshan University applies for all its patents by itself, without any cooperative institutions.

Table 1. Number of Industry-Academia-Research cooperation institutions and patents in Yunnan Province

Serial number	Universities	Number of cooperation institutions/patents	Universities	Number of cooperation institutions/patents
1	Kunming University	Yunnan Tobacco Agricultural Science Research Institute / 9	Honghe College	Zhaotong City Institute of Gastrodia Elata / 1
2		Yunnan Lvyuan Biotechnology Co., Ltd / 8		Yunnan Agricultural University/1
3		Yunnan Tobacco Company Lincang City Company /5		Honghe Health Vocational College / 1
4		Yunnan Academy of Agricultural Sciences	Yuxi Normal University	Yuxi Fuxianhu Water Management Co., Ltd /5
5		Kunming University of Technology/3		HanlongLaike Environmental Electronics CO., Ltd / 3
6		Kunming Hong Zhihua Horticulture Co., Ltd/3		Yuxi Centers for Disease Control and Prevention / 2
7		Yunnan Xinwo Agricultural Development Co., Ltd/3		Yunnan Tobacco Company Yuxi Company /2
8		Yunnan Science and Technology Institute/3		Yunnan Qingyuan Environmental Technology Company / 1
9	Dali University	Chinese Academy of Environmental Sciences /1	Yuxi Fuxianhu Protection and Development Investment Co., Ltd / 1	
10		Dali Chongyao Biotechnology Co., Ltd / 1	Chuxiong Teachers College	Chuxiong Green Wave Health Industry Limited /1
11	Qujing Normal University	Kingenta Ecological Engineering Group Limited /5		Chuxiong College of Technicians / 1
12		Yunnan Yuxin Agroforestry Biotechnology Co., Ltd / 3	Yunnan Tonggen Sanqi Industry Co., Ltd / 4	
13		Southwest Forestry University / 3	Wenshan Huaxin Sanqi Company Limited /4	
14		Heze Kingenta Ecological Engineering Co., Ltd/2	Guangzhou Mai Pu Regenerative Medical Technology Limited / 3	
15		Gold Earth Agricultural Technology Limited / 1	Wenshan Institute of Pharmaceutical and Drug Inspection / 3	
16		Kingenta Chemical Co., Ltd/1	Wenshan Laixi Trading Company Limited /2	
17		Guangdong Kingenta Ecological Engineering Co., Ltd / 1	Yunnan Branch of China Science and Technology Development Division/1	
18		Zhongzheng Chemical Industry Co., Ltd/1	Wenshan Jinwang Pharmaceutical Company Limited/1	
19	Honghe University	Institute of Agricultural Machinery of Honghe Hani Yi Autonomous Prefecture, Yunnan Province /5	Zhaotong College	Zhaotong Haoran Agricultural Development Co., Ltd/1
20		Yunnan Xintong Plant Pharmaceutical Co., Ltd/3	Pu'er College	Hongyun Honghe Tobacco (Group) Limited /6
21		Tsinghua University/3	Western Yunnan Normal University of Science and Technology	Chongqing Institute of Science and Technology / 4
22		Kunming Metallurgical Research Institute Limited	Western Yunnan University of Applied Technology	Yunnan Agricultural University / 5
23		Yunnan Tai Ran Biotechnology Co., Ltd /1		Pu'er Tea Research Institute / 3

According to the three cooperation modes of "university-research institutes, university-enterprise, university-research-enterprise", the first applicant of cooperation is classified as a university or an enterprise, and the number of relevant patents is counted to reflect the intensity and frequency of cooperation. After classifying

11 colleges and universities, they conform to the "university-research institute" cooperation model. There are 17 cooperative institutions, accounting for 37% of the total number of cooperative patents of all universities. There are 29 cooperative institutions with the attribute of enterprise, accounting for 63%. According to research

published by Hu Cheng, the rate of patent cooperation between universities and enterprises (the number of patent cooperation with enterprises/the number of all patent cooperation) should be kept between 60% and 90%. It is the connection between the supply of scientific research achievements and the demand of the enterprise's core technology to apply for patent in cooperation of a university enterprise[10]. It shows that Yunnan local colleges and universities tend to cooperate directly with enterprises, and the mode of cooperation is relatively simple, the scientific research achievements tend to be applied, and the frequency of cooperation is appropriate, which reflects the higher scientific and technological content and the stronger market demand, conforming to the policy of market-oriented application of scientific research achievements issued and encouraged by the state.

