

## Evaluation and Analysis about Information Industry Innovation Capability in Hubei Province of China

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**Abstract** Based on the definition of component of information industry innovation, this paper constructs an index system for evaluating information industry innovation capability, via employing fuzzy level comprehensive evaluation approach with correlated index of the years 2003, 2005 and 2008. The paper analyzes the capability and status quo of independent innovation, technology innovation capability of Hubei Province in China. The paper also discusses the technological innovation input, technological innovation output, industry chain innovation, industry cluster innovation and policy innovation of information industry in Hubei province. Finally, the paper proposes policy suggestions for promoting information industry innovation based on the evaluation outcome.

**Key words** Information industry; Innovation; Fuzzy level; Evaluation

### 1 Introduction

It is a hot new research on industry innovation. Different scholars from different angles have given various interpretations on the connotation of industry innovation. It is generally believed that the concept of industry innovation was first proposed by the British economist, (Freeman 1997). He believed that industry innovation includes skills and technology innovation, product innovation, process innovation and management innovation (including organization innovation) and market innovation. Industry innovation includes sub-macro and micro such two levels, the macro level refers to the ability of a country's industrial structure transformation, micro level is that enterprise breaks industry constraints which has been structured, using technology innovation, product innovation, market innovation or a combination innovation to change the existing structure or create a new "industrial" process, that Hamel and Prahalad's "business transformation capabilities and the ability to transform existing industries."

More international influential treatise of industry innovation on the current ought to "The Handbook of Industrial Innovation" write by Professor Mark • Dodgson from National Australian University and Professor Roy • Rothwell from the United Kingdom University of Sussex, this book is known as a masterpiece of European scholars on innovation management.

Research on the information industrial innovation is rare. One can view the information industry innovation is the process designed to enhance industrial competitiveness, with the formation and development of information industry-related factors of production to re-mix and draw into production systems. Including the following items:

#### (1) Technology innovation

Technology innovation is the core of information industry innovation, including: research and development innovation of information technology, cross-fusion-type innovation of information technology, coordination of information technology and application innovation of information technology, they can be reflected through such indicators, like technology self-innovation innovation, technology innovation input, technology innovation output and derivation and so on.

#### (2) Industry chain innovation

According to the general theory of division of the information industry, information industry chain is the one covering the information technology research, information product development, information product production and information services supplement and other sectors, including the main body of information application, information technology providers, information service providers, information content providers, telecom operators, information equipment manufacturers, and other components. Orderly combine the information technology industry, the information content industry and information service industries and logistics industry into a industry economical chain. The information industry chain innovation is the process of continuous differentiating new industries, and extending the industrial chain constantly.

#### (3) The industry cluster innovation

Through the geographic concentration or nearness, resulting in innovation aggregation, gain advantages of innovation to form a new innovative type of organization. With this particular

organizational structure, companies will make long-term, stable and innovation collaborative relationship between each other. A notable feature of electronic information industry is that it has a long industrial chain, while the longer chain provides the basis for high-tech industrial division of labor among enterprises, and also creates a lot of space for the entry of new companies. Therefore, information industry cluster innovation based on the local decomposition and off-site decomposition of industry chain forms more easily than other industries.

(4) The industry policy innovation

According to economic conditions change and industrial development reality, the governments make decision on the information industry independently, timely and correctly, or develop new policies or adjust existing policies to ensure the industry health, stable and sustainable develop.

## 2 Construction Index Systems for Evaluating Information Industry Innovation Ability

### 2.1 Index system

According to the main contents of the information industry innovation, build the index system for information industry innovation ability supported by the function of technology self-innovation ability, technological innovation input ability, technology innovation output and derivation ability, industry chain innovation ability, industry cluster innovation ability, policy innovation ability, to characterize the level of the information industry innovation, the ability and dynamic trend.

