

# Study on 'Value Grade' Rating System for Evaluating the Value of Technological Property Right in China

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**Abstract-**The paper proposed a concept of *value grade* to assess value of technological property right from four aspects: law value, economic value, technological value and market value. Firstly, the paper analyzes the influencing factors for the value of technological property right and formed a indexes system to analyze the value of technological perperty right. Some methods of calculating the value of indexes had been proposed ; Secondly, using Analytic Hierarchy Process method, the paper established an model to rate *value grade* of technological property right. The paper finally examined the rating system by calculating *value grade* of two technological property rights from two LED lighting manufactories in Guangdong province in China, and the method has been proven to be a feasible and practical way to evaluate the value of technological property right.

**Keywords-***Technological Property Right, Index System, Value Grade.*

## I. INTRODUCTION

Technological property right includes a series of technological assets such as patent, nonpatented technology and industrial copyright, etc.. Because index system that evaluating the value of technological property right influences the accuracy of evaluation, the paper researches the indexes that influencing the value of technological property right firstly, and then proposes some methods to calculate the value of those indexes. Finally, using AHP method, the paper formed a model to calculate value grade of technological property right.

The first achievement in indexes designing for evaluating technological property right is Patent Scoring Method, which was proposed by CHI research company in America. CHI method designed indexes from five aspects: current impact index(CII) ,patent citation, technology strength, technology life cycle and science linkage[1]. M.Reitzig(2004) choiced thirteen indexes such as patent life, company's market value, size of patent family and technical coverage,etc. from empirical study on value of 23 technological property rights[2]. J. O. Lanjouw&M. Schankerman (2004) found that adopting composite indexes can decrease deviation in evaluating the value of technological property right [3]. Xiao-Li WAN & Xue-Zhong ZHU (2008) formed a seventeen indexes system from three aspects :technology value, market value and right value, and adopted fuzzy comprehensive evaluation method

to rate the value of patents[4]. Ming WEN,He SHUN&Hong-Yi TU (2012) formed value evaluating system from five aspects: leading degree of patent technology , industrialization of patent technology, sufficiency of patent protection, defense of patent right and stability of patent[5]. In 2012, Patent Value Degree (PVD)[6] was published in China, and it's a result of cooperation by State Intellectual Property Office and China Technology Exchange, and it evaluates the value of patent from law, technology and economic aspects which including eighteen second lever indexes. Aboving researches contribute a lots to evaluate the value of technological property right, but there exist four kinds of problems in setting rating indexes for China. The first is that some indexes setting by foreign researchers is not suitable in China, such as index of current impact index (CII) and size of patent family index; The second is that some of indexes are difficult to quantified in evaluation, such as *patent strategy* index and *sufficiency of patent protection* index; The third is that in China, technological property rights are divided into three types when they are authorized: invention type, new utility type and appearance design type, and each type reflects different lever of value for technological property rights, and the existing researches had not considering the characteristic in China; The fourth is that the range of technological property right is larger than that of patent, and the existing researches almost pain more attention on evaluating value of patent. So, the paper aims to establish a rating system which is feasible and practical to evaluate the value of technological property right in China.

## II. FORMING INDEX SYSTEM EVALUATING THE VALUE OF TECHNOLOGICAL PROPERTY RIGHT

In our paper, the index system evaluating the value of technological property right is formed from four aspects in first lever: law value, economic value, technological value and market value, and there are eighteen indexes in second lever. Some methods calculating the value of each second lever indexes have been proposed. And we have some new ideas in setting and measuring some indexes, such as methods to calculate indexes in economic value lever, and that of patent class index measurement which belongs to technological value, and measurement of industry developing prospects index in market value lever. All of them are shown in table 1 as follows.

### III. A MODEL TO ASSESS THE VALUE OF A TECHNOLOGICAL PROPERTY RIGHT

*Structuring the Decisional Problem into a Hierarchical Model and Making Pair-Wise Comparisons and Obtaining the Judgmental Matrix.*

In this part, the paper proposed a concept of *value grade* to evaluate the value of a technological property right. We use Analytic Hierarchy Process as a means to assign weights to each criteria and sub-criteria. Designing the hierarchical structure of the decisional problem, it is structured as in figure 1.

The paper divided the decisional problem into three levels: First is the all objective related to the assessing of the value of a technological property right (lever V); Second is the primary criteria for assessing the value of a technological property right (lever  $C_i, i=1-4$ ); Third is the sub-criteria that operationalize the primary criteria (lever  $B_k, k=1-18$ ).

And then we introduce pairwise comparisons aimed at determining the relative importance of the criteria and sub-criteria. In this paper, managerial judgments are expressed on an integer scale ranging from 1 to 9, in order to avoid violation of the critical principle of proportionality. The semantic scale used in AHP is shown in table 2 as follows.

