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Chinese Patent Asset Evaluation Policy Based on Co-word Analysis

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Abstract: *Since implementation of China's intellectual property strategy in 2008, relevant institutions have issued a number of normative documents on patent value evaluation, but the development of patent evaluation business is not very smooth. Based on the revised Patent Asset Evaluation Guidelines (2017) as the data source, the text information of patent value evaluation policy is quantitatively studied by using co-word analysis method. Through further comprehensive analysis, it is found that the Patent Asset Evaluation Guidelines present the following three characteristics for the guidance of current patent value evaluation. The first one is the effect of the patent evaluation greatly influenced by the experience and practice ability of patent evaluators. Second, the key of the patent evaluation work patent is relied on the selection and measurement of factors of patent-value evaluation. The third is that the income method is the most respected method for patent value evaluation in the current policy. Finally, some suggestions are put forward based on the characteristics of the current situation.*

Keywords: *patent evaluation, patent value, co-word analysis, influencing factors, income approach*

1. INTRODUCTION

Patent is an important innovative resource in the national intellectual property right (IPR), which can greatly improve the core competitiveness of the country. In addition, enterprises can improve their core competitiveness, enhance innovation ability and obtain excess returns by means of patent application, pledge financing, transfer and so on. The fundamental purpose of patent operation is to realize the effective transformation of patent, and how to estimate patent value is the key step to realize the transformation. In order to promote the development of patent value evaluation, domestic and foreign scholars have made great efforts to it. Many studies have targeted the evaluation method of patent value research[[1]-[3]] and patent value assessment influencing factors research[[4]-[5]],while shill other studies have focused on patent-value assessment indicator system research[[6]-[7]] and patent value evaluation model research [[8]-[9]].

As a normative document, patent value evaluation policy plays a guiding role in the whole process of patent value evaluation. Since the implementation of China's intellectual property strategy in 2008, the number of patent applications in China has increased rapidly. At the same time, there has been a substantial increase in patent evaluation business. Although the evaluation cause in China started late and developed slowly, it has been paid great attention by the government. In order to better promote the development of patents, relevant departments have issued guidelines for patent evaluation.

However, in practice, evaluators still encounter a lot of difficulties. In order to solve these difficulties, it is very necessary to study the relevant patent value evaluation policy.

At present, the researches on patent valuation policy in China are as follows. Wu Jixing[[10]], Liu Fangfang[[11]], Xuan Yongsheng[[12]] compared Chinese intangible assets evaluation guidelines with international or foreign relevant evaluation policies. By reading the specific rules of the policy text, Bao Xinzhong[[13]] analyzed the possible obstacles in the implementation of patent value evaluation policy and put forward relevant suggestions. To sum up, scholars mainly make analysis of the structure, content and implementation of the policy. If we can take the text elements as the research object to conduct a certain degree of quantitative analysis, then it could dig out some potential details and provide a more comprehensive interpretation for policy users. In recent years, the method of co-word analysis has gradually become a hot research method, which is used in multiple disciplines[[14]-[15]]. This method can get the distribution of research topics through the co-occurrence of keywords in texts. Then the distribution, text users can understand the research focus of texts and grasp the research direction or trend in related fields betterly. Therefore, this paper will use co-word analysis to make a quantitative and qualitative research on patent value evaluation policy. The purpose is to grasp the distribution of policy research topics and explore its potential information.

2. RESEARCH DESIGN

2.1. Sample Selection

In this paper, the sample source is the revised Patent Assets Evaluation Guidelines (PAEG) issued on the official website of the China Appraisal Society in 2017. The PAEG contains 35 guidelines totally, the last of which has nothing to do with this research. Therefore, the research sample selects the first 34 opinions from PAEG. Then each piece of guidance is divided into a sample, a total of 34 research samples.

