

# Study on Evaluation System of Innovation Capabilities in Manufacturing Firms

DENG Ping, WANG Renxiang

School of Economics, Wuhan University of Technology, P.R.China, 430070

**Abstract** Innovation capabilities are the key ingredient in enhancing the firms' competitiveness and ensuring their survival. Obviously, there are quite different in innovation activities between manufacturing firms and service firms. It is necessary to consider the distinctness between them in evaluating firms' innovation capabilities. This paper proposes a model of innovation capabilities in manufacturing firms based on the innovation process which includes six parts: input capability, R&D capability, manufacturing capability, marketing capability, output capability and managerial innovation capability. Based on the model and systematic principle, scientific principle, commensurable principle, easy operative principle and guidance principle, this paper also presents a basic framework of the evaluation index system of innovation capabilities in manufacturing firms.

**Key words** Evaluation index system, Innovation capability, Manufacturing Firms

## 1 Introduction

The emergence of the knowledge economy, intense globalisation and technological advances have increased the role of innovation in the efforts of organisations to achieve sustainable competitive advantages. At the same time, innovation also becomes one of the necessary condition primarily to ensure enterprises' survival. It is an observable fact that firms which are not able to maintain satisfying levels of innovation capabilities through time show weak performance in terms of competitiveness and economic results (Raffa and Zollo, 1998). Thus, the problem of improving innovation capabilities is of fundamental importance both for researchers and practitioners. It is a main approach to enhance the firms' innovation capabilities by evaluating its status quo firstly. In the previous analysis, innovation is considered to be restricted to technology field which is mainly happened in manufacturing firms. Hence, the exploration on innovation capabilities at a firm level focus on innovation capabilities in manufacturing firms. In fact, there are quite different in innovation activities between manufacturing firms and service firms as the Consortium for Service Innovation has observed that innovation in service cannot happen in R&D labs nor be engineered in ways we have engineered products. Considering the aboved discussed, this paper tries to offer a basic framework of the evaluation index system of innovation capabilities in manufacturing firms which is mainly based on the innovation process. The paper is structured in the following way: after a brief review of the most directly relevant literature in section 2, the model is developed in section 3. In section 4 the first results are presented and discussed and finally section 5 summarizes the conclusions.

## 2 Review of the Literature

Innovation is one of the most widely researched and talked about concepts in organisational and popular literature. The literature studies innovation in terms of input, process and outcome, and the types of innovation are further studied at the levels of organisational process, products, and services<sup>[1]</sup>. Innovation is the mechanism by which organisations produce the new products, processes and systems required for adapting to changing markets, technologies and modes of competition(D'Aveni,1994). Porter(1999) believes the ability to develop new ideas and innovations is one of the top priorities of the organisations. Extending innovation argument, there have been a number of empirical studies on innvaotion capability. From the review of the extant innovation literature, there is a common point that almost all studies are exploring innvaotion capability from technological innovation prospective.

Technological innovation capability is the synthesis of organizational capability, adaptability, innovation capability, grasping information and technology capability (LarryE.Westphal,1981).

Burgelman and M.A.Maidique(1988) give a definition for technological innovation capability from the strategic management viewpoint. They believe technological innovation capability is a series of comprehensive characteristics advantageous for implementing technological innovation strategy, which includes resources and its allocation available, recognition for industry development and technology development, organizational structure, cultural condition and the strategic management ability. Moreover, D.L.Barton<sup>[2]</sup>(1992) indicates the core contents of the technological innovation capability which are the speciality, the technology system, management mechanism and enterprise values. Wernerfelt<sup>[3]</sup>(1984) bring a more systematic approach to firm-level analysis by characterising the firm as a collection of resources and capabilities, rather than a set of product-market positions. Teece, et al (1997)<sup>[4]</sup> further developed the area proposing dynamic capabilities theory as the “firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments”. Dynamic capabilities emphasise management capabilities and inimitable combinations of resources that cut across all functions, including R&D, product and process development, manufacturing, human resources and organisational learning. Lawson and Samson<sup>[5]</sup>(2001) also hold that innovation capability is the higher-order integration capability, that is, the ability to mould and manage multiple capabilities and propose a mixed model comprising vision and strategy, harnessing the competence base, organisational intelligence, creativity and idea management, organisational structures and systems, culture and climate, and management of technology. Furthermore, there have been attempts at developing models for innovation capability. Most of these models are process based<sup>[6]</sup>. Tranfield et al(2003).propose a Discovery, Realisation and Nurture (DRN) model expanded to search, capture, articulate, contextualise, apply, evaluate, support and re-innovate stages. O’Connor and Ayers present a nearly similar model—the Discover, Incubation and Acceleration (DIA) model. Nonaka’s socialisation-externalisation-combination-internalisation(SECI)model for knowledge creation in organisations is also a process based model and does not look at innovation as a capability.

