Compare Study of Corporate Innovation Capacity and its Evaluation Indices

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***Abstract*—This article is aimed to systemically summarize worldwide scholars' research achievements of the core issues such as connotation of corporate technical innovation, technical innovation capability, evaluation index system, evaluation methods, etc., and put forward the methods and paths for further studies on corporate technical innovation; meanwhile, as to the concept of corporate innovation, connotation of technical innovation, relevant elements of technical innovation capability as well as the evaluation indexes and methods of innovative achievements, the article has made in-depth discussions and comparative studies based on varied perspectives; besides, according to this article, firstly, it is necessary to build differentiated evaluation index systems and evaluation methods, as to the evaluation of corporate technical innovation ways, by integrating various influential factors like corporate economic environment, manufacturing environment, policy environment and corporate type; secondly, it is necessary to systemically conduct comparative studies on the technical innovations of Chinese-Foreign enterprises in order to find out common points, innovative rules and implement approaches to provide Chinese-Foreign enterprises with valuable experiences for their technical innovation; the unique feature of this article is reflected in that it integrates worldwide scholars' different study perspectives, systematically analyzes the core factors of corporate technical innovation, summarizes the rule of similarities, and provides enterprises with new perspectives and thinking modes for technical innovation.**

Keywords-corporate innovation; innocation capacity ; evaluating indicator

I. OVERVIEW OF THE CORPORATE INNOVATION CONCEPT AND ITS MEANING

Up to the present time, there has been no a uniform definition of corporate innovation in the academia. J.A. Schumpeter is one of the economists who studies corporate innovation. He believes that Schumpeter's innovation concept covers five areas: the introduction of a new good→ the introduction of a new method of production→a new market source of supply→ establishment and monopoly of the new supply(raw materials and semi-finished goods→establishment of new industrial organisations and commercial pattern. The innocation concept defined by Schumpeter is fairly extensive, covering the production, technical and managerial processes and incorporating extensive contents such as technical innovation, product innovation, process innovation, market innovation and organizational system innovation[1].

Following Schrumpeter, many scholars define innovation from their own research perspectives. Van de Ven(1986)defines innovation as the development and implementation of a new concept by traders under the

norm of a system. The definition emphases four elements: new concept, trader, transaction and system environement [2].Roberts(1988)maintains that corporate innovation includes two parts: (1) the emerging of human thought or invention; (2)commercial transformation of the invention or other usages. Therefore, innovation includes various stages from the inception of invention to commercialization. So corporate innovation management should incorporate the effective application of the labor resources and capital to the following: (1) the creation of knowledge; (2) technical progress aiming to improve the product, production process and service; (3) work formation upon the improvement; (4) production, circulation and utilization[2].

Ettlie，Bridges and O' Keefe (1984)define innovation as breakthrough innovation and progressive innovation. Breakthrough innovation is radical change, which represents the technically revolutionary change whereas the progressive innovation is mere adjustment to and local modification of the existing technology[3]. Cardinal(2001)defines the breakthrough and progressive innovations from the perspective of knowledge. He maintains that breakthrough innovation is tremendous technical progress based on the discovery of knowledge, which needs to bear huge technical risks and consume a great amount of time and cost. On the other hand, progressive innovation is based on the framework of the existing knowledge, a sligh improvement of the existing technology[4].

In the concept of Innovation, what is highlighted are the pure technical invention or creation, but it is not corporate innovation. It may be that corporate innovation is based on a certain technical invention and creation, but corporate innovation is not necessarily so. Schrumpeter believes that so long as an invention is not utilized in reality, it does not play an economic role. Any improvement of it to make it more effective is a task different from its invention and this task requires different capacity (J. A. Schumpeter，1934).

Two points can be seen from the different definitons of corporate innovation mentioned above. The first is that

different definitions and explanations are given by different scholars from different perspectives; the commercialization of innovation is emphasized. The second point is that although different scholars classify the innovation from different perspectives, they all regard innovation as several different processes. It is considered a combination of scientific concepts, technical application and commercialization. The connotation of corporate innovation lies in three aspects of technical innovation, system innovation and management innovation, of which the technical innovation is most dealth with.

