

# Construction of Industrial Technology Innovation Capability Evaluation Index System

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## Abstract

In order to provide theoretical support and observed basis for the implementation of industrial sustainable development, industrial technology upgrade, industrial structure optimization and other strategy initiatives, beginning with the research of enterprise technology innovation ability, access to lots of documents and the government work reports, summing up the current domestic and foreign study situation of industrial technology innovation capability evaluation index system, summarizing qualitative and quantitative evaluation index system at different levels, it is more intuitive, efficient and scientific for this system framework to assess industrial technology innovation capability.

**Keywords:** Technology innovation, Industrial technology innovation capability, Evaluation index system

With the advent of knowledge economy, at the big background of the development of economic globalization and industrial optimization, innovation research and industrial economic research will be combined, because the industrial technology innovation capability can reflect enterprise technology innovation ability comprehensively, and also constitute the vital resource of national competition. Therefore, establishing effective index system which examine industrial technology innovation capability and giving it a brief evaluation and analysis research will become one important aspect of technology innovation research, which provides micro perspective and basis for national innovation systematic construction and gives decision-makers some clues to fix industrial policy and management widely.

## 1. Introduction

### 1.1 Definition of Technology Innovation and Connotation of Industrial Technology innovation Capability

#### 1.1.1 Definition of Technology Innovation

The research for technology innovation problem was first proposed by American Austrian economist J.A.Schumpeter in 1912 in his book “the theory of economic development”.

In 1951, S.C.Solomon first put forward two conditions needed to build the technology innovation in his book “the innovation in the process of capitalization: evaluate the theory of J.A.Schumpeter” which are “the new thought source and the realized development of later stage”.

In 1962, J.L.Enos in the publication of “invention and innovation in oil-processing industry” for the first time directly and clearly defined technology innovation: “the result of several behavioral synthesis, including invention choices, capital investment guarantee, build the organization, make a plan, hire workers and open market.”

Until the middle 1980s, R.Mueser put forward that technology innovation is a meaningful and discontinuous event with the characteristics of unique ideas and successful realization after systematically studying main points of 300 relevant papers.

On August 1999, the CPC central committee and the state council defined the technology innovation that enterprises should use new knowledge, new technology, new process, and also use new productive fashions and management mode to increase quality of products, develop new products and improve new service, in the end enterprises can occupy the market and realize the market value.

All definitions above can reflect the essence and characteristics of technology innovation on one aspect, but still not form a strict definition of technology innovation uniformly.

### 1.1.2 Content of Industrial Technology Innovation Capability

The different understandings on factors included in technology innovation capability result in different opinions on technology innovation capacity, however giving research to technology innovation capability on industry level is not very often. Industrial technology innovation is the market-oriented, aiming to enhance industrial competitiveness and, from the beginning new products or new technology is produced, through acquisition of technology (research, development, introduction of technology, digestion and absorption), sum of a series of activities in the whole process from engineering to industry. Industrial technology innovation capability that uses advanced science and technology to produce new products and new technology forms the ability of economic benefits and also the capability of promoting industrial development.

### *1.2 The current research status of industrial technological innovation capability evaluation index at home and abroad*

Scholars at home and abroad have made a large number of researches on technology innovation capability evaluation index, while still not have formed a evaluation index system which is comprehensive and accepted by all scholars because of many influenced factors and complex structures.

American scholar Steele evaluated the R&D activities in the form of checklist, while Ransley and Rogers summarized the enterprise best R&D, and proposed thinking technologic strategy, selection and management of project, core competence, effectiveness, external awareness, technology transfer and staff. Scheerer considered that technology innovation ultimately contains very broad, and the patterns of innovation activities are different extremely, different evaluation indexes are used in the light of different types of technology innovation, it is unlikely to attempt to find a common evaluation indicators or system. Germany scholars who conduct survey of industrial technology innovation capability use a data to describe it. The data means industrial technology innovation cost (research and development costs, product testing costs, product design fees, purchase of royalties, market research fees and fees for product innovation while engaged in training) accounts for corporate sales. Canadian Professor Dehresson used eight indicators to compare with industrial technology innovation capability, which are: Innovation capital investment/ the number of employees, innovation capital investment/ sales revenue, non-specific innovative capital investment/the number of employees, dedicated to innovative capital investment / number of employees, dedicated to innovative capital investment / sales numbers, export sales revenue / sales revenue, business Innovation orientation.