### 3 Innovation Capability: A model

Generally speaking, innovation is a continuous process which occurs at any time and in any place. The model is presented based on the whole process in the manufacturing firms for convenience purposes, which consists of six sections: input capability, R&D capability, manufacturing capability, marketing capability, output capability and managerial innovation capability (as shown in Figure 1).

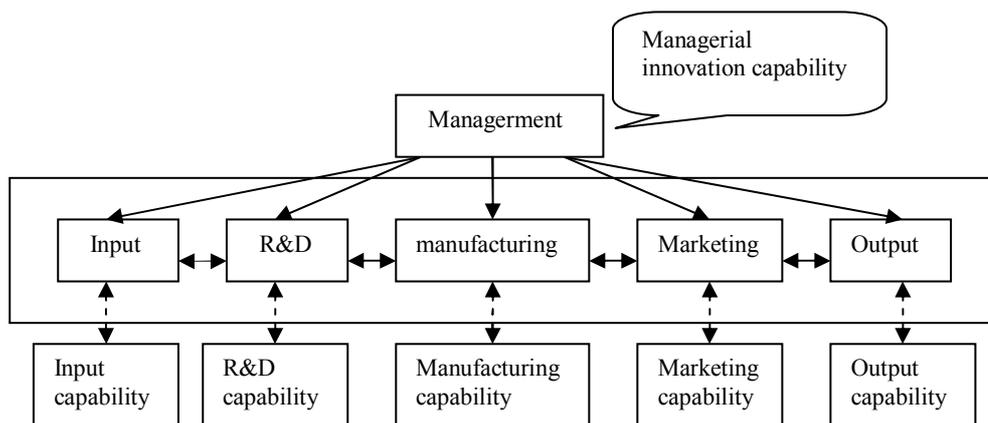


Figure 1. Process-based Innovation Capabilities model

#### 3.1 Input capability

Higher R&D intensity and higher R&D manpower are found to be predictors of improved firm performance. One of the crucial factors for successful product and process development is R&D

investment which is regarded as the engine of innovation. Cohen and Levinthal (1989) has pointed out that this engine has two main functions: firstly, as a direct source of product and process innovations, and secondly, to develop and maintain the broader capabilities to exploit and assimilate externally available information<sup>[7]</sup>. Another vital factor for successful product and process development is the firm's access to skilled labour<sup>[8]</sup>. Higher R&D manpower plays a key role in fostering technological change and diffusion and is necessary for the production of goods, services and knowledge. Its importance has increased as production processes become more knowledge intensive.

### **3.2 R&D capability**

R&D capability has been suggested as one of the primary characteristics that help to differentiate successful from unsuccessful firms (Bettis and Hitt, 1995; Teece 1982). Successful firms have stronger R&D capability in common. With the development of social labor's division and specialization, firms cannot pursue all the possible alternative paths available to them while conducting R&D. The effects of limitation lead firms to direct their R&D efforts toward external areas. R&D networks is the main form of external collaboration which are the pathways along which information flows both inside and outside the organisation. Both inter-organisational<sup>[9]</sup> and intra-organisational networks<sup>[10]</sup> are seen as aiding innovation effort. In addition, a shorter R&D period helps to improve the innovation success rate which is subjected to the employee's ability, creative culture, equipments and information system.

### **3.3 Manufacturing capability**

Manufacturing capability is the reflection of technological accumulation and learning and the combination of tangible and intangible assets the firms deploys in manufacturing products. R&D achievements bring the economical performance and the social performance on the premise that new products are manufactured for mass production and putted into the market successfully. It is crucial in the process of manufacturing products both the level of production equipments and the workers' know-how and other technical abilities. Research has shown that well-manufacturing capability could reduce manufacturing cost, improve R&D efficiency and accelerate the marketing speed of new products.

### **3.4 Marketing capability**

Marketing capability is the capacity to create superior customer value a firm possesses. It is proved that market is one of the essential elements for the firms' development. Only the customer is completely or more satisfied, he or she would repeat to purchase<sup>[11]</sup>. Although a number of factors decide whether firms could successful transform R&D achievements into products adapting to the market demand or not, it has been widely recognized that the development of marketing capabilities requires the joint effort in marketing research and sales management. Therefore, appropriate marketing means, favorable marketing network and customer relationship are the reliable base of the stronger market position and competitive advantages, which in turn supports the innovation activities.