II. Overview of the Corporate Technical Innovation

Technical innovation is one of the critical areas in the research on corporate innovation. There is a gradual evolution of the understanding of the technical innovation in the academia. There are dozens of different concepts emerging. In the early stage, the academia put forward various definitions of technical innovation based their own understanding of the concept given by Schumpeter and gradual extenions are made. Enos defines technical innovation from the perspective of behavior integration, maintaining that technical innovation is the result of synthesis of several acts, such as capital input guarantee, establishment of organization, making plans, labor recruitment and market exploration[5]. Mansfield maintains that technical innovation is the various steps of progressively introducing a new product or new process, including the technology, the design, the production, the finance, the management and the market[6].

In PRC, a comparatively sound system of technical innovation theory has been formed in the research on technical innovation. According to Xu Qingrui, technical innovation refers to all the activities ranging from the inception of a new idea to the successful commercialization of the idea. It includes a series of the scientific, technical and management activies ranging the entire process from the scientific discovery, invention, their introduction into the market, the commercialization and the extention of the application[7]. According to Guan Shixu, technical innovation does not refer to the innovation of the technology proper, but rather the restructuring of the production elements resulting from the introduction of the technical achievement or the transfer of the production function[8]. Professor Fu Jiaji defines technical innovation as “series of the comprehensive processes in the aspects of science, organization, commercialization and financing in which the enterpreneur grasps the potential market opportunity of making profit to obtain the target of commercial gains by restructuring the production conditions and elements, establishing effective and powerful, highly efficient and cost-effective production and management systems so as to launch new products, new processes, to explore new markets, to obtain new raw materials or semi-finished products supplies or establishing new organizations[9]. Jia Weiwen et al.maintain that technical innovation is the sum of a series of activities from the inception of a new product or process including the research, development, engineering, commercialized production as well as the market application[10].

Dr. Liu Xielin deal into the various aspects of technical innovation economics in a systematic fashion in hie treatise Technical Innovation Economics in 1992. He does not only reveal the technical innovation process and mechanism and technical innovation and market organization, enterprices, evelutionary process and the relationship between the economic growth but also analyzes various issues such as innovation policy, tehcnical innovation economics and dealt into the technical innovation incentive[11].

The above definitions define the concept of innovation from the perspectives of the processes and the combinations of elements, namely, in terms of the processes, what processes technical innovation includes and what the beginning and the finishing points are. The beginning mainly refers to the inception of the innovative idea while the finishing point is referred by early scholars to as the successful development of new technology or new product, and later to as realization of the market value by the new product, the improvement of the corporate competitiveness of the product etc. In terms of the combination of elements, innovation is defined from the combination of the innovative resources that the innovative body possesses. The innovative resources include the corporate labor, capital, system and management etc. But there has been no unanimous consensus among the academia concerning the concept of technical innovation. The debate centers around three aspects. The first one is the definition of the technical scope utilized in the technical innovation, namely, whih innovative activities re technical, which are not. The second one is whether the technical innovation has no restriction on the strength of the technical change and to what degree it has restriction. The third point is what the benchmark of technical innovation is.

III. Research on Technical Innovation Capacity and Its Evaluation Indices

The research on technical innovation has been going on for more than a half century. However, it was not until 1980s that technical innovation capacity was put forward and studied. From the research done home and abroad, it can be seen that different scholars define corporate innovation capacity from different perspectives to analyze the components of technical innovation capacity. For example, Burgel maintains that corporate innovation capacity is a series of comprehensive features to support the corporate new strategy, including the resources available and the allocation, comprehensibility of the industry development, the comprehensibility of the technical development, the strategic capacity, the structure and cultural conditions[12].Larry E. Westphal believes that innovation capacity is a synthesis of the organizational capacity, the adatability, technical innovation capaity and acquiring information. Seven Muller thinks that innovation capacity is the synthesis of the product development capacity, the production skill capacity improvement, the storage capacity, the production capacity and the organization capacity[12]. D. L. Barton asserts that the core of the corporate innovation

capacity is the people with the professional knowledge, the technical system capacity, the management system capacity the outlook of the enterprise[12]. Table 1 exhibits the composition of the technical innovation capatity in different perspectives.

