

# The Study on the Pattern of Enterprise Technological Capability Growth in the Context of Open Independent Innovation A Case from China Aviation Industry Enterprise

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**Abstract**—Today, the level of enterprise technological capacity has become a key factor that determines whether enterprise can sustainably get competitive advantage. However, in the process of technological capacity growth, technology model or path will be formatted, enterprise tend to face certain "lock-in effects", which shall hinder the development of their technical innovation. Aiming at this problem, this paper proposes open independent innovation of technological capability growth model and analyses its mechanism. Lastly we select China Aviation Industry enterprise as the case, launch the research to the pattern and its effects from the angle of enterprise technological capacity growth, expect to have certain model function for speeding up other industrial enterprises technological capability growth.

**Keywords-** open independent innovation, enterprise technological capability, China Aviation Industry Enterprise

## 1. Introduction

With the rapid progress of science and technology as well as the world economic integration, the enterprises are facing unprecedented challenges and threats. Only by innovating, unceasingly carrying out the technological development activity, quickly improving the level of enterprise technological capacity, can the enterprises survive in the competition. Although Chinese enterprises' technological capacity is continually enhancing, but compared with developed countries, the overall technological capacity level of Chinese enterprises is still low, especially in the aspect of technical innovation, R&D. About the question that seeking for the path of technological capacity growth in compliance with Chinese enterprises' actual development condition already has become the hot spot in academic circles and an urgent problem to be settled.

At present, the technology system in all walks of life are rapidly expansion, the new technical source springs up unceasingly, fierce market competition requires enterprises to establish open innovation system for continuously searching, absorbing external technology source, meanwhile using internal technical source for independent innovation and enhancing the enterprise's own technological capability. Therefore, it has very important theoretical and practical significance to built technological capacity growth model in the context of open independent innovation.

Aviation manufacturing industry is the high tech industry which is strongly associated with the economic and security of one country, has extremely important position in the national economy and social development. This article selects aviation industrial enterprise for case study object. In the course of more than 50 years' development, China aviation industrial enterprises constantly explore useful technical innovation model, have successfully carried out great-leap-forward technological capability growth. Analyzes China

aviation industrial enterprises' open independent innovation way and its effect, can get a lot of useful experience for the other enterprises.

## 2. Review Relevant Theoretical Basis

### 2.1. Open Independent Innovation Theory Review

The concept of open innovation was proposed by the famous United States scholar Chesbrough (2003), against the traditional "closed innovation" models. Chesbrough coined the term of open innovation to describe how large organizations involve in the development of new technology through linking internal and external knowledge and/or make use of external paths to market [1]. Open innovation can be described in terms of combination of two differently directed processes: inbound and outbound. Inbound process stands for insourcing external knowledge through licensing in, spinning in, acquisition (in order to get valuable technology, personnel etc.) and collaboration alongside value chain. The latter can be illustrated at the example of Procter & Gamble, who cooperate with customers, suppliers, competitors and other institutions to pursue ideas, which can be utilized in the process of new product development [2]. Chen Jin (2006) improved Chesbrough's open innovation model (2003), added the main customers and suppliers as important technical innovation sources [3]. Improved open innovation mechanism map, as shown in Figure 1.

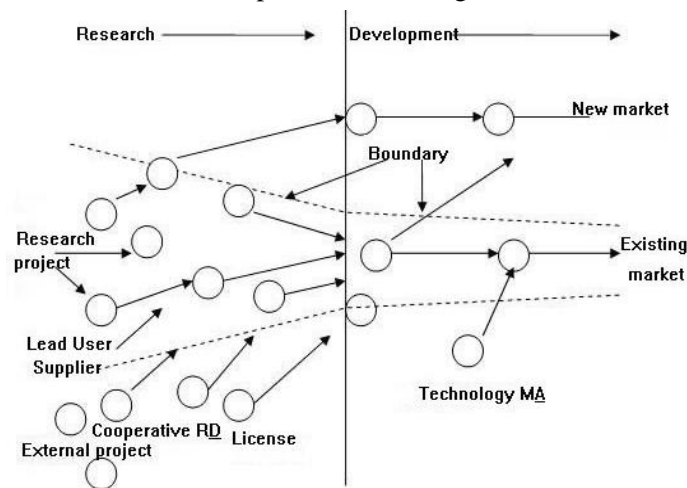


Figure 1. Improved open innovation model Source: Adapted from Chen (2006).

