Research on Technological Innovation Capability Evaluation

of Guangxi Pharmaceutical Industry

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Abstract

According to the information of inputs and outputs of technology innovation, this paper analyzed the current situation of technology innovation in Guangxi pharmaceutical industry and then gave an evaluation index system of technology innovation capability. Based on the theory of analytical hierarchy process (AHP), this paper discussed the technology innovation capability by using basic data of Guangxi Pharmaceutical industry. The results showed that it would be improved in the ability to commercialize innovations.

Keywords: Guangxi pharmaceutical industry, Technology innovation capability, Evaluation index system

1. Introduction

With the development of economic and improvement of living standard, more and more people are starting to focus on health care and the traditional Chinese medicine have received more and more close attention from international area. In recent years, the natural medicine accounted for about 30% market share in the international Medicinal Plant market and the demand of plant medicine is increasing by the average annual growth rate of 10% in market.

Guangxi is very rich in resources of Chinese medicine and has unique advantages in developing Chinese medicine industry. Guangxi has the most medicinal plant species in China. Guangxi Botanical Garden of Medicinal Plants which has been named the "Asia's first drug Park", has most varieties of medicinal plants and is the largest of professional Medicinal Botanical Garden in the Asia Pacific. In 2008, the Guangxi Botanical Garden of Medicinal Plants, which was confirmed as national engineering laboratory by the State Development and Reform Commission. In Guangxi, not only the kinds of medicinal plant species are rich, but also the scale of artificial cultivation of medicinal herbs is large. And now Guangxi Botanical Garden of Medicinal Plants has 28000 various planting of medicinal drugs farm, has formed 12 large-scale plant bases and is one of the four largest herbs bases in China. The area of planted medicinal herbs accounted for one-fifth of the total cultivated area in China. Last year, Guangxi had more than 150 Chinese medicine production enterprises, planted 50,000 hectares of Chinese medicine and had 320000 tons output of Chinese medicine annual. The Chinese medicine industry output reached 6.7 billion, accounting for 70% of the total output value of the pharmaceutical industry. Chinese medicine industry played a dominant role in the Guangxi pharmaceutical industry.

Therefore, it should be taken into consideration how to turn advantages of traditional Chinese medicine resources in Guangxi into industrial advantages, and how to promote the Guangxi medicine industry sustainable development with technology innovation. Innovation is the driving force to promote industrial development and also is one of important factor for industry to get a competitive advantage (Albayrakoglu, 1996). The role of innovation in high-tech pharmaceutical industry is more obviously. Based on the historical data of Guangxi pharmacy, the paper attempted to study on the technological innovation capability of Guangxi pharmacy by using the theory of analytical hierarchy process (AHP). And then the paper analyzed the influencing factors of the technology innovation in Guangxi pharmaceutical industry and tried to find the bottleneck of pharmaceutical industry development. It is significant for Guangxi medicine industry to be sustainable development.

2. Analyzing on Technological Innovation Capability

2.1 Technological innovation input ability

(1) Technological innovation fund input

In recent years, the total funding for science and technology activities in Guangxi pharmaceutical industry showed a higher growth trend. The fund of technology innovation increased from 6.17 million Yuan in 1995 to 137.9 million Yuan in 2007 (showed by table 1) and an average annual growth reached 177.92%. It showed that Guangxi pharmaceutical industry had entered the stage of rapid development. However, the fund of scientific and technological activities accounted for the proportion of sales revenue showed a downward trend in recent years. In 2007, a total of 137.9 million Yuan funding for science and technology activities was sales income's 1.71%, lower than the national average. This meant that innovative consciousness would not go hand in hand with innovation input.

(2) Technological innovation personnel

The total number of employed person in Guangxi pharmaceutical industry was increasing year by year and the number of S&T (science and technology) activities personnel showed the changing trend, showed by table1. In 2007, Guangxi pharmaceutical industry in S&T activities personnel account for the proportion of employees was 3.32%, lower than the national average which was 5.34%. But the scientists and engineers in scientific and technical personnel accounted for the proportion was 74.04%, higher than the national average which was 67.79%. This meant the scientific and technological talents of Guangxi pharmaceutical industry did not form a stable team. We need to create an environment and atmosphere to ensure the development of human resources.

<Insert Table 1 here>

2.2 Technological innovation output ability

(1) New products sales revenue

Fig.1.visually described sales revenue of Guangxi pharmaceutical industry. Sales revenue of Guangxi pharmaceutical industry was increasing year after year, from 8.079 billion Yuan in 1995 to 1.904 billion Yuan in 2007; but the new product sales revenue increased slowly in recent years. The ratio of new product sales revenue in the pharmaceutical industry's total sales income fluctuated from 5.15% in 1995 up to 15.36% in 2004, and then down to 9% in next two years. It reflected that the rapid development of the industry mainly depended on traditional products and that innovation output had not brought significant benefits.