#### A. Testing Consistency of Comparisons

Once the judgemental matrix (matrix A) of comparisons of criteria with respect to the goal is available, it has been generally agreed (Saaty, 1980)<sup>[7]</sup> that priorities of criteria can be estimated with Eq. 1 by finding the principal eigenvector  $\omega$  of the matrix A as follow:

$$A\omega = \lambda_{\max}\omega \quad (1)$$

When the vector  $\omega$  is normalized, it becomes the vector of priorities of the criteria with respect to the goal.  $\lambda_{\max}$  is the largest eigenvalue of the matrix A and the corresponding eigenvector  $\omega$  contains only positive entries.

The consistency of the judgmental matrix can be determined by a measure called the consistency ratio (CR), defined as Eq. 2 as follow:

$$CR = \frac{CI}{RI} \quad (2)$$

Where CI is called the consistency index and RI, the Random Index. CI is defined as Eq. 3:

$$CI = \frac{(\lambda_{\max} - n)}{(n - 1)} \quad (3)$$

RI is the consistency index of a randomly generated

reciprocal matrix from the 9-point scale, with reciprocals forced. Saaty (1980)<sup>[7]</sup> has provided average consistencies (RI value) of randomly generated matrices (up to size  $11 \times 11$ ) for a sample size of 500. The RI values for matrices of different sizes are shown in table 3.

If CR of the matrix is higher, it means that the input judgements are not consistent, and are not reliable. In general, a consistency ratio of 0.10 or less is considered acceptable.

From information in figure 1 and table 1, we can calculate the priorities of assessed technological property right with respect to each criteria and sub-criteria by solving matrix equations that translates the pairwise comparison into weights.

#### B. Calculating Sub-Value of Lever C and Total Value Grade of Lever V

The paper calculates the overall value grade of a technological property right by substituting each weights into corresponding indexes.

Concerning value grade of lever C, for example, the value grade of lever  $C_1$  ( $V_{C1}$ ) can be calculated with Eq. 4 as follow:

$$V_{C1} = \sum_{k=1}^4 (B_k \times \text{local priority of lever } B_k \text{ with respect to lever } C_1)$$

So, for lever  $C_i$ , the value grade of lever  $C_i$  ( $V_{Ci}$ ) can be calculated with Eq. 5 as follow:

$$V_{Ci} = \sum_{k=m}^n (B_k \times \text{local priority of lever } B_k \text{ with respect to lever } C_i)$$

Where m is the beginning number of k in  $B_k$ , and n is the ending number of k in  $B_k$ .

Therefore, value grade of lever V ( $V_V$ ) can be calculated with Eq. 6 as follow:

$$V_V = \sum_{i=1}^4 (V_{Ci} \times \text{local priority of lever } C_i \text{ with respect to lever } V)$$

#### C. Assigning Weights to Each Criteria and Sub-Criteria

Using expert-consulting method, we formed judgement matrix to assign weights to criterion level in table 4 as follows. And the results of pairwise comparisons in table 4 is from consulting to researchers who are professional in study of technological property right.

Because  $CR < 0.1$ , we can conclude that the input judgements are consistent and reliable, thus we get the weights and orders of C factors ( $C_1, C_2, C_3, C_4$ ) of criterion level from table 4, that is:  $V = (C_1, C_2, C_3, C_4) = (0.1192, 0.2517, 0.4720, 0.1571)$ .

Using the same method, we get each factors's weight in each sub-criteria levers as follows:

$$C_1 = (B_1, B_2, B_3, B_4) = (0.1386, 0.2832, 0.0782, 0.5000);$$

$$C_2 = (B_5, B_6, B_7) = (0.5922, 0.1707, 0.2371);$$

$$C_3 = (B_8, B_9, B_{10}, B_{11}, B_{12}, B_{13}, B_{14});$$

$$= (0.1056, 0.1983, 0.2212, 0.0641, 0.2049, 0.0203,$$

0.1856);

$C_4=(B_{15}, B_{16}, B_{17}, B_{18})=(0.3112, 0.1894, 0.2703, 0.2291)$ .

Each of CR value of aboving judgement matrixs is smaller than 0.1, so the orders of each uni-lever have satisfactory consistency also.

#### IV. APPLICATION OF THE MODEL

With the proposed method, we calculate the *value grade* of two kinds of technological property right. One of which is A kind of LED circle light source, which belongs to practical and new type technological property right, and was invented by CY company, a LED lighting manufactory in Guangzhou. The other is A kind of highly colored lighting diode and its manufactory method, which belongs to invention type technological property right, and was invented by MLS company, a LED lighting manufactory located in Zhongshan. Using above evaluating model, we've calculated their value grade. The valeu grade of the first technological property right is 4.2361 and the other is 6.6157, which is much higher than the first owing to that it has been authorized and it belongs to a higher degree of technological property right, and MLS company had invested more cost to invent it than that of CY company.

