

Research on the Core Competence of Science and Technology Enterprises in Yunnan Province——Based on the perspective of BP neural network

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Abstract: This paper designs a five-dimensional scientific and technological enterprise core competitiveness evaluation index system from the perspective of science and technology enterprises from the perspective of academic circles on the core competitiveness evaluation system of science and technology enterprises. At the same time, the system evaluation method based on neural network is proposed. Through the simulation experiment and the ability of self-learning, self-adaptation and self-organization, the BP neural network model based on artificial intelligence is constructed to systematically analyze the core competitiveness of science and technology enterprises and establish close proximity. With the combination of qualitative and quantitative evaluation models of leadership thinking, the simulation experiment is used to calculate the weights, remove the subjectivity and uncertainty of the model, and reveal the true core competitiveness level of real technology enterprises. Empirical studies show that the index system and the neural network expert system can better solve the problem of evaluating the core competitiveness of enterprises.

1. Introduction

The core competitiveness of an enterprise is a complex system, which is the comprehensive result of the interconnection and interaction between the internal factors of the enterprise and the external environment. According to research, core competitiveness has three characteristics: First, it has sufficient user value, that is, it can provide users with the required utility; Second, it is unique, if the company's expertise is easily imitated by competitors or can be established quickly through hard work, it will be difficult to provide a lasting competitive advantage to the company; Third, it has certain scalability, and should be able to provide support for enterprises to open a variety of product markets, and promote the competitiveness of a series of products or services.

In September 2013, China implemented the “One Belt, One Road” strategy for enterprises to go global, and promoted two-way direct investment, including foreign direct investment and foreign direct investment, and absorbed more technology spillovers from high-tech industries, which has made China's science and technology enterprises have made rapid progress. As an important strategic fulcrum for the “Belt and Road” initiative in Southeast Asia, Yunnan Province's core competitiveness is rapidly condensing. Therefore, the author studies the core competitiveness of science and technology enterprises in Yunnan Province.

2. Statistical Analysis of Influencing Factors of Core Competitiveness of Science and Technology Enterprises in Yunnan Province

The indicator system is the carrier of the evaluation content of the core competitiveness of the enterprise, and it is also the external manifestation of the evaluation content of the core competitiveness. The core competitiveness evaluation indicators must fully reflect the basic content

of core competitiveness, and build a system of rigorous, interconnected, complementary, and independent evaluation indicators around the core competitiveness of the factors. Therefore, the author sorts these elements into the order of the hierarchy, including: market competitiveness of technology-based enterprises, management innovation capability, capital operation capability, enterprise resources and technology development capabilities, in order to systematically evaluate the core competitiveness of technology-based enterprises.

3. Data source

Therefore, this paper selects 12 scientific and technological enterprises in China, and the author divides it into two parts, among which there are 8 samples for network training and 4 test samples. The specific indicators are:

1) Market competitiveness (U1). The market competitiveness of an enterprise is the performance of the company in satisfying the customer's individualization, diversified demand, and market share in the "super-competitive" market environment characterized by "3C" (ie customer, competition, change). The threat to competitors is also the most direct manifestation of the core competitiveness of the company. Regarding market competitiveness, it can be measured by the sales growth rate indicator of the product.

2) Management innovation capability (U2). Management innovation ability refers to the ability of enterprises to create and implement new and more effective resource integration models to achieve the harmonious ability consistent with the entire business content. It reflects through three aspects: corporate strategy, organizational innovation and mechanism innovation. This paper comprehensively analyzes the core competitiveness of enterprises by sorting out the proportion of technical personnel and innovative personnel of listed companies, the proportion of senior managers and the innovative thinking of senior managers.

3) Capital operating capacity (U3). The capital operation capability mainly refers to the efficiency and efficiency of the working capital of the enterprise. The essence is to achieve as much business results as possible with as little capital investment as possible. The capital operation capability reflects mainly: profitability, solvency, asset operation efficiency, fundraising ability and growth ability. This article uses stock prices to reflect the capital operation capability of sample companies.

