

“The Trinity”: Synergy Innovation Mechanism of Science and Technology

— A Case Study Based on Nantong Industrial Technology Institute

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Abstract

“The trinity” is that NITI focuses on the universal, critical and forward-looking technology which is from enterprises in Nantong, and uses the strategic, service, and benefit synergy, to integrate the research of scientific institutes, the incubation of incubators, and industrialization of industry bases to be an organic entirety which produces collaborative innovation. It is a science and technology innovation chain. The case proves that the scientific and technological transfer efficiency of “the Trinity” is higher than others, and has both social and economic benefits. To a certain extent, it is “1 + 1 + 1 > 3”. At present, China’s scientific and technological innovation has not been widely into fast development. On the back of the local strong financial strength and in the intention of enhancing the level of local science and technology innovation, “the Trinity” is a kind of convenient form.

Keywords

“The Trinity”, Collaborative Innovation, Case Study, Nantong Industrial Technology Institute (NITI)

1. Introduction

In China, the scientific and technological achievement conversion is low; it does not meet the requirement of supporting economic development [1]. In order to improve the situation that technology and economy are separated from each other, China needs to perform theory studies in terms of synergy innovation of Industry-Academic (IA) collaboration; China also needs to conclude from practical experience; then, it can accelerate the development and cooperation among industries, universities, and research institutions. This has become a focus of attention of both enterprises and the whole country. Based on the thoughts above,

this article uses “the Trinity”, created by Nantong Industrial and Technological Institute, as an example to analyze “the Trinity” synergy innovation mechanism of science and technology. “The Trinity” is to integrate research from scientific institutes, incubation from incubators, and industrialization from industries into a whole and to form an integrated innovation of science and technology. This research article exhibited an in-depth study on “the Trinity” mechanism; it concluded experiences and explored new mechanisms to establish synergy innovation. The current studies rarely have any conclusion or exploration in terms of synergy innovation of science and technology.

2. Research Basis: Literature Research, Analytical Framework and Method

“The Trinity” and IA collaboration both emphasize the synergy of multiple organizations and factors; they become a new type of synergy innovation of IA collaboration. A section below mainly summarizes literature research on the synergy innovation of IA collaboration.

2.1. Literature Research on the Synergy Innovation of IA Collaboration

In 1971, German physicist Hermann Haken first proposed the concept of synergy in Systems Theory. He believed that synergy is a collective behavior: subsystems coordinate, cooperate, or synchronize with each other within a system; as a result, it has an effect that could make “ $1 + 1 > 2$ ”. The Synergy Theory was widely used in the resource shared and collaborated operation of a company both internally and externally. After 1980s, with the close integration of technology and economy, the concept of synergy was valued and expanded in the innovation of System Theory; there are tons of researches on the synergy innovation of technology. In 2003, American scholar Henry Chesbrough coined the term Open Innovation. Some scholars studied on Synergy Innovation Theory [2], some studied Synergy Innovation theory in various perspectives, such as self-organization [3], knowledge stickiness [4], and factor synergetic [5]. On the basis of studying current synergy innovation of IA collaboration, scholars concluded its law of development and then, created new mechanisms of synergy innovation [6]. These research achievements promote the development of synergy innovation of IA collaboration. With thesis of this article, the following sections will be elaborating in three parts: the basis of synergy innovation mechanism, innovation mechanisms, and synergy innovation.

The basis of synergy innovation of IA collaboration is the cooperation of innovation factors. During 1970s-1980s, some scholars proposed and developed a Dual Core Theory. This theory represented the idea of synergy innovation; it believed that the innovation in a company should be divided into two categories: technology innovation and other factors. Other factors included market and organization. With further studies in this theory, scholars moved their focus to the synergy innovation of three factors. They emphasized synergy innovation of

technology, organization, culture, market, management, institution, and so on, and later formed the synergy innovation of three factors. On the basis of three factors theory, there are new innovation patterns appearing in recent years, they were represented by factors such technology, organization, culture, market, management, institution, strategy, craft, product, and so on; they conveyed the management theories of synergy innovation.

The establishment of IA collaboration mechanism has achieved much accomplishment. The academic world studied the mechanism of synergy innovation of IA collaboration from knowledge management, cooperation motive, benefit distribution, and synergy pattern. Synergy was a comprehensive integration of knowledge, resources, behaviors, and performances [7]. The dynamic mechanism of IA technology alliance synergy innovation included internal dynamic mechanism and external dynamic mechanism. Meanwhile, it also proposed that the internal contains the needs of each individual development with IA technology alliance and benefits drive individual external dynamic mechanism; the external mechanisms contains market pull, technology push, and policy implementation [8]. Benefit distribution is a vital part of the operation of technology alliance. It is associated with the success or failure of alliance members' cooperation [9]. Scholars create distribution models so that the benefits of technology alliance can be equally distributed [10]. During the coordination of innovation patterns, in 2008, Jin Chen emphasized the cooperation between enterprises and research institutes [11] (or emphasized solely on the promotion of technology intermediary agencies) in his publication [8].

The evaluation of IA synergy innovation is a significant approach to examine the synergy degree of an innovation. The performance evaluation of IA collaboration should include the satisfaction of stakeholder [12]. The design of IA collaboration performance evaluation should consider strategies of the organization; otherwise, it will increase the amount of work for performance evaluation [13]. The current study on IA synergy innovation evaluation mainly focuses on the efficiency and performance evaluation of IA synergy innovation. Evaluation model has three types: one type of evaluation model is based on expectancy and motivation, another one is based on balance scorecard, and the last one is based on investment (conversion) [12].