All in all, the corporate technical innovation capacity is a comprehensive capacity system composed of several main elements. It is the sum of the internal conditions under which the enterprise can implement and complete the technical innovation as the main part of the technical innovation. Due to the important role that technical innovation capacity plays in the technical innovation, the technical innovation capacity has become a hot topic of research home and abroad. Despite the differences in scholars' concrete expression of technical innovation capacity, the contents revealed are generally similar. Almost all scholars regard corporate technical innovation capacity as a comprehensive capacity system composed of several main elements and as a sum of several intrinsic conditions for the corporate technical innovation.

TABLE I. COMPOSITION OF THE TECHNICAL INNOVATION CAPATITY IN DIFFERENT PERSPECTIVES

Perspective Of Analysis	**Composition Of Technical Innovation Capacity**	**Representative scholars**
Organizational behavior	Synthesis of organization capacity, adaptability, innovation capacity and information acquisition	Larry
	The technical innovation capacity is considered the combination of a resource available, the understanding of rivals, the understanding of the environment, the organizational structure and change, the exploring strategy	Bergman
Resources elements of technical innovation	The technical innovation capacity is broken down into several aspects such as technical innovation input capacity(including the R&D personnel, R&D funds, patents), the output capacity and activity process capacity and internal support of corporate technical innovation social support etc.	Wang Jian, Wang Haishan
Behaviorial agent of technical innovation	The technical innovation capacity is composed of the skills of the technicians and senior technicians, the technical system capacity, the management capacity, the outlook etc.	Barton
Categories of corporate technical innovation	From the linking perspectives of product innovation capacity and process innovation capacity, the combined innovation capacity is put forward, namely the product innovation capacity, process innovation capacity and the integral systematic function thus determined.	Wang Weiqiang
Technical innovation process	The technical innovation capacity is broken down into the innovative resources capacity, the innovative management capacity, the innovative aptitude, the R&D capacity, the manufacturing capacity and marketing capacity.	Fu Jiaji, Gao Jian et al.
	The 5 components of the technical innovation: innovative decision capacity, R&D capacity, production capacity, marketing capacity and organizational capacity.	Wei Jiang, Xu Qingrui
	The technical innovation capacity is in fact the overall system capacity of an enterprise with the product innovation capacity, the production technical innovation capacity and management technical innovation capacity as the mainstay, namely, the capacity of coordination to realize the economic profit. Based on the technical innovation process, the main content and the affecting factors, the technical innovation capacity can be broken down into seven aspects: R&D capacity, production capacity, organization management capacity, input capacity, marketing capacity, financing capacity, output capacity.	Cao Chongyan, Wang Zhunxue
	On the basis of profound analysis of the technical innovation operation mechanism, the technical innovation capacity can be defined as production technical innovation decision capacity, R&D capacity, implementation capacity, realization capacity and organization management capacity with the capacity elements during the entire innovation process broken down and analyzed.	Guan Shixu
The tecnique, the product and production process innovation, the organization management innovation, the economic process innovation are used as evaluation criteria.	The technical innovation capacity is broken down into the capacity of the corporate technical and market opportunity selection, the technical design and R&D capacity, sample manufacturing capacity, pilot project capacity, scale production capacity, sales and market exploring capacity, market information and feedback and product updating capacity etc.	Yuan Deyu et al.

The corporate technical innovation capacity evaluation indices are the set of the basic elements of innovation capacity and its evaluation elements. The components can be different judging from different perspectives. Great efforts have been made home and abroad in the researches on technical innovation capacity evaluation indices, but up to now, there is no complete set of index system. Scherer(1992)maintains that what technical innovation realizes is extensive and there are different methods of innovation activities. Therefore, different evaluation indices are employed for different types of technical innovation. During the corporate technical innovation survey conducted in Germany, the ratio of the technical innovation funding to the toal sales volume is used to describe the technical innovation[14]. In Canada, Professor Debresson uses 7 indices to compare the corporate technical innovation capacity: innovation capital input/staff number, innovation capital input/sales revenue, non-special innovation capital input/staff number, special innovation capital input/staff number, special innovation capital input/sales persons, export sales revenue/sales revenue, corporate innovation aptitude[16]. Clark K.(1990) suggests that the technical innovation capacity can be measured from the product innovation capacity and process innovation capacity, of which the product innovation capacity is synthetical representation of the corporate product development cycle, the product development efficiency and comprehensive good quality while the process innovation capacity refers to the synthesis of the development of the corporate production process equipment molds, low rate initial production and mass production[16].