<Insert Figure 1 here>

(2) Patent condition

Fig.2 described patent applications received of Guangxi pharmaceutical industry. The number of patent applications of Guangxi pharmaceutical industry presented ever-changing phenomenon. In 2005, the number of patent applications increased to 85 units and decline in subsequent years. The last five years, the average number of patent applications was 54.8 units. However, the quality of patents was improving; the number of invention patents was increasing year by year. Particularly, the proportion of owned inventive patent applications accounted for the total number of patent applications received had significant increased, from 25% in 2003 to 90% in 2007. It showed that Guangxi pharmaceutical industry has gradually strengthened the emphasis on the patent. And this meant that technological innovation has accumulated some capacity, but it should further enhance ability of patented product's commercialization.

<Insert Figure 2 here>

3. Building Evaluation Index System of Technology Innovation Capability

Based on the previous study, an evaluation index system of technology innovation capability was constructed. The index system integrated with the advantages of traditional Chinese medicine resources and the characteristics of technological innovation in the pharmaceutical industry. According to the information of inputs, outputs of technology innovation, marketing capability and technology innovation resource base, the index system of technological innovation capability of Guangxi pharmaceutical industry was investigated from four aspects. It included 4 targets at first level, 9 indexes at second level, and 28 indexes at third level. The evaluation index system included A11 Government Funds; A12 Loans from Financial Institutions; A13 Funds Raised by Enterprises; A21 Number of S&T Institutions; A22 Number of S&T Institutions; A23 Projects of New Products; A24 Intramural Expenditure for S&T Activities in the S&T Institutions; B11 Personnel for S&T Activities; B12 Scientists and Engineers in S&T Personnel; B13 Full-time Equivalent of R&D Personnel; B14 Labor Expenses in the Intramural Expenditure for S&T Activities; B21 Intramural Expenditure for R&D; B22 Expenditure on Purchase of Domestic Technology; B23 Expenditure for Developing New Products; B24 Expenditure on Technical Renovation; B25 Expenditure on Technology Import; B26 Expenditure on Technology Absorption; B31 Original Value of Micro-electronic Equipments; B32 Original Value of Fixed Assets; C11 Patent Applications Received; C12 Owning Inventive Patent; C21 Innovation Output Ability; C22 fund Input efficiency of New Products; C23 Personnel Input Efficiency of New Products; D11 Industrial Output Value of New Products; D12 Sales Revenue from New Products;D21 Original Value of Fixed Assets; D22 Export.

4. Survey Data, Evaluation Methodology and Analysis

4.1 Survey data

Based on the above-mentioned evaluation index system, we got the basic data of Guangxi pharmaceutical industry and the national pharmaceutical industry (the data came from China Statistics Yearbook on High Technology Industry (2008), in order to evaluation and determine it with the theory of analytical hierarchy process (AHP).

4.2 Analytical hierarchy process (AHP)

The AHP approach, initially developed to study complex, multi-attribute problems, is a multi-objective decision methodology combining both quantitative calculation and qualitative analysis (Saaty,1980). It has been widely used to justify the acquisition of strategic technologies, in the evaluation of strategic projects, to characterize the environmental quality of housing and so on (Sarkis & Sundarraj, 2002). It could effectively analyze the targets for system-level relationship between the non-sequential; it is systematic, simplicity and practicality (Zhangbao WANG & Lei LI, 2007).

(1) Index system

This evaluation system was set up according to metric demands of technological innovation capability of Guangxi pharmaceutical industry, including the one total target (technological innovation capability of Guangxi pharmaceutical industry), rule (4 indexes at first level), sub- rule (9 indexes at second level), and indexes (28 indexes at third level) .

(2) Judgment matrix

First, some scholars, experts and governors in Chinese pharmaceutical industry were invited to compare and determine relative importance of factors at same level. Second, judgment matrix was be built, $C = (C_{ij})n*n$,(C_{ij} means the factors i and factors j relative to the important value of target)

(3) Consistency check

Coherence check Conduct a consistency validation of the judgment matrix forms. $CR = CI/RI$, $CI = (\lambda_{max} - n)/(n-1)$ (n means the order of the matrix, RI is stand for the mean random consistency index). If $CR = CI/RI < 0.10$, it means that the comparison matrix has satisfactory consistency; otherwise, it need to adjust the comparison matrix in order to obtain a satisfactory consistency.

<Insert Table 2 here>

(4) Calculate

Calculate the relative importance of each factor and weight the overall ratings of every layer

(5) Obtain final results

Give a score to each factor based on the score index system and local situations to obtain final results.