Carry on innovation under open innovation background, whatever it makes full use of internal resources, seeks for the innovation source outside the enterprise (including global learning), or find the appropriate business model to realize the innovation, as long as the enterprises master the ownership and control power of the innovation, namely "autonomy", then open innovation is the "open independent innovation" [4].

### 2.2. Technological Capability Theory Review

The research on technological capability began in the 1980s, mainly aimed at resolving problems in the developing countries (areas) as well as the emerging industrialized countries (areas) [5]. Since the late 80s, enterprise technological capability has been gradually aroused wide attention; And from the 1990s on, the research on the micro-level of technological capability has been influenced by the theory of enterprise core competence; Recently, the understanding about connotation of enterprise technological capability gradually incline to the area of organizational knowledge, and learning from each other with knowledge management in research methods and tools. However, in researches that about technological capability, due to the different analysis perspective, causing the theorists couldn't reach a consensus on the definition of technological capability until now. Wei Jiang defined the technological capability as, the enterprise for supporting the realization of technical innovation, the sum total of all intrinsic knowledge storage which adhere to the internal personnel, equipment, information and organization [6]. Here, the author consider that technological capability including the capacity of technology searching, choosing, absorbing, learning, innovating, transferring and diffusing.

## 3. Raise the Question and Build the Theoretical Framework

### 3.1. Problem that Brings in the Course of Technological Capability Growth

If an enterprise wants to have long-term development in the fierce competition, it must put the development of technological capability in the important position. Enterprise's technological capability growth has a vital strategic significance for enterprise's survival and development. Technological capability growth is a complex and dynamic process, which is also a process of long-term accumulation, be affected by several factors, has characteristics of generative, cumulative, path dependence, update, and dependencies, and so on[7]. Linsu Kim(1997) has given the general pattern of developing countries' technological capability growth: Import the mature technology --- digest and absorb--- innovate new product[8]. Xie Wei(1999)hold that technological capability growth is based on the technical study, and proposed "technology introduction --production capacity --innovation ability" as the technological capability growth model[9]. After having analyzed the trend of international technology management development ,Wu Gui sheng(2002)considered that Chinese enterprises technology gain pattern should change from the simple introduction to diversification mode,such as cooperative development and technology acquisitions with domestic and abroad universities, research institutes, and enterprises[10].Zhou Yong hong , according to vast observed technological development practice , drawn the conclusion that the growth or continuous accumulation of technological capability were usually conducted in one fixed technological paradigm, this fixed technology paradigm has strong exclusive effects. Once the enterprises' technology model or path are formatted, enterprises will face a number of transformation traps caused by "lock-in effect " , which will hinder enterprises from actively integrating the technology and knowledge that broader technical innovation field produced into technological capability growth process, restrict the enterprises' technology, knowledge and the stock of resources developing differently and diversely [11]. However , technical innovation, for gaining widespread information as far as possible ,needs an open mind and the open technological environment. Therefore, technological capability growth may have a negative impact on enterprise technical innovation, the slow development of enterprise technical innovation is bound to hamper technological capability growth.

### 3.2. Technological Capability Growth under the Open Independent Innovation

In order to avoid the mutual obstruction effect which may arise between technological capability growth and technical innovation .So this article proposes the technological capability growth pattern which is based on open independent innovation, and meanwhile summarizes its theoretical framework, as shown in Figure 2.