Cooperation intensity equals to the number of cooperative patents divides by the number of cooperative organizations[11]. The average cooperation intensity of each university is 2.11. According to the table, the top three institutions with the largest number of co-operative institutions and patents are: Kunming University has cooperated with 8 institutions with 39 patents, and the cooperation strength is 4.875; Wenshan University has cooperated with 7 institutions with 18 patents, and the cooperation intensity is 2.57; Qujing Normal University is the same as Honghe University, which has cooperated with 8 institutions with 17 patents, and the cooperation intensity is 2.12. Among the local universities in Yunnan, the total number of patent applications is the largest, and the local universities in Yunnan are also active in Industry-Academia-Research, with the highest cooperation frequency and the cooperation intensity is higher than the total average cooperation intensity. There are 20 cooperative enterprises and 11 institutes in these four colleges and universities. The cooperative mode is consistent with the general pattern rules of the 11 colleges and universities. It has formed a relatively stable patent cooperation mechanism. It is worth noting that Dali University, with a strong R&D capability and a total of 387 patents, ranks the second among the 12 universities in total, does not have strong patent cooperation. It shows that universities only pay attention to patent research and development and neglect the application and

transformation of patents with enterprises and external institutions of research institutes, which may lead to a series of problems such as low patent quality and low patent conversion rate.

3.2. Technical field matrix analysis of patent cooperation application

Each patent document has at least one international patent classification number (i.e. IPC), which represents the technical field of the patent. A complete IPC classification number includes parts, main class, subclass, main group, and subgroup. A01B39/08, for example, A represents the part, 01 represents the main class, B represents the subclass, 39 represents the main group, 08 represents the subgroup[12].

According to the principle of concentration of major categories, seven major hot spots of cooperative patent of local universities in Yunnan Province are summarized, and the representative technical fields reflect the structure of discipline development. The number of patents between 2000 and 2012 is scarce, so the analysis is of little significance. Patent applications are concentrated in 2012-2019, in particular, 2015-2019 is a period of active production, education and research. Based on the statistical analysis of technology domain matrix and the classification according to the international IPC technology domain classification, the corresponding matrix of IPC number of each year is established for the patents after the annual de-duplication. The main technical fields of cooperative patents are concentrated in 7 categories, with a total of 88 patents. Figure 1: Category A01(for agriculture, forestry, animal husbandry, hunting, entrapment). There are 38 patents in the technical field, accounting for 43%. Category A23 (for food or foodstuff)has 18 patents, accounting for 20%. Category A61 (for medicine or veterinary medicine and health) and C02(for the treatment of water, wastewater, sewage or sludge) have 9 patents, accounting for 7% each. Category C07(organic chemistry) and G01(measurement; test) have 6 patents respectively. Category C09 (education, cryptography, display, advertising, seal) have 2 patents.