#### V. CONCLUSION

The paper designed *value grade* rating system to evaluate internal value of technological property right from four aspects: law value, economic value, technological value and market value, and had set a series of sub-indexes under the four indexes. Using AHP method, the paper

assigned weights to each criteria and sub-criteria, and finally founded a practical evaluation model. The method has been proven to be a feasible and practical way to evaluate the value of a technological property right through application.

#### ACKNOWLEDGEMENT

This research was financially supported by the Science and Technology Planning Project Foundation of Science and Technology Agency of Guangdong Province, China under Grant 2015A030401085. And it's also supported by the Accounting Research Project of Finance Department of Guangdong Provance, China under Grant 2015A59.

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TABLE I. INDEX SYSTEM FOR EVALUATING VALUE OF TECHNOLOGICAL PROPERTY RIGHT AND THEIR MEASUREMENT METHODS

First order indexes	Secend order indexes	Measuring methods of the indexes
Law value	warranted assertibility of technolotical property right infringement	Is 1, No. 0
	Period of validity	number of years
	Multi Country application	Is 1, No. 0
	Status of technological property right licensing	Is 1, No. 0
Economic value	Cost of investing	Natural logarithm of the amount of book value for the technological property right.
	Cost of application	Natural logarithm of the amount of applicating fee.
	Cost of transaction	Natural logarithm of the amount of transaction fee.
Technological value	science linkage	Natural logarithm of the amount of technolotical property right citations
	Technology life cycle	The median age of all cited technolotical property right / The sum of the age of the cited technological property right.
	technology maturity	Whether industrialization, Is 1, No. 0
	Patent class	Innovation type give 3 score, new utility type give 2 score and appearance design type give 1 score.
	Substitutability	Whether there exists alternative technologies, Is 1, No. 0.
	Transfer times	Actual transfer times.
	Supporting technology dependence	Is 1, No. 0
Market value	Industry developing prospects	Measuring industry life cycle of the firm who owned the technological property right ,and industry life cycle can be divided into three stages: developing life stage(give 2 score), maturity life stage (give 1score), declining life stage (give 0 score) using Industry sification Method.
	market share	Amount of market share of the firm who owned the technological property right
	Competitors have the same kind of technonogical property right	Is 1, No. 0
	Policy adaptability of the technological property right	Is 1, No. 0

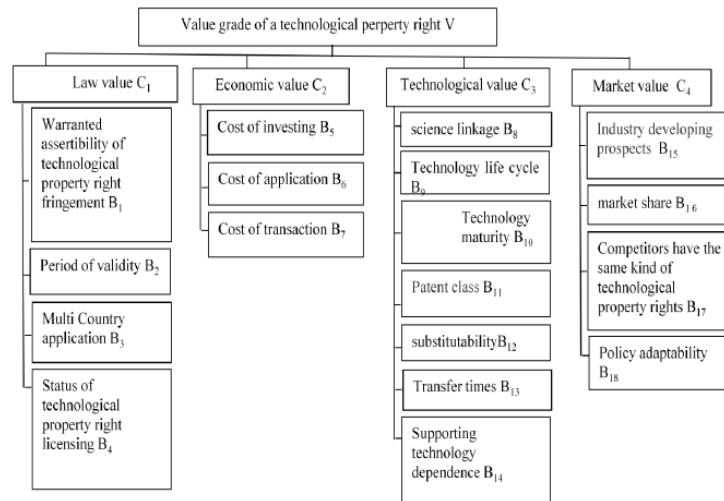


Fig. 1 The hierarchical structure of the decisional problem

TABLE II. THE SEMANTIC SCALE USED IN AHP

Intensity of importance	Definition	Description
1	Equal importance	Elements Ai and Aj are equally important
3	Weak importance of Ai over Aj	Experience and judgement slightly favour Ai over Aj
5	Strong important	Experience and judgement strongly favour Ai over Aj
7	Demonstrated improtance	Ai is very strongly favoured over Aj
9	Absolute importance	The evidence favouring Ai over Aj is of the highest possible order of affirmation
2,4,6,8	intermediate	When compromise is meeded, values between two adjacent judgements are used
Reciprocals of the above judgements	If Ai has one of the above judgements assigned to it when compared wity Aj, then Aj has the reciprocal value when compared with Ai.	A reasonable assumption

TABLE III. THE AVERAGE CONSISTENCIES OF RANDOM MATRICES(THE RANDOM INDES-RI-VALUES)

Size	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

TABLE IV. JUDGEMENT MATRIX OF CRITERION LEVEL: VCI

V	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	weight	order
C <sub>1</sub>	1	1/2	1/3	1/2	0.1192	4
C <sub>2</sub>	2	1	1/2	2	0.2517	2
C <sub>3</sub>	3	2	1	4	0.4720	1
C <sub>4</sub>	2	1/2	1/4	1	0.1571	3
$\lambda_{\max}=4.2088$ ; CI=0.0696; RI=0.90; CR=0.0773						