4) Enterprise Resources (U4). The resources that a company has are the basis for its products or services. It mainly includes the following indicators: human resources, material resources, and so on. The level of employee education in the human resources element can represent the level of human resources; the ratio of operating income to total assets can reflect the quality of the sample enterprise resources.

5) Technology development capability (U5). The size of an enterprise's technology development capability largely determines whether it can achieve its own sustainable development, directly reflecting the level of the core competitiveness of the enterprise and the potential for sustainable development. Technical development capabilities include: R&D capabilities. In this paper, the factors of R&D capital investment are used to comprehensively reflect the technology development capability of the enterprise.

4. Statistics on the factors affecting the core competitiveness of enterprises

Based on the above analysis, the author screened 12 science and technology enterprises in Yunnan Province, and then statistically analyzed the basic data of five factors including market competitiveness, management innovation capability, capital operation capability, enterprise resources and technology development capability, with a view to Yunnan Province. The systematic analysis of the scientific and technological enterprises, the data descriptive statistics are shown in the following table:

Table 1. Descriptive statistics of factors affecting the core competitiveness of science and technology in Yunnan Province

Serial number	Name	Total operating income	Undergraduate ratio	Stock price	sales growth rate	Fixed assets	Technical worker ratio	Management innovation thinking
1	Yunnan Baiyao Group Co., Ltd.	1, 884, 966	10.61	43.31	25.93	948, 899	-	5
2	Yunnan Zhongke Bencao Technology Co., Ltd.	3, 870, 233	12.52	5.28	23.45	3, 272, 233	45.64	1
3	Guiyan Platinum Co., Ltd.	917, 459	9.04	7.72	23.89	632, 944	9.60	7
4	Yunnan Energy Investment Group Co., Ltd.	535, 970	11.06	6.22	10.78	468, 890	7.23	12
5	Yunnan Innovation New Materials Co., Ltd.	3, 870, 232	12.52	5.28	23.45	3, 272, 233	4.56	9
6	Yunnan Innovation Bio Industry Incubator Management Co., Ltd.	48, 460	15.77	8.57	4.13	102, 154	14.32	2
7	Yunnan Wisdom Innovation Telecommunications Equipment Co., Ltd.	654, 542	15.26	12.19	9.80	932, 834	1.60	10
8	Yunnan Tongfang Technology Co., Ltd.	57, 452	15.02	6.05	4.32	253, 198	9.81	11
9	Yunnan Xiniuokang Biotechnology Co., Ltd.	12, 071	28.17	17.05	11.28	42, 609	4.23	3
10	Yunnan Zhongfu New Energy Technology Co., Ltd.	86, 442	21.93	21	25.91	201, 836	15.48	4
11	Yunnan Qifan High-tech Co., Ltd.	79, 224	29.11	5.14	50.52	430, 931	8.39	6
12	Dali Bai Autonomous Prefecture Important Pharmaceutical Co., Ltd.	79, 616	17.80	8.39	21.55	92, 179	9.22	8

Data source: author collation. Unit: 10,000 yuan

5. Digitization of factors affecting the core competitiveness of enterprises

Based on the analysis of each influencing factor in the previous article, the corresponding data are counted, and the various factors are digitized under the premise of the range of uniform variables, and the mathematical description of the factors is completed, which is ready for the establishment and analysis of the following mathematical model. First, digitally process the specific values and scores of the same factor of each enterprise: “Unified standard range”, that is, first use the search tool to determine the maximum value Max and the minimum value Min among the different enterprises in the same factor to determine the data change. The basic scope, and then according to the share of different enterprise values, determine its digital value, making the comparison between different enterprises more intuitive and effective. It is determined by the following formula:

$$L = \max - \min \quad (1)$$

Then, according to the value of each enterprise factor, determine its share, and uniformly define the domain change range to (0-1), complete the range and digitization. As shown in equation (2):