4.3 Data processing

Firstly, this paper discussed the technology innovation capability by using basic data of Guangxi Pharmaceutical industry from China Statistics Yearbook on High Technology Industry (2008). Secondly, with the software yaahp5.0, it combined with quantitative calculation and qualitative analysis on the technological innovation capability of Guangxi pharmaceutical industry. Thirdly, according to above-mentioned method, author established layer weight matrix using the theory of AHP. The rule layer weight matrix was $U = (0.19, 0.33, 033, 0.15)$ .The Index layer weight matrix was $A = (0.35, 0.65)$, $B = (0.45, 0.30, 0.25)$, $C = (0.40, 060)$, $D = (0.77, 0.23)$ $A_1 = (0.34, 0.20, 0.47)$, $A_2 = (0.20, 0.18, 0.34, 0.28)$, $B_1 = (0.20, 0.26, 0.26, 0.18)$, $B_2 = (0.21, 0.11, 0.25, 0.12, 0.14, 0.17)$, $B_3 = (0.40, 0.60)$, $C_1 = (0.40, 0.60)$, $C_2 = (0.40, 0.31, 0.29)$, $D_1 = (0.69, 0.31)$, $D_2 = (0.65, 0.35)$.

Based on the above weight matrix and the basis data of Guangxi pharmaceutical industry, we marked each evaluation index and then calculated the value of comprehensive evaluation of Guangxi pharmaceutical industry: w=89.4.The Scores was based on the evaluation standard that technological innovation capability of national pharmaceutical industry was 100 points. It was observed that the technological innovation capability evaluation of Guangxi pharmaceutical industry has already had a foundation. However, there were still some problems when we analyzed every index value. That basically reflects the following respects:

(1) Innovation resources foundation

All indicators were underdeveloped except the indicator of funds Raised by Enterprises and Intramural Expenditure for S&T Activities slightly higher than the national average. It meant that the development fund of Guangxi pharmaceutical industry was low and development funds from the government was limited. The Science and Technology fund was far less than other developed provinces in China. Innovation organizational competence needs to be improved.

(2) Technological innovation input ability

Guangxi pharmaceutical industry attaches great importance to the cultivation of high-level talents. The number of

Personnel for S&T Activities was higher than the national average; the number of personnel for S&T was weaker compare to the national level 62.3%, which still need to adjust the personnel structure. It also needs to invest more on technological digestion, absorption and transformation. Overall, Guangxi pharmaceutical industry is still in the developing phase and independent innovation is still in its infancy. The production technical level was low, the technical structure remained irrational, and the technological innovation capacity and the reserve strength for technological progress were weak.

(3) Technological innovation output ability

Guangxi pharmaceutical industry gradually strengthened emphasizing on intangible assets, especially the number of applications for invention patents, but it was still below the national average. Sales revenue from new products accounted for the low proportion of revenue and innovation output capacity was still weak.

In a word, Guangxi pharmaceutical industry had a certain degree of development and the certain foundation, especially has already reached the national average level in the personnel, funding, equipment, etc. But, compared to the advanced provinces, it was still in the developing phase. The pharmaceutical industry need to be further improved the ability to commercialize innovations.

5. Conclusion

This paper built an evaluation system of technological innovation capability based on the theory of analytical hierarchy process (AHP). After that, author analyzed the technological innovation capability of Guangxi pharmaceutical industry, according to the information of inputs and outputs of technology innovation. The results showed that Guangxi pharmaceutical industry has made quick development in recent years but would pay more attention on improving ability to commercialize innovations.

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Table1. 1995-2007 science and technology activities of Guangxi pharmaceutical industry

year	1995	2000	2003	2004	2005	2006	2007
Expenditure for S&T Activities (10000Yuan)	617	4005	10462	10584	13119	12498	13790
Annual Average Number of Employed Personnel (person)	28183	23885	30943	29251	33260	31739	31284
Personnel for S&T Activities (person)	286	633	866	975	1306	989	1040
Scientists and Engineers in S&T Personnel (person)	177	451	689	656	946	902	770

Table 2. 1-9 the mean random consistency index

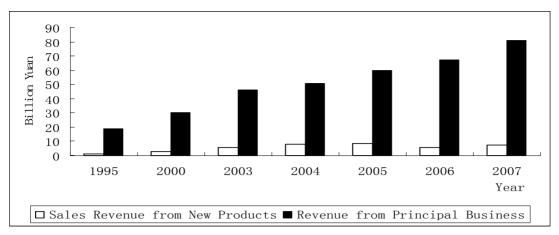| 1	2	3	4	5	6	7	8	9
0.00	0.00	0.58	0.90	1.42	1.24	1.32	1.41	1.45

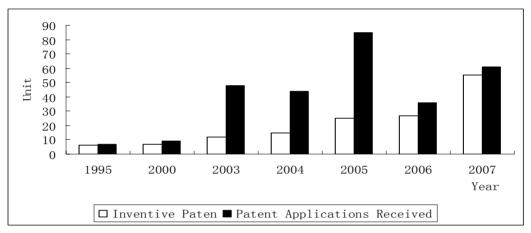Fig 1. Sales revenue of Guangxi pharmaceutical industry

Fig 2. Patent applications received of Guangxi pharmaceutical industry