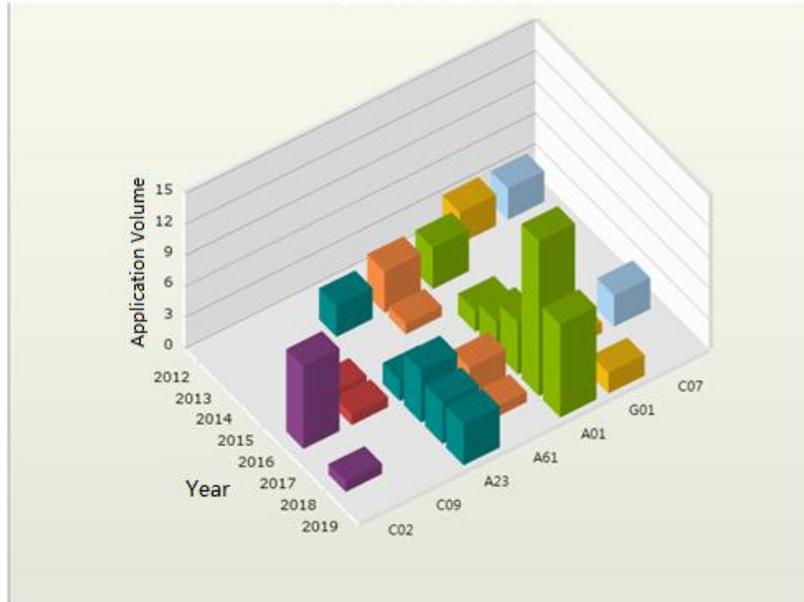


Figure 1. Matrix analysis of technical domain

3.3. Relationship between invention patent and cooperation mode

3.3.1. Analysis of network characteristics of invention patent

According to the number of patents of three kinds of cooperation institutions, such as invention patents, utility model patents and appearance patents, all local undergraduate university cooperation patents in Yunnan Province have no appearance patents, and there are 59 invention patents and 38 utility model patents, mainly those with high degree of creativity. The number of invention patents representing originality is a key indicator of regional innovation capability and competitiveness [13-14]. As a result, mapping and data analysis is used to study the social network relationship of invention patents. Additionally, the social network analysis software UNICET is used to count the number of invention patents of each university cooperative organization and cooperative output, so as to obtain the visual processing of the invention patent cooperation network of each university (Fig.2.). Each cluster represents the number of invention patents that a university cooperates and produces with other institutions as the center, and the centrality of the visual network is analyzed. The size of the circular node represents the number of institution patents that cooperate with universities in this node: the more other institutions and patents for patent cooperation with the node university, the largest central node. The trend of invention patent ranking is consistent with the trend of overall cooperative patent ranking. The top three colleges and universities are still Kunming University, Wenshan University, and Qujing Normal University.

These three schools are active in Industry-Academia-Research, comprehensive strength and technical development strength. Dali University, Chuxiong Normal University, Western Yunnan University of Applied Technology, Zhaotong University have the worst performance in the joint application of invention patents, with the lowest number of cooperation centers. Yunnan Agricultural University is the associated node of Honghe University and Western Yunnan University of Applied Technology, and has output cooperation patents with both schools.

(1) Overall network indicators

Through the network numerical calculation analysis, it can obtain the specific data of the overall network of the invention patent cooperation network of local universities in Yunnan Province, and further carry on the accurate explanation to the cooperation process creation and the diffusion[15-17].

Average degree represents the average degree of all nodes in the network. The degree of node (i) represents the number of edges connected to the node, n represents the number of nodes in the network, which is one of the indicators to characterize the characteristics of the node. Calculation formula is $\bar{K} = (\sum_i K_i) / N$.

Network diameter refers to the number of connections between the longest two nodes (i, j) in the network (the distance between the two nodes directly connected is 1), which generally does not exceed 7, and it measures the degree of distortion of information propagation in the network, and the network connectivity. The calculation formula $D = \max_{i,j} d_{ij}$

The average path length is the mean of the shortest path between any two nodes, and the length of communication path and transmission efficiency are described. Calculation formula is $L = \frac{1}{n(n-1)} \sum_{i \geq j} d_{ij}$

Network density reflects the aggregation degree of the network. In this work, network density refers to the ratio of the number of existing cooperative relationships to the most likely cooperative relationships between all patentees, reflecting the cooperation depth between collaborators, that is, the degree of density, and the value range of

network density is between [0,1]. The calculation formula is:

$$d = \frac{L}{n(n-1)/2}$$

The d is the network density, the L is the actual number of connections in the cooperative network, and the n is the number of nodes in the network.