**Table 1 Index System for Evaluating Information Industry Innovation Ability**

Objective Level A	Criteria Level B	The Index Level C <sub>it</sub>	Index Explanation	
Information industry innovation ability	Technology self-innovation ability	Original innovation ability	Integrated circuit (CPU) manufacturing output / industry industrial output value	
			Software and system integration manufacturing output/industry industrial output value	
			Computer manufacturing output / industry industrial output value	
			Communications equipment manufacturing output / industry industrial output value	
			Radio and television equipment manufacturing output / industry industrial output value	
			Integration innovation ability	
		Secondary innovation ability	To combine existing intellectual property technology and resources, carry on innovation ability based on the technology integration	
		Technology innovation input ability	Talent input ability	The form of purchasing of the core technology of the first innovators, re-innovation on the base of fully grasping the technology
				The proportion of R & D personnel in the total employees
				The number of college and above / the total number of employees
				The annual R & D spending / the total industrial output value
		Technology innovation output and derivation ability	Finance input ability	The completed investment in the project of annual technical measures
				Domestic and international science and technology papers
				Total industrial profit
Innovative product output				
Export delivery value / total industrial output value				
The new products output value / total industrial output value				
	Innovation derivation ability	The annual amount of foreign capital in place		

**Continued Table 1**

Industry chain innovation ability	Integrated circuit chain innovation ability	Microprocessor, microcontroller, logic circuit, analog circuitry, dig fax hybrid circuit deliverability
	Software chain innovation ability	System software, support software, application software, software service support ability
	Computer value chain innovation ability	PC, notebook, server, peripheral, PDANC support ability
	Communication value chain innovation ability	Mobile phone, fixed-line telephone, switchboard, base station, router, gateway, optical fiber cable support ability
	Audio-visual value chain innovation ability	Broadcast equipment, TV set, home video camera, videodisc, stereo support ability
	Component value chain innovation ability	Chip component, physics and chemistry electron device, optoelectronic device, discrete device, sensor, display parts support ability
	Radar value chain innovation ability	Radar, specialized equipment, military electronic equipment support ability
Industry cluster innovation ability	Region cluster innovation ability	The number of science and technology park
	Enterprise cluster innovation ability	The top 100 information industry sales / sales of all enterprises The number of associated industry enterprises (manufacturing, software industry)
Policy innovation ability	Industry management innovation	Government's the macro-regulation to electronic information industry, as well as the completeness of national policy
	Finance policy innovation	Government's finance policies ability to support information industry technological research and development
	talent policy innovation	Government's ability to train and introduce information industry-related personnel
	Technology policy innovation	Government's ability to support basic technology, core technology and industry cutting-edge technology
	Procurement policy innovation	Government's ability to purchase domestic information industry technology, and product

### 2.2 The index weight

To build the matrix of indicators at all levels, single sequencing and its consistency test and the total sequencing and its consistency test of hierarchical analysis can use a greater degree of mathematical methods to a large extent to reduce uncertainty of the possible results of the evaluation. On the other hand, when determine the membership of the qualitative indicators, the results of the evaluation determined by experts may lead to uncertainty, in order to reduce the degree of uncertainty, this article uses an improved type of the Delphi method - weight statistical method for processing. Weight statistical method is to assign different weights value to those evaluation experts come from many fields, with varying degrees of familiarity with the object (assignment for the various experts is between 0 and 1, the total weight of all experts is 1), to highlight authority of specialist and reduce the level of uncertainty of statistical results because of equally of weight.

### 2.3 Fuzzy and comprehensive evaluation of target level

Based on the formulation of the evaluation index standard, the information industry innovation ability is divided into four grades, namely, the collection of V = (strong; a little strong; not strong; weak).

## 3 Evaluation of Implementation

According to the above-mentioned index system, the program of index weight distribution, the

evaluation of target level and the adopted method of calculation, we can evaluate the information industry innovation ability in Hubei Province (of China) fuzzy and comprehensively. We mainly evaluate that level of three years, which are 2003, 2005, 2008. And we mainly analyze the ability of various aspects of the information industry of Hubei Province (of China) in 2008. Quantitative data is primarily from the comprehensive annual information industry reports of 2003, 2005, 2008 in Hubei Province (of China), at the mean time, an expert questionnaire to gather expert opinion is being designed according to the design matrix built by the qualitative indicators for the annual property judgments and judgments at all levels.