Domestic research of industrial technological innovation capability is basically following two channels. One way is integrating and summarizing the characteristics of industrial technological innovation capability, and giving countermeasure suggestion to problems; the other is establishing evaluation index system of industrial technological innovation capability and attempt to analyze industrial technological innovation capability. In the beginning of 20<sup>th</sup> century and the early 90s, National Bureau established comprehensive index system of technology development capability mainly on the basis of technology development investment funding, research staff, scientific research, technology transfer, new product sales, new products based on exports. WEI Jiang, Guobin and XU Qingrui established technology innovation indicators which are: R&D ability, marketing ability, production capacity, financial capacity. Han Jingyuan and others divided evaluation index of enterprise technological innovation ability into three parts which are: the production of knowledge, direct effects, combined effect, a total of eight indicators. Chang yu and Liu Xian dong divided evaluation index of enterprise technology innovation ability into five kinds which are: innovation input capacity, innovation management capacity, innovation development capacity, product manufacturing capacity, marketing capacity and so on, topping to 13 sub-indicators.

In summary, many factors impact technology innovation ability are vague and uncertain, so domestic and foreign scholars who come from different perspectives have got different results, but these index systems provided a theoretical framework with the evaluation of technology innovation ability.

## **2. The Construction of Evaluation Index on Industrial Technology Innovation Capability**

### *2.1 Principles of building index system*

There are many evaluation indexes of industrial technology innovation capability. Each indicator has interactions between the others, which form a multi-level dynamic system. In order to give the industrial technology innovation capability a comprehensive, objective, scientific evaluation, several principles should be followed below:

#### *2.1.1 The scientific principle*

Whether the result of the assessment is scientific or not largely depends on whether its indicators, standards,

procedures and so on are scientific. Therefore, when designing evaluation index system, the factors of industrial technology innovation and rationality of the whole index structure should be taken into thought, the indexes that reflect industrial technological condition should be designed from different aspects.

#### 2.1.2 The principle of comprehensiveness

The evaluation index of industrial technology innovation capability should reveal the full picture of it as comprehensively and systematically as possible. The evaluation indexes that reflect the basic features of all industrial levels should be selected as many as possible in the initial establishment of index system in order to determine the final room selection.

#### 2.1.3 The oriented principle

Some significant comprehensive and professional indicators should be selected as many as possible on basis of comprehension. According to the current central task and main work, relative indexes should be determined and highlighted to guide this area to gain efficiency successfully.

#### 2.1.4 The practical principle

Designing index system should be subject to the actual level of industrial technology innovation, quantitative indicators are widely used as more as possible, qualitative indicators also need to be quantified indirectly, which give great convenience to practice.

#### 2.1.5 The principle of dynamic continuity

Industrial technology innovation is a dynamic development and continuous improvement process. Therefore, its determination depends on not only the performance of past and current technology innovation behavior, but also industrial potential, future technology innovation capability. The static indicators are used to reflect the current situation level of industrial technological innovation and the dynamic indicators are used to predict the future development prospects of industrial technology innovation capability.

### 2.2 *The contents of construction*

Technological Innovation is different from the material product and the scientific research, so assessing the technological innovation ability should

Combine macro and micro evaluation, individual and the comprehensive index, static and dynamic evaluation and many other issues. Therefore, summarize above views, Evaluation index system of industrial technology innovation capability is built as followed, as shown in the table 1 below:

#### 2.2.1 Innovation resources input capability

Enterprises input all tangible and intangible materials for technological innovation, the size of investment revealed more or less quantity and high or low quality. Resources are generally classified as R&D investment and non-R&D investment and mainly measured in the aspects of staff input, capital investment, introduction of technology and market research and so on.

#### 2.2.2 Output capacity of innovative products

Innovation output is the direct embodiment of industrial technology innovation capability and an important decision factor of international competitiveness. As the input element is a necessary condition to improve industrial technology innovation capability, but may not lead to innovation results, innovation output elements can directly reflect the level of technological innovation ability, mainly from new product sales as well as both the number of patents and papers to measure.