### **3.5 Output capability**

Innovation output are the final results of the innovation actions, which can be measured from both financial dimension and technologic dimension. Innovation financial effect is mostly manifested by the increase in income and profit, while innovation technologic performance is creating new intellectual property and Know-how, providing a spingboard for subsequent innovation.

### **3.6 Managerial innovation capability**

Managerial capabilities play a vital role in the firms' innovation activities, which needs give significantly more attention to develop and nurture dynamic integration of capabilities. Managerial innovation involves new strategies and new organizational forms, which are indirectly related to basic business activities within an organization. Innovation strategy determines the configuration of resources, products, processes and systems that firms adopt to deal with the uncertainty existing in their environment, which enables organization to clarify their vision and translates them into action. Successful innovation requires a clear articulation of a common vision and the firm expression of the

strategic direction.

The second factor affected managerial innovation capability is information communication which has been shown to have a role to play in innovation in dynamic environments<sup>[12]</sup>. A number of studies have pointed out that interfunctional co-ordination is a prerequisite for a successful innovation process (Mukhopadhyay & Gupta 1998). Organisations encouraging both formal and informal channels of information sharing have more successful chance of innovation. Since innovation is a kind of risky activity and needs large numbers of capital. Many studies have demonstrated that it is nearly impossible to afford for innovation activities only seeking the internal funds. Therefore, the ability to seek external funds and manage financial risk becomes a determining factor of managerial innovation capability. The fourth factor is the firm's innovative culture. It is recognized that culture force is the most powerful and significant core competence in enterprise. Innovative culture as a powerful force compel staff to innovate continuously, which can penetrate all operating-processes and be accepted by all employees. Hence, an enabling culture environment which encourages innovation and tolerates defeat promotes innovation as a stronger drive force.

## 4 Results

As stated in the previous part, in this paper we propose to establish the scientific systematic all-around evaluation system of innovation capabilities in manufacturing firms. It is necessary to abide by some basic principles such as systematic principle, scientific principle, commensurable principle, easy operative principle and guidance principle. Based on the above discussed model and the basic principles, an evaluation index system of innovation capabilities was designed, as shown in table 1.

**Table 1 Evaluation Index System of Innovation Capabilities**

First-level index	Second-level index	Third-level index
Input capability	Financial resources input	Percentage of R&D expenditures
	Human resources input	Percentage of R&D personnel
R&D capability	R&D network	Intensity of technical collaboration
	R&D period	New-product period
Manufacturing capability	Equipment level	Advanced standard of equipments
	Workers' technology level	Workers' technological title
Marketing capability	Market research capability	Total number of personnel involved in marketing research
	Sell capability	Intensity of sell network customer satisfaction
Output capability	Financial performance	Ratio of the new products income to total income
	Technological performance	Amount of patent application Amount of Know-how
Managerial innovation capability	Strategic management of innovation	Perfection level of innovation strategies
	Information communication	Ability to information capture, processing and transmission
	Financial management	Ability to raise funds
		Ability to manage financial risk
Innovative culture	Innovative spirit of entrepreneurs Amount of putting and adopting rationalization proposals	

The evaluation index system of innovation capabilities can be divided into three levels, which is composed of five first-level indexes, fourteen second-level indexes and eighteen third-level indexes. The evaluation index system presented is only a basic framework. In practice, the evaluation index should be appropriately adjusted and given weight coefficient by considering the development stage and other actual situation of the studied manufacturing firms. Moreover, there are some qualitative indexes in the evaluation index system which needs adopt the method of questionnaire survey or expert's experience to obtain data and then carry out quantitative calculation and evaluation.

## 5 Conclusions

In this paper we have presented a model of innovation capabilities in manufacturing firms based on the innovation process which includes six parts: input capability, R&D capability, manufacturing capability, marketing capability, output capability and managerial innovation capability. R&D expenditures and R&D manpower input are the main input of the innovation activities. R&D stage, manufacture stage and marketing stage lie in the core of the innovation process, which have a primary effect on the firm's innovation performance. Innovation output capability can be measured from both financial dimension and technologic dimension. Managerial innovation capability has significant influence on innovation activities, which could accelerate or impede innovation. At last, this paper presents a basic framework of evaluation index system of innovation capabilities in manufacturing firms.

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The author can be contacted from e-mail : dengping1982@163.com