2.2. Research Method

This paper mainly uses the co-word analysis method, which is a common method of content analysis. The main principle is to reflect the structure and relationship of texts theme by studying the hot words with high frequency appearing in texts of a certain research field, and then analyze the research hot topics and development trends in this field. In other words, the first step is to form a co-word matrix by counting the number of co-occurrence of text keywords, such as co-occurrence matrix, similarity matrix or dissimilarity matrix. The second step is to carry out quantitative research, such as cluster analysis, multi-dimensional scaling analysis and social network analysis. Finally, the above results are analyzed comprehensively. The main steps are as follows:

2.3. Co-word Matrix

The co-word matrix can be obtained through the statistics of the number of co-occurrence of keywords. Because the frequency difference will affect the subsequent statistical analysis, this paper uses the Ochiai coefficient to convert the frequency into a dissimilar value (1-*Ochiai* coefficient value), which is controlled between 0 and 1. The formula of *Ochiai* is

$$Ochiai = \frac{C_{ij}}{\sqrt{C_i} \times \sqrt{C_j}}$$

where C_{ij} represents the frequency of occurrence of the two keywords A and B, C_i represents the frequency of the occurrence of keyword A, and C_j represents the frequency of the occurrence of keyword B.

2.4. Cluster Analysis

The operation basis of clustering is to determine the distance between keywords through the dissimilarity between them. Then they are divided into different categories according to the principle of minimum distance within groups and maximum distance between groups. In the classification, we first classify the two nearest keywords into one class, and then classify them into a new class with other adjacent keywords. Until all the keywords are grouped together. By analyzing the clustering results, the closeness and internal relations between keywords can be obtained, which provides a scientific basis for follow-up research on topic analysis.

2.5. Multidimensional Scale Analysis

Multidimensional scale analysis is based on the dissimilar or similar value of keywords and carries out dimensionality reduction on the basis of retaining their original relationship. Then keywords are located, analyzed and classified. The result is that keywords are presented in the strategic coordinate map in the form of dots. Those highly relevant keywords will gather around the more core words and form groups. Multidimensional scale analysis can be used to verify the authenticity of cluster analysis, which makes the classification of research topics more clear.

2.6. Social Network Analysis

Social network analysis (SNA) studies the relationship between or among groups and individuals. The individuals are transformed into nodes in a structure, and the connections stands for the relationship between couples of nodes. In this paper, the position shows the relationship between keywords and the overall policy text, and the lines can reflect the degree of connection between keywords. SNA can show the relationship between keywords more intuitively, and further explore their potential relationship. So that we can better analyze the internal connections of the research topics in patent value evaluation policy.

In this paper, a variety of methods are used to research the text information of PAEG. The reason is that each method has different advantages and disadvantages. Only by giving full play to its strengths and making up for each other can we grasp potential information of the text more accurately. Cluster analysis fails to show correlation between keywords. The performance of multi-dimensional scaling analysis is similar to that of clustering analysis, it can verify and further extend the clustering results. But it cannot further reflect the strength of the relationship between keywords. Social network analysis can make up for the deficiencies of the above two methods, but it cannot classify keywords.

3. RESEARCH AND RESULT ANALYSIS

3.1. Co-word Analysis Results

In this research, 344 keywords were extracted from PAEG, and the total word frequency were 1091 times. After deleting and merging some meaningless words, a total of 46 keywords were selected as high-frequency keywords whose a frequency is greater than or equal to 3 (see

Table). The frequency of these words were 332 times, accounting for 30.43% of the total word frequency. It exceeds 27% of the empirical value, and fully meets the requirements of statistical analysis. It should be noted that since the main body of this research sample is patent assets, the two high-frequency keywords 'patent' and 'asset' have no practical significance in this research, so they were deleted.

In order to further understand the relationship between hotkey keywords, pair the 46 high-frequency

keywords into two pairs. The high frequency keyword co-occurrence matrix is generated, as shown in Table. Then use 1 minus the Ochiai coefficient value to transform the co-occurrence matrix into the dissimilarity matrix (see Table). The large value in the dissimilarity matrix, the smaller the distance between two high-frequency keywords, the smaller the correlation is.