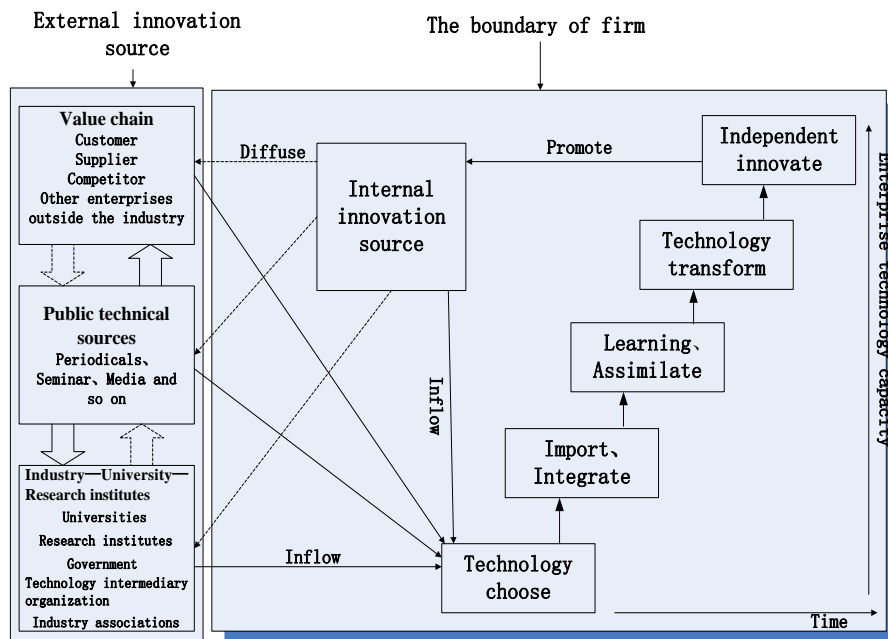


Figure 2 The technological capability growth pattern based on the open independent innovation

Under the background of open independent innovation, enterprise is defined as an open system. Customer, supplier, the people in similar industry ,universities, related research institutions, technical intermediary organizations are no longer exogenous variables, which are all placed inside the system. They together formed a dynamic relationship network. In this open network , the enterprise can easily exchange knowledge and

technology, not only can absorb and integrate technology, but also create and transfer the technology. Simultaneously, this open network can also let enterprise's technical value maximization. Enterprise followed an technological capability growth path, likes “search technical source from the interior and exterior simultaneously --- choose --- assimilate --- transform --- independent innovate --- diffuse”.

One of the reasons for many enterprises technological capability growth slow is that the existing technology paradigm caused enterprise's knowledge and information network relatively closed, enterprises excessively relied on internal research and innovation, but neglected gaining and using exterior technological resources. Yet, enterprise under the background of open innovation, can make the technical choice from the widespread innovation source on the global scale. But meanwhile, enterprises should notice that the use of external technology cannot replace internal R&D, the use of external technology is only a supplement of internal R&D, not replacement. Enterprises must establish their own internal research and development institutions, grasp technology development initiative [1][12][13], carry on the independent innovation continuously. For the advanced and applicable technology which can directly get from the outside, enterprises should immediately use. Enterprises' internal research and development should focus on core technology, system solutions and those technologies that cannot be got from external [14]. Enable open innovation become goal-oriented using the knowledge of inflowing and diffusing, which can accelerate enterprise interior independent innovation. Eventually, forming the valid pattern which will impel enterprises' own technological capability heightened.

## **4. Case Study**

This article uses the exploration case study method, aimed at revealing the specific pattern and its effect that the model of open independent innovation technological capability growth operates in practice.

### **4.1. Background of the Case**

Because of the aviation industry has the features of high relevancy, strong technological radiation and technology-driven, has huge impetus for domestic machinery, instruments, electronics, materials, metallurgy, chemical and petroleum industry and so many related upstream industries, as well as downstream industries like infrastructural facilities, environmental protection, etc[15]. Thus, the development of aviation manufacturing industry plays a positive role in promoting the economic growth, development of science and technology of one country. Today, the world aviation industry is facing market rapidly changed, application cross-technology source, technology uncertain such questions, complex external environment and intense competition within industry. Only by endlessly innovating, chasing and surpassing ,can China aviation manufacturing enterprises gain a foothold in the market . Therefore, it is very necessary to raise technological capability of China aviation manufacturing enterprises, increase independent innovation number and improving the quality of innovation .

Review China aviation manufacturing enterprises more than 50 years' development process, after several generation of aviation person's unremitting struggle, China aviation industry started from scratch, expanded from small to big, had experienced the process of development from repair to manufacture, imitation to independent development, then to international cooperation, has made great progress and formed a certain scale aviation industry system . But summarize the above development phases of China aviation industry, can discover that the technological capability and self-sufficiency degree of key technologies are always too low and have large gap with developed countries in respects of resources of research and development and product competitiveness. All can be ascribed to China aviation industry didn't choose a correct development way.

In the development process, technology transfer by joint ventures, imitation, domestic production, purchasing production line and assembling are the most convenient, also the easiest to see the surface effects of a development approach which enables enterprises to quickly get production capacity or technology. But we must realize that it has essential distinction between the concepts of the technology and technological capability. Under certain conditions, the technology can be introduced, but the technological capability cannot be obtained by introducing. To get these technological capability, enterprises must learn, digest and absorb consciously. By this, they can truly transform to the enterprises' own internal technological capability. Only by having these intrinsic technological capability , can the enterprises carry on the innovation. Otherwise, the

aviation manufacturer enterprises will get into the vicious circle of "introduce---fall behind---introduce again--lag again", never get the core aviation manufacturing technology.