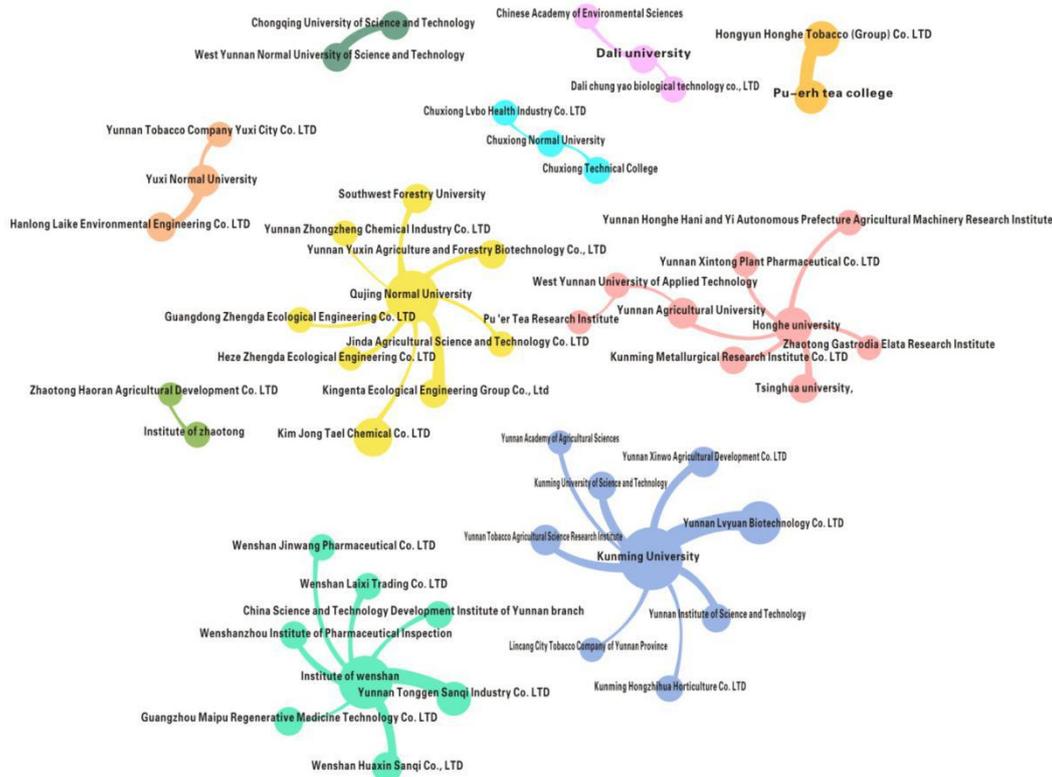


Figure 2. Patent cooperation network of local universities in Yunnan Province after central processing

If there is an edge connection between any nodes in a complex relational network, then the density of this network is 1, and the accessibility of this network is the

best, whereas if the network density is smaller, the integrity of the network is worse.

Table 2. The whole network of patent cooperation network of local universities in Yunnan Province

Overall network indicators	Average	Network diameter	Average path length	Network density
Value size	1.6	4	1.838	0.033

Table 2 shows that the average value of the whole network index of cooperative invention patent in each university is that the greater the transmission of kone, the faster it is. The average value of patent cooperation network of local colleges and universities in Yunnan Province is small, and the transmission of cooperation between universities and enterprises and institutes is slow. In the overall network index constituted by the situation, the network diameter value is in the middle, indicating that the information transmission and connectivity are moderate. The average path length is short, which is beneficial to the communication between nodes and improves the efficiency

of cooperation. The network density is 0.033, which reflects the loose connection node between the school and the enterprise. The degree of interaction between technology creation and diffusion is insufficient, the flow of information is small, and most of the sub-networks are independent and unrelated. It shows that if colleges and universities want to grasp the current cooperation conditions that are conducive to communication and exchange with short communication paths, they need to increase the space for cooperation, continue to strengthen technology circulation and technology integration, and strengthen the intensity and frequency of cooperation.

(2) Centrality index

Centrality is the quantitative expression of the power of different nodes. By measuring the centrality of nodes, the position of different nodes in the network can be identified. Based on different assumptions, scholars put forward different indicators of centrality measurement. Point degree centrality and proximity centrality are based on the accessibility of nodes in the network, that is, how easy information is to reach a node [18].