$$q = (x - \min) / L \quad (2)$$

Secondly, for ranking data, it cannot be processed by conventional digitization methods because its share is inversely proportional to its value, ie the smaller its value, the greater its weight. This paper adopts the "reverse order normalization weight method". As shown in equation (3):

$$q_{final} = \frac{n}{(f_1 + f_2 + \dots + f_n)} \quad (3)$$

Then it is the comprehensive digitization of the different conditions that affect the same factor. In this paper, the "mean filtering" method based on engineering application is adopted. As shown in the formula:

$$q_{final} = (f_1 + f_2 + \dots + f_n) / n \quad (4)$$

Based on the above digitization principle, the corresponding digital words of the mathematical model are obtained, and Table 2 is obtained.

Table 2. Factors affecting core competitiveness and statistics

Serial number	Name	Operating income	Stock price	Stock price	sales growth rate	Fixed assets	Technical worker ratio	Management innovation ability
1	Yunnan Baiyao Group Co., Ltd.	1.0000	0.0782	1.0000	0.4719	0.2806	-	0.3636
2	Yunnan Zhongke Bencao Technology Co., Ltd.	2.0600	0.1734	0.0037	0.4182	1.0000	1.0000	0.0000
3	Guiyan Platinum Co., Ltd.	0.4834	0.0000	0.0676	0.4277	0.1828	0.1817	0.5455
4	Yunnan Energy Investment Group Co., Ltd.	0.2797	0.1006	0.0283	0.1439	0.1320	0.1278	1.0000
5	Yunnan Innovation New Materials Co., Ltd.	2.0600	0.1734	0.0037	0.4182	1.0000	0.0672	0.7273
6	Yunnan Innovation Bio Industry Incubator Management Co., Ltd.	0.0194	0.3353	0.0899	0.0000	0.0184	0.2888	0.0909
7	Yunnan Wisdom Innovation Telecommunications Equipment Co., Ltd.	0.3430	0.3099	0.1847	0.1227	0.2756	0.0000	0.8181
8	Yunnan Tongfang Technology Co., Ltd.	0.0242	0.2980	0.0238	0.0041	0.0652	0.1864	0.9091
9	Yunnan Xinuokang Biotechnology Co., Ltd.	0.0000	0.9532	0.3120	0.1548	0.0000	0.0597	0.1818
10	Yunnan Zhongfu New Energy Technology Co., Ltd.	0.0397	0.6423	0.4155	0.4714	0.0493	0.3152	0.2727
11	Yunnan Qiufan High-tech Co., Ltd.	0.0359	1.0000	0.0000	1.0041	0.1202	0.1542	0.4545
12	Dali Bai Autonomous Prefecture Important Pharmaceutical Co., Ltd.	0.0361	0.4365	0.0851	0.3771	0.0153	0.1730	0.6364

Data source: author collation.

6. Core competitiveness evaluation model

In this paper, a three-layer BP neural network, namely input layer, hidden layer and output layer, is selected to establish a core competitiveness analysis model of Yunnan enterprises. Each layer unit only accepts the output information of the previous layer and outputs it to each unit of the next layer. Based on the analysis of actual problems, it can be seen that the network has only one output w , which is the final core competitiveness level; five input variables, namely market competitiveness, management innovation capability, capital operation capability, enterprise resources, and technology development capability; The number of nodes of the input layer and the output layer is 5 and 1, respectively.

According to this, the optimal network topology based on the BP neural network core competitiveness evaluation model is: $5 \times 5 \times 1$.