Table1. *Statistics of High-frequency Keywords and Word Frequency (Part)*

The serial number	High-frequency words	Word frequency
1	Assessment	45
2	Value	20
3	Analysis	16
4	Patent technology	15
5	Earnings	13
6	Law	12
7	License	11
8	Asset appraisal professional	9
9	Market	9
10	Patent right	9

Table2. *Co-occurrence Matrix of High-frequency Keywords (Part)*

	Assessment	Value	Analysis	Patent technology
Assessment	0	10	12	7
Value	10	0	8	3
Analysis	12	8	0	6
Patent technology	7	3	6	0

Table3. The *Difference Matrix of High-frequency Keywords (Part)*

	Assessment	Value	Analysis	Patent technology
Assessment	0.00000	0.66667	0.55279	0.73057
Value	0.66667	0.00000	0.55279	0.82679
Analysis	0.55279	0.55279	0.00000	0.61270
Patent technology	0.73057	0.82679	0.61270	0.00000

3.2. Cluster Analysis Results

Based on the results of various clustering methods, it is found that using Euclidean distance and intra-group connection to measure respectively the distance between samples and classes can better classify high-frequency keywords. The clustering analysis tree is generated, as shown in Figure. From the tree graph of cluster analysis, it can be seen that the theme of PAEG is divided into five categories. According to the order from top to bottom, it is name as 'legal factors affecting patent value assessment', 'summary of patent valuation work', 'guidance of patent valuation preparation', 'economic factors and technical factors affecting patent value assessment' and 'patent valuation assessment method'.

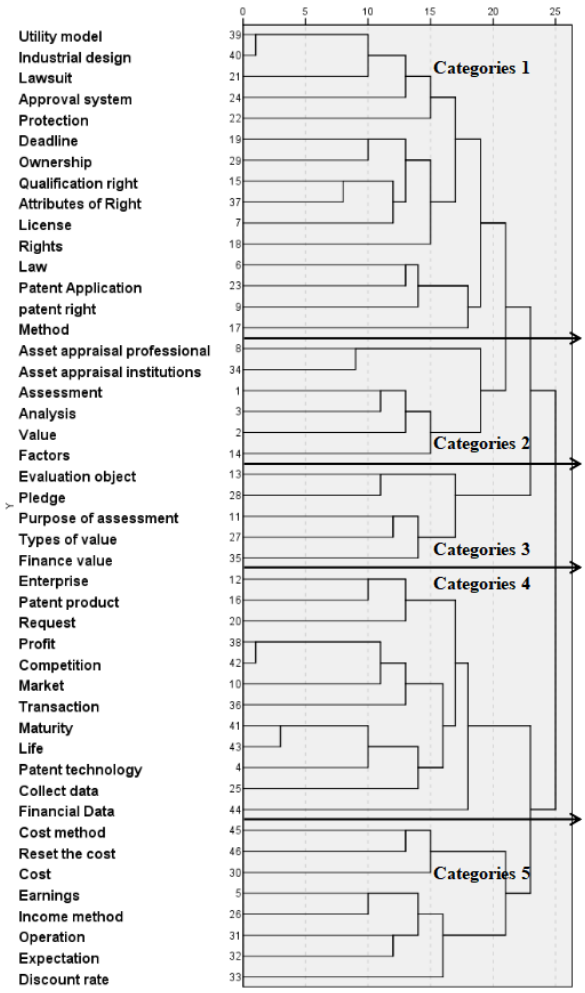

Figure1. *High Frequency Keywords Clustering Analysis*

As can be seen from Figure, categories 1 and categories 2 include 27 high-frequency keywords, accounting for more than half. This initially shows that these two topics have received the most attention and the relevant norms are more detailed in PAEG. It should be noted that there are many factors that affect patent evaluation, which are intertwined to form a complex system. Because they have a certain degree of cross-relationship, it is impossible to make an absolute distinction. In order to further understand the theme distribution of PAEG, this research will also carry out multi-dimensional scale analysis and social network analysis.