A node has a direct connection with many other nodes. Intermediary centrality is based on mediation, that is, if a node is in the shortest path of other point pairs, then the node controls more resources, and occupies a more central position to measure the value of node importance. The larger the value indicates, the easier it is to control other nodes. Proximity centrality is an indicator that is not controlled by other nodes. The farther the node is from other nodes, the smaller the degree is, the more independent the other nodes are, and the calculation formula $C(i) = \frac{1}{\sum_j d(i,j)}$

In terms of node size and numerical value, Kunming University and Qujing Normal University have the highest degree of point centrality and intermediary centrality, indicating that the two schools have the largest number of neighbor nodes and the largest number of related cooperative organizations. Therefore, it is easier for them to master the resources of cooperation with other enterprises and research institutes in local colleges and universities of Yunnan Province, and occupies an important position in the Industry-Academia-Research

cooperation of 12 local colleges and universities. Then Honghe University and Wenshan University have higher degree of point centrality and intermediary centrality. It shows that these four colleges and universities are the most cooperative enterprises and institutes. At present, they are the first group of leading universities among the 12 local universities in Yunnan Province, with the largest number of cooperative institutions and the most frequent and close Industry-Academia-Research activities. Keeping invention patent technology development in the future for a period of time still has advantages, which is in the important position in the process of integration of technology innovation in Yunnan Province. If it continues to strengthen the track of activities and enhance the integration of technological innovation and technology, it will be able to rapidly increase cooperation nodes, obtain more opportunities for Industry-Academia-Research cooperation and output of invention patents.

In proximity analysis, when a point is very far away from all the other points, that is, when this point is not at the center, its proximity goes to 0. Except for Honghe University and West Yunnan University of Applied Technology, the degree of closeness to the center of other schools is 1, which may be because these schools are an independent network, so each institution has a high centrality. Honghe University and Western Yunnan University have the smallest value of applied technology, which is related to each other, and does not belong to the central position in the network, and the technical input comparison does not rely on other nodes.

Table 3. Center Index of Patent Cooperation Network of Yunnan Province

Universities	Degree centrality	Intermediary centrality	Standardized proximity centrality
Kunming University	8	28	1
Dali University	2	1	1
Qujing Normal University	8	28	1
Honghe University	6	25	0.854167
Yuxi Normal University	2	1	1
Chuxiong Normal University	2	1	1
Wenshan University	7	21	1
Zhaotong University	1	0	1
Pu'er University	1	0	1
Western Yunnan Normal University of Science and Technology	1	0	1
Western Yunnan University of Applied Technology	2	7	0.520833

3.3.2. Industry-Academia-Research cooperation model and authorized invention patent efficiency

This work analyzed the amount of patent application and authorization in the process of cooperation, obtained the law of limited invention patent change, and analyzed the

relationship between Industry-Academia-Research and patent quality. The quantity and quality of patents can reflect the scale and level of scientific and technological innovation in colleges and universities, the ability of scientific and technological industrialization and the strength of comprehensive competitiveness of colleges and universities, which is one of the important indexes to measure the patent management work in colleges and

universities, and also an important symbol of the scientific and technological innovation ability of colleges and universities.

The legal status of cooperative invention patent in colleges and universities is limited to the state of "authorization" and the state of having been authorized. The legal status of the patent that has been authorized is declared invalid, the revocation of the patent right, the alteration of the description item and the transfer of the patent right shall be counted as invalid.

According to statistics, only 4 of the 12 universities' invention patents jointly developed by them meet the valid patents, while the others' invention patents have not been maintained and are invalid. Four colleges and universities

are Kunming University, Qujing Normal University, Pu'er University, Western Yunnan Normal University of Science and Technology. The cooperation mode of the two universities is university-enterprise, and the cooperation mode of the two universities is university-research institute. The most efficient invention patent is the patent developed by Qujing Normal University and Southwest Forestry University, but the number of invention patents is the least. Kunming University has the most invention patents, but the effective ratio is the lowest. Pu'er University and Western Yunnan Normal University of Science and Technology have the middle number of invention patents and the effective ratio is also the middle.

Table 4. The effective rate of cooperative invention patent in Yunnan Province

Universities	Cooperation agencies	Number of invention patents	Number of effective invention patents	Effective ratio%
Kunming University	Yunnan Lvyuan Biotechnology Co.,Ltd.	8	3	37.5
Qujing Normal University	Southwest Forestry University	3	3	100
Pu'er University	Hongyun Honghe Tobacco (Group) Co.,Ltd.	6	5	83.3
Western Yunnan Normal University of Science and Technology	Chongqing University of Science and Technology	4	3	75.