6.1 Analysis of core competitiveness evaluation model

The above completes the establishment and training of the neural network, and verifies the correctness and usability of the model through inspection and analysis. On this basis, this paper will conduct a preliminary analysis of the competitiveness evaluation model based on the correct model parameters. Because the curve based on neural network is the same, the basic function is the same as the ordinary function curve fitting method. The application of the neural network algorithm is mainly used to solve the problem that the input and output relationships are complex, the data randomness is large, and the conventional algorithm cannot achieve the purpose. The biggest difference between the neural network algorithm and the general function curve is that it replaces the one-dimensional coefficient of the original function by the form of the weight matrix, but the fundamental theoretical basis and actual meaning of the coefficient have not changed, and it is still the magnitude of the effect on the output (dependent variable) when characterizing the same order variable. Therefore, the same analysis method can be applied: the coefficient of the same-order variable in the same domain (the form of the weight matrix) is used to characterize the magnitude of the influence on the output result or the degree of the constraint, so as to analyze the complex problem. However, in order to standardize the analysis process, applying correlation analysis and comparison theory, it is necessary to process the weight matrix and convert it into a one-dimensional coefficient form [28]. The following is a detailed analysis:

Firstly, the weight matrix of the BP neural network core competitiveness evaluation model based on M file is analyzed (the final input variable weight matrix after the five intermediate weight coefficients of the middle layer is integrated). The weight matrix is (the row represents the different influencing factors of the input; the column represents the neuron weight of each input variable):

$$ans = \begin{bmatrix} -0.1990 & 0.4649 & -0.3444 & 1.3265 & -2.4327 \\ -1.4444 & 1.6782 & 1.4424 & -1.8544 & -1.5341 \\ 0.3506 & -0.1255 & 0.1542 & 4.3459 & 3.0503 \\ 1.5672 & 0.0305 & -1.4592 & -1.3241 & -1.4985 \\ 0.9942 & 0.8694 & -1.8825 & 0.1829 & -3.5624 \end{bmatrix} * \begin{bmatrix} \text{Management} \\ \text{innovation ability} \\ \text{Technology} \\ \text{development capability} \\ \text{Market} \\ \text{Competitiveness} \\ \text{Enterprise resources} \\ \text{Capital operation} \\ \text{capability} \end{bmatrix}$$

Here, the "mean filtering" mathematical representation method is still used to convert the weights and independent variables (influencing factors of core competitiveness): the average value of each weight coefficient of the same variable is obtained, and the absolute value is taken as the corresponding factor. The degree coefficient of the core competitiveness impact is analyzed. Because the arithmetic weights of different weights of the same variable (influencing factors of core competitiveness) can obtain the overall weight value of the whole network, the weight values of different variables are finally taken as absolute values, and the benchmarks for comparing them are the same. The size of the different weight values can be distinguished by all positive comparisons. In addition, the weight of the BP neural network is only used to adjust the balance within the network, so that the training model can converge as soon as possible. In the end, when comparing different independent variables (influencing factors of core competitiveness), you can ignore them. In the

following, the corresponding "degree of influence coefficient" is obtained by using the "mean filtering" method to calculate the input weight. The result is:

$$result = \begin{bmatrix} \text{Technology development capability} & \text{Enterprise resources} & \text{Market Competitiveness} & \text{Management innovation ability} & \text{Capital operation capability} \\ 0.9547 & 0.4193 & 0.8372 & 1.2830 & 0.2537 \end{bmatrix}$$

Therefore, it can be obtained through parameter comparison, and the factors affecting the core competitiveness according to the coefficient of influence degree on the core competitiveness are shown in Fig. 1.

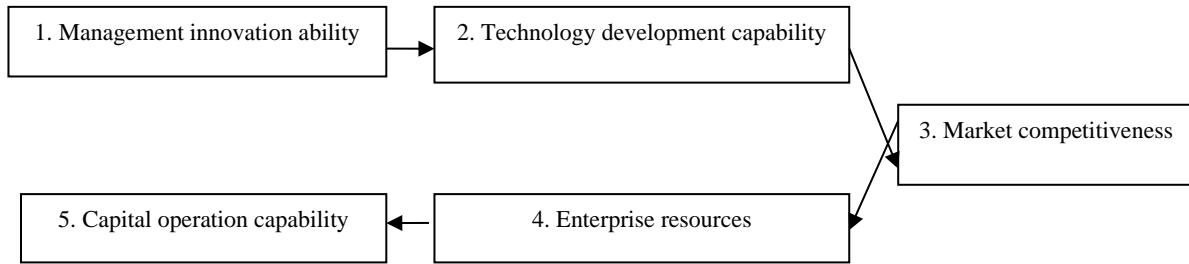


Figure 1. The impact of various factors on core competitiveness.