3.3. Multidimensional Analysis Results

In order to further explore the knowledge structure of PAEG, the Euclidean distance model is used for multi-dimensional scale analysis of high-frequency keywords (see Figure). According to the empirical standard proposed by Kruskal, we can see that the normalized raw stress is 0.17496, less than 0.2, and the Tucker's coefficient of congruence is 0.83666, more than 0.6. This indicators that the model fits well and generally reflect the linkage relationship between high-frequency keywords. Comparing the results of multi-dimensional scale analysis with the clustering analysis, it can be found that the classification results are very similar. It verifies the correctness of the clustering results to a certain extent. However, it is worth noting that some high-frequency keywords in the clustering results are scattered into other categories in multi-dimensional coordinate. This shows that the text topics obtained by multi-dimensional scale analysis are a little more extensive in denotation.

In the multi-dimensional scale coordinate map, 46 small dots represent 46 high-frequency keywords, and the position of each dot represents the distance between them. The closer the distance between them, the closer the relationship is. And the closer the dot is to the center of the coordinate, the greater its influence. According to Figure, the six high-frequency keywords 'analysis', 'value', 'assessment', 'asset appraisal professionals', 'factors' and 'management' are in the central position of coordinates, and the other high-frequency keywords are surrounding them. It means that these six high-frequency keywords have a great influence on other topics. This indicators that when evaluating the value of a patent, evaluators need to make a qualitative analysis of the relevant data on the evaluation information, influencing factors and evaluation methods of the patent.

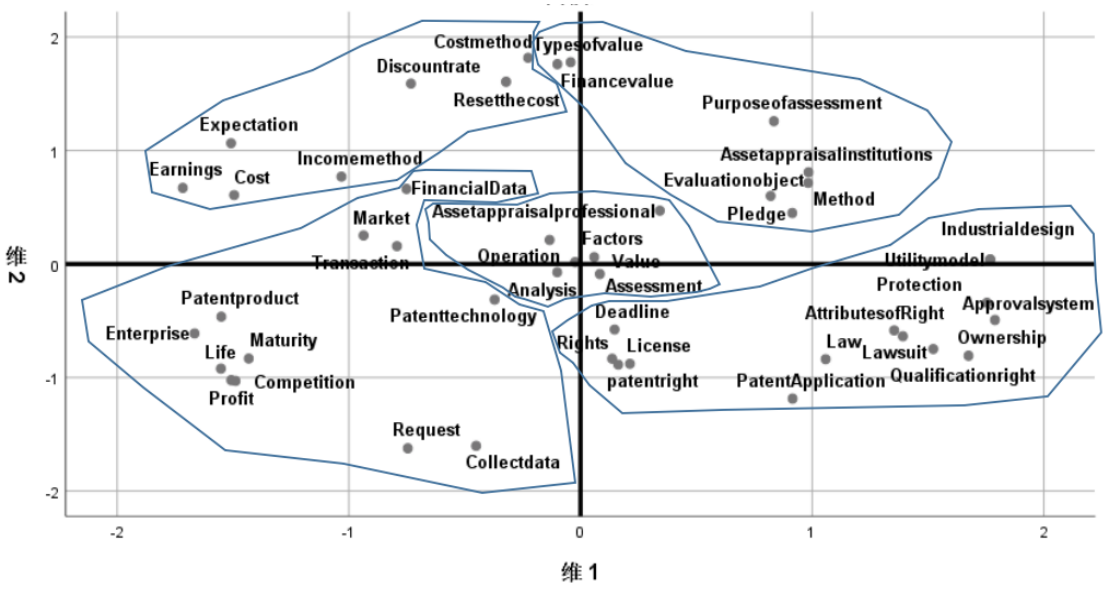

Figure2. *Multidimensional Coordinate Chart of High-frequency Keywords*

4. RESULTS OF SOCIAL NETWORK ANALYSIS

The social network analysis of high-frequency keywords is carried out, as shown in Figure. SNA usually describe the relationship of high-frequency keywords from the dimensions of network density and centrality. The density can measure the degree of connection between the nodes, and the centrality reflects the importance or status of high-frequency keywords. The frequency of the high-frequency keyword is proportional to the size of the node, and the large node represents that the high-frequency keyword plays an important role in the whole network. The thick connection indicates that there is a strong connection between high-frequency keywords.