It is worth noting that in these four institutions, the previous analysis shows that Kunming University and Qujing Normal University are the top three universities with the most patents and effective invention patents. However, Wenshan University is also the university with the most patents among the top 3 universities, but it has 0 effective patents. Therefore, from the perspective of the effective ratio data, the effective invention patents produced by the university-institute cooperation model are higher, so universities need to strengthen the effective cooperation with enterprises in R&D and improve the maintenance of invention patents to ensure more high-quality patent output.

enterprises that meet the "university-enterprise" cooperation model, accounting for 63% of the total. Kunming University, Wenshan University, Qujing Normal University and Honghe College are the local universities in Yunnan Province, which are active in Industry-Academia-Research. The cooperation intensity and frequency are higher than the total average cooperation intensity. In order to increase the frequency and intensity of cooperation, there is a need to expand Industry-Academia-Research activities and carry out technological innovation cooperation with more institutions.

4. SUMMARY

4.1. Analysis of quantitative distribution characteristics

4.1.1. The relationship between cooperation mode and cooperation intensity and frequency

There is no cooperation organization in Baoshan University, and the remaining 11 colleges and universities have total 46 cooperative institutions. There are 29

4.1.2. Technical field analysis

The main technical areas of cooperation are concentrated in seven categories: A01 (for agriculture, forestry, animal husbandry, hunting, trapping, fishing); A23 (for food or foodstuff, and its treatment); A61 (for medicine or veterinary science; hygiene) and C02 (for water, wastewater, sewage or sludge treatment). In the future, these three areas will continue to maintain their advantages, focusing on joint research and development of deep technology to obtain more patent output. While giving full play to the advantages of technology and enterprises to carry out Industry-Academia-Research cooperation, it should also attach importance to other non-advantage technology areas of Industry-Academia-Research

cooperation, so as to maintain the balanced development of the overall technology.

4.2. The structure characteristics of the Industry-Academia-Research cooperation network for invention patent

4.2.1. Overall network analysis

The average degree of patent cooperation network of local colleges and universities in Yunnan Province indicates that the communication power between universities and enterprises and institutes is slow; the overall network index shows that the information dissemination and connectivity are moderate; the average path length is conducive to the communication between nodes and improves the efficiency of cooperation; the network density shows that the cooperative connection nodes between schools and enterprises and research institutes are loose, the interaction degree of technology creation and diffusion is not enough, and the information circulation is less. The degree of point centrality and intermediary centrality of Kunming University, Qujing Normal University, Honghe University and Wenshan University indicates that the four schools have the most neighbors and cooperative institutions, which is easier to master the resources of cooperation with other enterprises and research institutes in local universities in Yunnan Province. It plays an important role in the technological innovation process of Industry-Academia-Research cooperation in Yunnan Province. Superior colleges and universities make good use of their own resources and actively use superior technologies to carry out more extensive and in-depth cooperation with enterprises.

4.2.2. Analysis of centrality indicators

It shows that universities need to increase technological innovation and diffusion, strengthen technological circulation and knowledge integration with cooperative institutions to grasp the cooperation conditions of communication path which is short for communication and communication. If the cooperation activities of Kunming University, Qujing Normal University, Honghe University and Wenshan University continue to be strengthened, and the integration of technology innovation and technology continues to be enhanced, it will be able to rapidly increase the cooperation nodes and obtain more opportunities for cooperation and patent output.

4.2.3. The efficiency of Industry-Academia-Research cooperation patent

Only Kunming University, Qujing Normal University, Pu'er University and Western Yunnan Normal University

of Science and Technology are the only universities that cooperate in R & D patents. Although the number of invention patents produced by the "university-institute" cooperation model is not as high as that of the "university-enterprise" model, the invention patent efficiency is higher, up to 75-100%. Colleges and universities need to strengthen the effective joint research and development with the knowledge flow of enterprises, so as to improve the maintenance of invention patents and obtain more high-quality patent output.

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