#### Insert table 1 here

#### 2.2.3 Manufacturing capacity

Manufacturing is an ability that transfers the results of research and development in the laboratory into mass-produced products that meet the design requirements. Manufacturing capabilities include three basic aspects: first, advanced equipment of the most of industrial enterprises; second, the technical level of workers, flexibility and quality; third, process design and management capabilities. Only combined the advanced technical equipment with high-quality technical staff, the advanced nature of innovation technology will work sufficiently.

#### 2.2.4 Innovation diffusion capability

Innovation diffusion is an “imitation” or “learning” behavior of technical innovation. It includes two forms: the spread between enterprises, the internal proliferation and overall proliferation. Innovation diffusion here mainly spread between corporations, the purpose that technical innovation is realized in the whole industry is achieved

through this process.

#### 2.2.5 Market structure element

Any form of technological innovation can not be divorced from the impact of market structure. Elements of market structure in many ways play a vital role to promote technological innovation and are one of the determinate factors of the size of technological innovation. The relationship between Technological innovation and market structure includes three major aspects: firstly, the level of competition; secondly, firm size; thirdly, the degree of monopoly. In short, the influence that whether corporate size or degree of monopoly impact the technological innovation all can be attributed to influence that the level of competitiveness impact the technological innovation. Therefore, the level of competitiveness can be used to show the influence that elements of market structure impact the technological innovation.

#### 2.2.6 Innovation environmental support capacity

The surrounding environment largely impacts industrial technology innovation capability, a industrial economy support capacity can affect not only the all participants' behaviors of innovation activities but also promote or restrain brilliantly innovation awareness and the formation and development of culture. Therefore, a positive correlation exists between support elements of industrial technological innovation environment and technological innovation ability

From above analysis, we can see that innovation resources input capability, innovation products output capacity and manufacturing capacity are factors that affect industrial technology innovation capability through analyzing the research results of enterprise technology innovation ability by predecessors from the point of enterprise technological innovation. While the industrial technology innovation is not limited to a single enterprise or a few companies, but the entire industry, all firms or at least most of the business together that achieve technological innovation. Therefore, later three key factors are proposed continuously on the basis of analysis.

### 3. Conclusion

Industrial technology innovation capability determines the speed and direction of industrial development, and evaluation index of industrial technology innovation capability is the scientific evaluation of its real property, so a reasonable scientific evaluation index of the industrial technology innovation capability is very important. This thesis, starting from the process of technological innovation, on the basis of summarizing enterprise technology innovation ability, give full consideration on the characteristics of industrial technology innovation capability, and increase the influencing factors from industry level, so that the entire evaluation index system has become more scientific and comprehensive. Therefore, from the perspective of technological innovation, building index system to evaluate industrial technology innovation capability has great significance in determining the direction of China's industrial development, formulating industrial development policies and accelerating the industrial advancement.

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Table 1. Evaluation index system of industrial technology innovation capability

Target layer	Level indicators	Two indicators
Evaluation Of Industrial Technology Innovation ability	Innovation resources Input capacity	1.R&D input intensity(R&D expenses/sales)
		2.Non-R&D input intensity(technology transfer fee + technical modification/sales)
		3.total employees in technical/staff
		4.the number of patents approved
		5.a share of scientific research institutions of enterprises
	Innovation products output capacity	6.new product sales revenue/total sales revenue
		7.total inventive patents/applications
		8.innovation award index
		9.number of papers published
	Manufacturing ability	10.the level of industrial technical equipment
		11.transformation rate of investment
		12.the level of industrial technology
	Innovation diffusion ability	13.technology introduction and absorption rate(absorption cost/technology transfer cost)
		14.scientific research completion rate(number of completed projects/total number of research projects)
	Market structure factors	15.market share
		16.rate of export products
		17.market advantage index
	Innovation environment support capacity	18.government science and technology activities expenditure
		19.growth rate of domestic investment in fixed assets
		20.R&D expenditure/GDP
		21.overall labor productivity
		22.industrial value added