Secondly, the input variable weight matrix obtained by Matlab-based BP neural network model is introduced. For the sake of comparison, the same representation as above is used:

$$ans = \begin{bmatrix} 0.8182 & -3.2680 & -3.0515 & 2.5591 & -1.5229 \\ 1.2743 & 0.1421 & -0.1571 & 0.8503 & 0.2474 \\ -5.4364 & 1.9979 & 0.6389 & 3.0050 & -0.0602 \\ 0.7929 & 1.7079 & 0.1134 & 0.2546 & -0.8004 \\ -3.4479 & 3.6196 & -1.9648 & 0.5569 & 0.5919 \end{bmatrix} * \begin{bmatrix} \text{Management innovation ability} \\ \text{Technology development capability} \\ \text{Market Competitiveness} \\ \text{Enterprise resources} \\ \text{Capital operation capability} \end{bmatrix}$$

Its final "degree of influence coefficient" matrix is shown below:

$$result = \begin{bmatrix} \text{Technology development capability} & \text{Enterprise resources} & \text{Market Competitiveness} & \text{Management innovation ability} & \text{Capital operation capability} \\ 0.9380 & 0.4201 & 0.8399 & 1.2030 & 0.2617 \end{bmatrix}$$

The results are basically the same as the previous model, and the parameters in the details are slightly different. After comparing and verifying the two models, the order of influence of the ranked core competitiveness evaluation factors is correct, and through its specific data analysis, it can be found:

(1) The influence of management innovation ability factors is relatively large, indicating that they have the greatest impact on the core competitiveness level. When evaluating the core competitiveness level, it is the first consideration.

(2) The two factors of technology development capability and market competitiveness are moderately affected. They are the balance point that affects the core competitiveness level and are two key factors that distinguish the core competitiveness level of different enterprises.

(3) The relative impact of corporate resources and capital operation capacity is small compared with other factors.

(4) Finally, statistics on the influence degree coefficient of each factor can be found that the different influencing factors in the three levels basically satisfy the 1:2:2 relationship, that is, the distribution is relatively uniform, and the size of the effect is compared in the core competitiveness charging. Clearly, it is closer to the actual situation.

6.2 Analysis of the core competitiveness of sample companies

The companies selected as samples have been analyzed in the past. They are relatively authoritative in all aspects of management and technology. The strategies and management ideas are relatively mature and standardized. Their development is concerned by the state, society and investors. Large and transparent, the core competitiveness model is built on this basis. Therefore, one of the main aspects of the application of this core competitiveness evaluation model is to analyze 12 companies according to the different factors such as market competitiveness, and finally apply the model to obtain the core competitiveness level indicators to illustrate the level of core competitiveness. Another major function is to evaluate the core competitiveness of other companies based on their various influencing factors and to study the level of core competitiveness of other companies.

This paper uses four sets of samples to obtain a more accurate core competitiveness level using the model, and uses the graph to predict and analyze the core competitiveness level, thus obtaining the opinions on the adjustment of the sample enterprise management strategy.

From the above analysis, the model is trained to obtain the weights, and the results are summarized as shown in Table 3:

Table 3. Model analysis results

Serial number	Company name	Result
1	Yunnan Tongfang Technology Co., Ltd.	1.375441
2	Yunnan Zhongfu New Energy Technology Co., Ltd.	0.022043
3	Yunnan Qiufan High-tech Co., Ltd.	0.009345
4	Dali Bai Autonomous Prefecture Important Pharmaceutical Co., Ltd.	0.025031

Data source: author collation.