In recent years, the Statistics Administration of PRC has established the technical development capacity comprehensive index based on the six indicators such as the technical development expenditure, scientific research personnel, scientific achievements, technical transfer, new product sales and new product export. Some domestic scholars classify the technical innovation into six components: innovation resource input capacity, innovation management capaciy, innovation aptitude, R&D capacity, manufacturing capacity and marketing capacity. To evaluate the corporate technical innovation capacity is to evaluate the level of the six components and its combinaed efficiency. Wang Weiqiang et al maintain that the evaluation indices for product and process innovation capacity are the corporate comprehensive good quality, the product development cycle, the product development efficiency, the prototype producing cycle, the mould production cycle and the process preparation cycle[17].From the perspectives of input and output, Fu Jiaji et al consider six indices as the evaluation indices for corporate technical innovation capacity including innovation resource input capacity, innovation management capacity, innovation aptitude, R&D capacity, manufacturing capacity and marketing capacity[17]. Zhao Yanyun et al, from the perspective of R&D, put forward the evaluation indices for the corporate technical innovation capacity[18]. Lu Yibo and Su Jingqing(2009) put forward the innovation evaluation system for SMEs by refering to the corporate innovation evaluation frame raised by Chiesa and Yam to establish the corporate innovation evaluation system applicable to SMEs in PRC. The SMEs innovation capacity is evaluated from six dimensions such as learning capacity, the strategy management capacity, the resource support capacity, the manufacturing capacity R&D capacity, marketing capacity and organization capacity[19]. Table 2 exhibits the methods and indices to evaluate the innovation performances in the enterprises in PRC.

TABLE II. METHODS AND INDICES TO EVALUATE THE INNOVATION PERFORMANCES IN THE ENTERPRISES IN PRC

Major Viewpoints and Content	Representative Scholars
The corporate technical innovation performance evaluation indices are composed of economic gains and social performance. Comprehensive judgement method in fuzzy math is used to analyze and judge comprehensively the corporate technical innovation performances.	Hu Enhua (2002), Shan Hongmei (2002)
The corporate innovation performance evaluation indices are composed of innovation output performance and innovation process performance, of which the innovation output performance consists of economic performance, social performance, direct technical benefits and technical accumulative benefits.	Chen Jing et al. (2006)
From the perspective of acquiring resources, and with the help of BP neural network, the relation between the resource acquisition and the technical innovation is empirically proved.	Zhang Fanghua (2006)
Osculating value method is used to evaluate the corporate technical innovation performance.	Nie Ping et al. (2006)
The corporate technical innovation performance evaluation indices are composed of economic benefits and social benefits and multi level gray evaluation method is used to evaluate the enterprise performances.	Wang Qingyun (2004)
DEA method is used to analyze the effect of the current situation of the innovation system and innovation organization resource allocation in different regions of PRC on the innovation performances.	Gong Jiancheng et al.(2003)
"BSC(balanced scorecard" is used to put forward the four dimensions to evaluate SMEs technical innovation performances including technical innovation input, technical innovation management, technical innovation result and financing condition.	Zhao Linan (2006)
Based on the impact of the social capital on the technical innovation performances, factor analysis, multinominal regression and structural equation are used to make the analysis.	Wei Ying (2005)
BSC is used to break the corporate technical innovation target into financing, users, internal business flow, learning and growth, and then corresponding performance evaluation indices are designed based on the requirements of each target.	Zhang Fanghua (2004), Li Hong (2006)

On the basis of the above analysis, the author of this paper believes that different evuation methods should be used to evaluate corporate innovation of enterprises of various types in terms of economic regions, production environment, and different state policy. The evaluation indices system should be different. In addition, comparative analysis should be made on the corporate innovation home and abroad so as to identify the lessons to be learned and to offer support to the sound and vigorous innovation assit. This is what we lack of during the current research[20].

ACKNOWLEDGMENT

This work is supported by the China-Australia Cooperation Foundation of Shenzhen Polytechnic (Grant No. 1) and the project of Philosophy and Social Sciences for 12th Five-Year Plan of Shenzhen (Grant No. 125B051)

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