As can be seen from Figure, such as 'assessment', 'analysis', 'value', and 'factors' are the core of the network, and their connections with the surrounding nodes are thicker. It shows that these keywords have a strong connection with the surrounding nodes, which verifies the results of multi-dimensional scale analysis to a certain extent. Therefore, it is found that the experience of evaluators runs through the evaluation work all the time.

In the social network diagram, the lines between the legal, economic and technical factors are dense and thick. Meanwhile the connections between them and the subject of evaluation are also very close. It shows that the relationship between the influencing factors is strong, and they are also strongly related to the evaluation results. Combined with the results of cluster analysis, we can see that influencing factors is the focus of patent value evaluation.

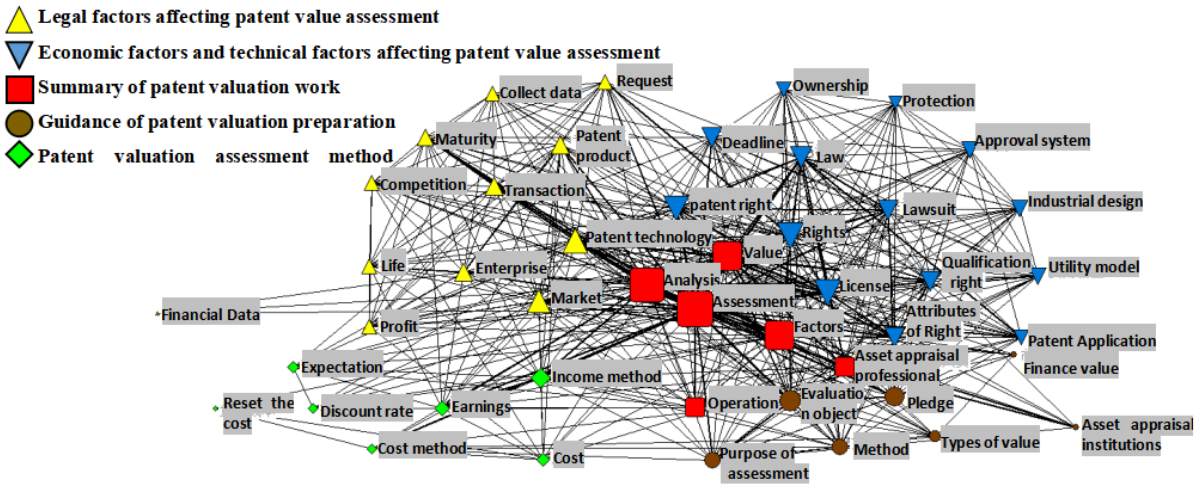

Figure3. *High-frequency Keyword Social Network Diagra*

In the diamond icon area shown in Figure, the position of the high-frequency keyword 'income method' is the largest and most closely connected to other topic nodes. At the same time, there is a big difference between 'cost method' and 'income method' in terms of node size and number of lines. And it can be found that the market method, which is called as the traditional economic evaluation method together with the income method and the cost method, has not appeared in this diagram. Through the search of PAEG content, it is found that 'market method' appears only twice. According to the differences of 'income method', 'cost method' and 'market method' in network distribution, as far as the evaluation method of patent value is concerned, the recommended order of PAEG is: income method> cost method> market method.

Based on the above quantitative research, it is found that the guidance of PAEG on the current patent value evaluation shows the following three characteristics:

The effect of the patent evaluation greatly influenced by the experience and practice ability of patent evaluator. In the preparatory stage, the evaluators should collect relevant patent data according to the purpose, object and value type of the patent asset, so as to analyze the appropriate evaluation method of the patent asset. In the evaluation stage, the evaluators need to consider various factors that affect the value of patents, such as legal factors, economic factors and technical factors, and measure the indicators of each factor. The optional measurement methods are expert estimation method, analytic hierarchy process, composite scoring method and the use of calculation formulas or models. When different evaluation institutions evaluate the same patent asset, choosing different evaluation methods and index measurement methods may lead to different evaluation conclusions[[16]]. These choices are mainly influenced by the experience and practice ability of the evaluators.