### **3.1 Evaluation of technology self-innovation ability**

From 2003 to 2008, Hubei (of China) information industry technology self-innovation ability was at the "not strong" level, but in the world of segments also demonstrated some changes. First, the original innovation ability, the evaluation results as "weak" accounted for 40.3% in 2003, 27% in 2005, and 24.6% in 2008, from changes of the last five years, the ability of original innovation had a trend from the "weak" to "strong". The integration innovation and secondary innovation ability remained unchanged, the reason is that production and research cooperation platform is not sound, the intensity of opening up need to be raised, illustrate the integration of the IP technology and the existing resources, as well as the acquisition of core technology and re-application is still needed to be improved.

### **3.2 Evaluation of technology innovation input ability**

From 2003 to 2008, Hubei (of China) information industry technology innovation input ability has been in a "weak" level. The proportion of R&D personnel in the total employees, the number of college and above in the total number of employees, including the annual R&D spending in the total industrial output value were in a relatively "weak" level, only the completed investment in the project of annual technical measures moved from "weak" to "strong" in 2008. The reason is that: first, the policies of attracting qualified personnel in business and government level are not perfect, especially the overall wage level in Hubei Province (of China) lagged far behind the developed coastal cities, lack attraction to top talent; second, the attention of R&D is inadequate, in particular, economic foundation of other cities except Wuhan (of China) is relatively weak, lack adequate financial supporting the development of information industry.

### **3.3 Evaluation of technology innovation output and derivation ability**

From 2003 to 2008, Hubei (of China) information industry technology innovation output and derivation ability has been at a "weak" level. Especially the indicator of innovation derivation ability, because the number of foreign-funded enterprises in the Hubei Province is only 79 (figure in 2008, accounting for 12% of the province's total number of enterprises), the annual amount of foreign capital in place is very low (compared with the total output value of information industry), this is the main factor restricting technology innovation output capability to enhance. In addition, the number of the domestic and international science and technology papers, the ratio of export delivery value in the total industrial, and the ratio of the new products output value in the total industrial output value have been at a "weak" level. The reasons are: First, the cooperation and exchange between enterprises and universities and research institutes is scarce, and the mechanism and system to promote transformation of scientific and technological achievements is not yet perfect; second, electronic information product in Hubei Province (of China) is targeted at the home market, the expansion of foreign markets relies mainly on Wuhan Post and Telecommunications Institute of Science (of China) and a few other leading enterprises; the third is new product development ability and market development ability is not strong. Optoelectronics and other scientific and technological strength are not well translated into new products, and a variety of scientific and technological strength is not given full play.

### **3.4 Evaluation of industry chain innovation ability**

After expert scoring and face to face interviews, combined with the existing government work reports and statistics, we found that from 2003 to 2008, integrated circuits, software, communications and audio-visual industry chain had obvious change in information industry chain innovation ability in Hubei Province (of China), embodied by the "weak" to "strong" trend, while the computer, components industry chain innovation ability did not change significantly, being at a "weak" level. The reasons include: first, the "Eleventh Five-Year" in Hubei Province (of China) had strengthened support effort in integrated circuits, displays, polysilicon, two-dimensional bar code, broadband wireless communications, security engineering, LCOS light engines and IC design and software industry and so on, made these industries achieve breakthrough development; second, from a national perspective, the main layouts of complete machine production in Beijing (of China), Tianjin (of China) and Hubei (of China), the Pearl

River Delta (of China), Yangtze River Delta (of China) and central regions, including Hubei (of China), had no economies of scale, except only in certain areas parts production developed. The electronic components such as basic industries in Hubei Province (of China), also mainly concentrated in small and medium enterprises. There were no large-scale enterprises, which also restricted the integral development of electronic information industry in Hubei province (of China).