Through the BP neural network model, and the empirical analysis of the science and technology enterprises in Yunnan Province, the conclusions of the above models are obtained. Therefore, the model can better reflect the influence level of the core competitiveness influencing factors on the core competitiveness of enterprises.

7. Conclusions and policy recommendations

Core competitiveness is the source of corporate access and long-term competitive advantage. The core competitiveness of an enterprise is the ability to integrate a cluster of related knowledge and technology. This paper designs a core evaluation index system of five core dimensions from the perspective of the enterprise itself. Based on the evaluation system, an expert model of artificial intelligence BP neural network is constructed, and the core competitiveness of the enterprise is systematically analyzed. 12 enterprises are selected as samples to calculate the influencing factors of the core competitiveness of these enterprises and quantify them. It can be applied to the artificial neural network model to provide useful tools for the formulation and implementation of the enterprise's competitive strategy. The artificial neural network uses the sample to train the learning model to improve the accuracy of the system learning. After the results meet the artificially selected error, the weight of the influencing factors of the core competitiveness of the enterprise is automatically given, and finally the level of the core competitiveness of the enterprise is obtained. The accuracy of the weight is much higher than the weight of the artificially assigned weight. Empirical research shows that the index system is representative in the selection of indicators and data screening, and the BP neural network model runs accurately. It is accurate to assign the weight to the factors affecting the core competitiveness, and can better solve the problem of evaluating the core competitiveness of the enterprise.

References

- [1] [Guo Wei, Zhang Xiangjian. Evaluation of Enterprise Core Competence Based on BP Neural Network [J]. Shanghai Academy of Social Sciences. 2006 (6) 15 - 19.

- [2] Zhao Shuai, Li Yuhua, Hu Yunquan, Hu Yaobiao. Comprehensive Evaluation of Core Competitiveness of Old Industrial Base Enterprises Based on BP Neural Network [J]. School of Management, Harbin Institute of Technology. 2007 (5) 45 - 56.
- [3] Jiang Linkui, Fu Cunjun, Cao Yukun. Analysis of Key Factors of Enterprise Core Competence Based on BP Method [J]. School of Urban and Environmental Sciences, Northeast Normal University, 2007(6) 151 - 155.
- [4] Lei Xia. Evaluation of the core competitiveness of textile enterprises based on evidence theory and neural network. Xi'an Engineering University. 2008 (6) 17 - 21.
- [5] Zhao Wanhua, Zhao Shuai. Fuzzy Comprehensive Evaluation of Core Competitiveness of Property Management Companies-Based on BP Neural Network [J]. Journal of Graduate School of Yunnan University. 2009 (5) 43 - 47.
- [6] Fu Jianhua, Zhang Li. Performance Evaluation of Circular Economy Green Marketing Based on AHP and BP Neural Network Model [J]. Science and Technology Management Research, 2012, 32 (20): 215 - 220+242.
- [7] Huang Haifen. Research on performance evaluation of corporate marketing team members based on BP neural network [D]. Wuhan University of Science and Technology, 2013.
- [8] Yin Huibin, You Daming. Research on Performance Evaluation of Breakthrough Innovation Based on BP Neural Network [J]. Soft Science, 2014, 28 (05): 125 - 129.
- [9] Mei Li, Wang Xiaodong. Evaluation Model of Enterprise Management Based on BA-BP Algorithm [J]. Technology and Innovation Management, 2015, 36 (04): 385 - 387.
- [10] Li Bingxiang, Niu Xiaoqin, Niu Xiaodong. Construction of Quality Evaluation Model for Enterprise Internal Control Information Disclosure [J]. Statistics & Decision, 2016 (10): 173 - 176.
- [11] Wang Lijuan, Li Xinyu. Coal Logistics Cost Prediction Based on PCA-EBP Neural Network [J]. World Science and Technology Research and Development, 2016, 38(05): 1101 - 1106.
- [12] Andrew A. Toole, the Impact of Public Basic Research on Industrial Innovation: Evidence from the Pharmaceutical Industry Rutgers University. 2008.