#### **4.2. The Practice of Technological Capability Growth of China Aviation Industry Enterprises under the Open Independent Innovation Pattern**

The above historical lessons let us recognize that, by the road of opening independent innovation improving enterprise technological capability by the road of opening independent innovation, is the inevitable choice of China aviation manufacturing industry enterprises.

Since China aviation industry has been affected by the planned economy in earlier times, The aviation enterprises mostly be distributed in remote regions, where are "dispersed, in mountains and in caves", enterprises in the same system farther away from each other, caused cooperation between these enterprises is not fully, had emerged the situation of construction and development repeatedly. So resulted in resources wasted seriously. In addition, the separation of factories and research institutions made the aviation manufacturing industry fail to achieve vertical integration. The achievements of scientific research in research institution can not be effectively transformed. Externally, too stress the self-developed, insist the Chinese holdings, and does not allow foreign technology share. The low openness degree of entire internal and external industry resulted in China aviation industry enterprises technological capability growth slow. Therefore, using the model of open independent innovation, taking full advantage of all resources from domestic or overseas, increasing the depth and breadth of open, at the same time never give up the autonomy of research and development, which has an important role in enhancing the success rate, efficiency and utilization ratio of resources of China aviation enterprises develop new product, grasping the core technologies for improving the enterprise technological capability, maximizing the enterprise technology value, and creating more economic benefits for enterprises.

In the composition of China aviation industry, compared with other aircraft types, the gap between the development level of China helicopter and overseas is relative smaller. Because China helicopter industry consistently adhere to the combination of opening cooperation between domestic and overseas, the introduction of technologies and independent R&D. Undoubtedly, this provides a referential road for the development of entire China aviation industry.

In aspect of civil aircraft, the successful development and production of large regional jet ARJ21 was also very good proof. In its development process, enterprises exactly adopted the open independent innovation model, tendered for the global, and established broad cooperation with enterprises in other related industries, research institutes, and universities. Such as the 3D dynamic display software, which was joint researched and developed with Shanghai Jiao tong University, the first test flight data management system which was independently developed with Shanghai University, the GPS flight path observation system and a series of proprietary software and systems which were developed by cooperation with domestic measurement and controlling enterprises. All of these have been successfully applied to AR J21 project now. Enterprises carried out open innovation, and meanwhile, griped the ownership and control power of innovation, namely "autonomy".

ARJ21 regional aircraft has become first jet regional aircraft that owns full independent intellectual property rights in China. It is also the first civil turboprop regional aircraft that export to western developed countries. Due to its accurate market position and advanced performance design, this airplane has received widespread attention from domestic and abroad airline since its development. By then, before the first flying of ARJ21-700, the domestic and international orders have reached 208 aircraft. In its development process, ARJ21 regional aircraft through using open independent innovation concepts and pattern, so as to we have gathered rich experience, a large number of core technology, and the enterprise technological capability has been truly improved.

The successful practice of ARJ21 has become the important breakthrough point for big airplane project and even the entire China civil aviation industrial. Through the development of large aircraft project, climbing for the high-end of technical structure and industrial structure. Fully recognize the significance of technological capability, and by adhering to the road of open independent innovation to improve China

aviation enterprises' technological capability, ultimately elevate its position and competitiveness in the world aviation industry.

## 5. Conclusion and Outlook

China aviation industry enterprises' open independent innovation road is those enterprises' inevitable choice for promoting nationality independent will of aviation industry. In the context of opening up, China aviation industry enterprises can take full advantage of technical resources from all global industries. In process of introduction and absorption, format the enterprises' independent innovation capacity.

For Chinese enterprises whose technical innovation capacity are generally weak, not only high-tech industry such as aircraft industry, but also a large number of traditional industries, all need to realize technological capability great-leap-forward improvement, shrinking the gap with international advanced enterprises. So, this article proposed corresponding theoretical framework, hoping through researching the principles and specific implementation way of this theoretical system, provided guidance for exploring the way of Chinese enterprises technological capability growth. Of course, deeper and more extensive research needs to further expand, particularly, methods applied empirical study, and researching on the relative important practical issues. Sequentially, improving the practical value of this research.

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