The key of the patent evaluation work patent is relied on the selection and measurement of factors of patent-value evaluation. In practice, in order to better promote patent value evaluation, China National Intellectual Property Administration and China Technology Exchange jointly launched the Operation Manual of Patent-value Analysis Index System in 2012. It includes 3 influencing factors (legal, economic and technical) and 18 factor indicators. However, due to the differences in the evaluation purpose and industries of the patent, the influencing factors that need to be considered are also different. At present, some scholars have conducted in-depth research on the relevant contents. For example, Li Zhipeng[[17]] thinks that enterprise factors should be taken into account when patent pledge financing; Wang Qinghong[[18]] put forward three important factors for the power industry. In other words, the evaluators need to take the patent-value assessment indictor system as the static basis and make some dynamic changes according to the particularity of the patent itself. This combination of subjective and objective method may lead to differences in evaluation results, so strengthening the research on patent-value assessment indictor system is an important step in patent value evaluation in the future.

The income method is the most respected method for patent value evaluation in the current policy. As traditional economic evaluation methods, the income method, the cost method and the market method are most frequently used in the asset evaluation industry. However, due to the particularity of patents

and the different emphasis of the three methods, their applicability to patent value evaluation is also different. As far as the market method is concerned, appraisers are required to find at least three identical or similar patents in the market as transaction cases to measure patent value. However, because of the uniqueness and exclusiveness of patents, it is impossible for identical trading cases to exist in the market. Moreover, similar patent trading cases are also difficult to find. Therefore, its applicability to patent value evaluation is the lowest. The idea of the cost method is to use the replacement cost and the depreciation of patent to measure the patent value. It is not the best of the three methods, and there are three shortcomings. First, the cost method does not fully take into account the future profitability of the patent and the potential value-added space of the patent. Second, because the depreciation of the patent asset is not easy to measure and the cost composition is complex, the replacement cost obtained may be inaccurate. Third, the purpose of patent research is to make a profit, and its value far exceeds the R & D cost. All the above limitations will make the evaluation price lower than the true value. The reason why the income method is the most commonly used is that it takes into account the present value of future cash flows on patent assets. Although the income method can make up for the deficiency of the cost method, it also has some shortcomings. Because there are many factors that affect the expected return in the future, it is difficult to estimate them accurately. Moreover, the parameters of the formula are highly uncertain and difficult to predict, such as the discount rate. All these increase the difficulty of using the income method to evaluate, so it still needs to be studied deeply.

5. CONCLUSIONS AND SUGGESTIONS

Through the above quantitative and qualitative analysis, it is found that the current patent value evaluation can be improved from three aspects: the professional ability of evaluators, the research on the influencing factors of patent value evaluation and the evaluation methods of patent value. Based on this, the following relevant suggestions are put forward：

First, strengthen the professional ability training of evaluators. Due to the particularity of patents, the evaluation of patent value is more difficult and complex than that of tangible assets. Therefore, evaluators need to carry out qualitative and quantitative analysis of a large number of data, which is also a big test of their practice ability. Evaluation institutions can improve the practice ability of evaluators by organizing training, evaluation studies or competitions.

Second, the patent-value assessment indictor system is constructed based on the evaluation purpose of patent and the characteristics of the industry. Under different evaluation conditions, system researchers need to fully consider the differences of influencing factors and index factors of patent value. The specific indictor system can provide an objective basis for evaluators to carry out patent value evaluation.

Third, strengthen the research and practice of evaluation methods. At the present stage, the relevant theoretical research has been relatively mature, including the classical comprehensive evaluation method, the emerging intelligent method and the supplementary research to the traditional method. However, due to insufficient data or evaluation results in the form of non-amount and other reasons, the final results only have reference value and can not be used as a direct evidence. Therefore, theoretical research and practical exploration are inseparable. Only with enough practical cases can we make a substance contribution to the development of patent value evaluation.

6. ACKNOWLEDGEMENTS

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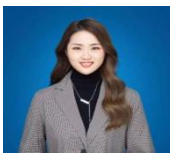

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