### **3.5 Evaluation of industry cluster innovation ability**

Region cluster innovation and enterprise cluster are two indicators reflecting the industry cluster innovation ability, but both are at a relatively “weak” level, because:

First, the industrial layout of Wuhan (of China) dominates. In addition to the national optoelectronic industry base in Wuhan Optical Valley (of China), laser industries cluster in Wuhan Donghu development zone (of China); the electronics industries cluster in Caidian District in Wuhan City (of China); electronic materials industries cluster in Yichang City (of China); electronic information industries cluster in Xiaogan City (of China); other electronic information parks are on the small side.

Second, the key enterprises account for a high proportion of the province's electronic information industry, while business group is underdeveloped. More than 20 key enterprises account for half of the electronic information industry. In the first half of 2007, the total industrial output value of 20 key enterprises was 17.22 billion Yuan, accounting for 47.9% of the industry's total economic output. From January to June in 2007, the total industrial output of 30 independent innovation SMEs increased by more than 35%. The first quarter of 2008, total industrial output value of 20 key enterprises was 7.34 billion Yuan, accounting for 32.3% of the industry's total economic output.

### **3.6 Evaluation of policy innovation ability**

Industrial policy innovation ability changes most obviously in all indicators, especially industry management policy, finance policy, technology policy all have realized the transformation from “weak” to “strong”, while personnel policy and procurement policy is still at a “weak” level, but also achieved a breakthrough, indicating the policy environment in recent years for the information industry development in Hubei Province (of China) is improved, which is closely related with the move that identify information industry in Hubei Province in 2006 as an important strategic and supported industry.

### **3.7 Evaluation of the overall ability of industry innovation**

First, membership index suggested that there was no strong index in the three years. In 31 membership of index in 2003, 12 were weak, 16 were not strong and 3 were strong; in 2005, the number of the weak dropped to 8, the not strong grew to 21, but the relatively strong declined 1 index; in 2008, the number of the weak continued to decline until to 6, not strong indicators increased by three compared with that in 2003, and decreased by two compared to that in 2005, but the a little strong index reached to six. From the overall change trend of membership level of annual index, Hubei (of China) information industry innovation ability gradually increased, but the pace of improvement was slow, and the overall level was low.

Second, the three fuzzy comprehensive evaluation results showed that from 2003 to 2005, the weak index decreased directly from 71.93% to 62.50%; the proportion of not strong index rose by about 10.3%; from 2005 to 2008, a major breakthrough was achieved, for the weak index had fallen to 48.41%, and the proportion of not strong index had risen to 41.43%. It showed that Hubei (of China) information industry innovation ability has a trend of gradual improvement over time. But on the whole, the level of innovation ability is still at the weak level.

## **4 Conclusions**

Through using fuzzy analytic hierarchy process to comprehensively evaluate the level of information industry innovation ability in Hubei (of China), the following conclusions are drawn:

First, there are membership degrees, such as primary, secondary and tertiary three fuzzy comprehensive evaluation levels. No matter from the number or proportion of the three evaluation levels, it can be seen in the study period that the ability of Hubei (of China) information industry innovation has been increasing gradually, but the growth rate is small.

Second, in terms of the criteria level, the technology self-innovation innovation ability, policy innovation ability and technology innovation output ability are major factors that affect the ability of information industry innovation at this stage in Hubei Province (of China); in terms of the target layer, the original innovation ability, talent input ability, industry management innovation ability are the main

factors that affect the ability of information industry innovation at this stage in Hubei Province (of China). Therefore, in order to achieve the overall innovation ability in Hubei (of China) information industry, it is necessary to regard above factors as a breakthrough, and to enhance the information industry innovation ability through a series of policies and regulations to promote and.

Third, although the Hubei (of China) information industry innovation ability has improved year by year, this increase is not balanced, for some factors rose faster, while other factors slower, the overall information industry innovation ability is still not strong. For example, policy innovation ability has elevated quickly, which has played an important role in the process of promoting the information industry innovation ability in Hubei Province (of China) in recent years, but technology self-innovation ability, technology innovation input ability such main factors, has upgrading much slower, and the original innovation ability, talent input ability on the target layer also showed corresponding phenomena.

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