2.2. Analytical Framework

On the foundation of synergy innovation, this article creates an analytical framework for "The Trinity" Synergy Innovation Mechanism (**Figure 1**).

2.3. Research Methods

This part can be divided into two parts. The first is to search in-depth for operating mechanism of synergy innovation from different perspectives. The research problems in the part are to ask HOW. These problems cannot be solved by empirical research which uses big samples. What's more, in terms of the

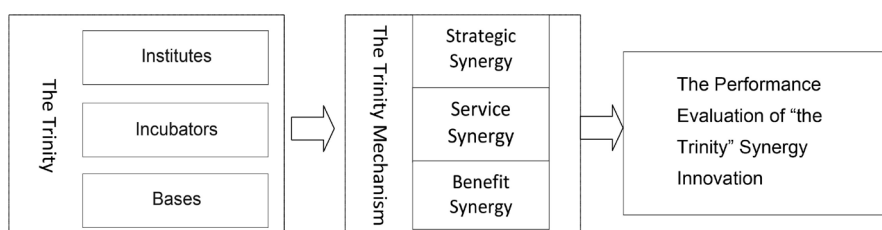


Figure 1. “The Trinity” analytical framework.

internal synergy innovation mechanism, China is lack of such study. Only a few accessible foreign researches cannot be used straightway with China’s particular governing situation. Case study method is particularly used for new research fields or for research fields which are under further exploration. The second part is to find the differences between “the Trinity” Synergy Innovation and other synergy innovations. The research problems in this part are to gather related information and make a comparison. In this part, China could attempt to conduct exploratory case study, and then use analysis of induction method. China does not need have preconceived assumptions due to the lack of referential research on comparing different types of synergy innovation.

The selection of NITI as an example is because of three considerations: Firstly, NITI example is different from other synergy innovations; secondly, NITI has been operated for a period of time, and it has been through a development process; thirdly, NITI was chose for its accessible data and information. The author co-wrote this article with NITI for 13th Five Year Plan from October to December, 2015. During this time, the author conducted field trip and interview in NITI and obtained the first-hand information about “the Trinity” Mechanism. The author used the first-hand information together with some other literature research systematically to analyze the evolution and mechanism of “the Trinity” innovation process.

3. Case Study: “the Trinity” Synergy Innovation Mechanism

3.1. Background and Development History

The case area is in Nantong, China. Nantong is located at the north bank of the entry point of Yangzi River with Shanghai across the river; it is one of the thirteen cities in Jiangsu Province. Until the end of 2016, the income per capita of Nantong is 12,500 USD and the public revenue is 55.5 billion RMB. NITI mainly went through three phases.

The first phase was Technological Innovation and Entrepreneurship Community. In 2004, Nantong learned the innovation-driven development strategy from Suzhou, in Jiangsu, too. Nantong made a requisition of land which was next to Nantong University and invested 200 million RMB to build an innovation-driven and entrepreneurship community. The purpose of this community was to make technological innovation covering every village and town in Nantong. The planned function of this community was for people to work, live, and entertain. After finishing a few infrastructure projects, the commercialized operation of this community went

well. In 2009, Technological Innovation and Entrepreneurship Community was re-named Nantong Science and Technology Park Development Co., Ltd.

The second phase was Nantong Science and Technology Park Development Co., Ltd. In 2010, Technological Innovation and Entrepreneurship Community was combined with Nantong Advanced Technology Establishment Center; later, Nantong Science and Technology Park was founded. It belonged to Science and Technology Bureau of Nantong. The main functionality of this park was a technology incubator; it transferred and transformed technology. During the opening year, there were 82 incubated enterprises entering the park, and more and more came in the following years. NITI made assessment of enterprises according to their technological innovations, which increased the efficiency of this incubator. At the same time, NITI made more space for those qualified incubated enterprises to enter in the park. In 2011, Nantong Science and Technology Park was recognized by Nantong Social Development Bureau that technology incubator significantly stimulated the technology improvement of enterprises in Nantong.

The third phase was Nantong Industrial Technology Institute Co., Ltd. (NITI). After concluded experiences from Nantong Science and Technology Park, studied from Industrial Technology Research Institute of Taiwan and Kunshan, Jiangsu; in 2013, Nantong Science and Technology Park Development Co., Ltd. was renamed to be Nantong Industrial Technology Institute Co., Ltd. (NITI). It was invested and managed by Nantong Industries Group Co., Ltd. In 2016, 182 enterprises entered NITI. Among them, there were over 10 research institutes, 3 of which were led by academicians. The total incubating area was 58,180.2 m² and the total registered capital was 560 million RMB. NITI also signed an agreement to joint development of the industrial bases in both Nantong Development Zone and Binhai Industrial Park. NITI also had a Science and Technology Service Square to provide enterprises that were operating “the Trinity” with management consulting, intelligence property, law, financing, talents, technology research development, and so on.

The initial purpose of establishing Technological Innovation and Entrepreneurship Community was for technology innovation. But technology innovation was too broad to cover and the innovation direction of the community was vague. What’s more, the operation of the community was not clear. The innovation direction and the operation pattern of Nantong Science and Technology Park were comparatively clearer. The main focus was on technology incubation, and promoting the incubation achievements to enterprises in Nantong so that the business could implement enterprise operation. The technology incubation was a research that Nantong Science and Technology Park did on technology innovation chain; it was also an expansion of industrialization. It was the leading factor that caused NITI to be appeared in front of people’s eyes. NITI concentrated on the generic technology and critical and forward-looking scientific problems in the industrialization of Nantong; it had a clear direction and formed a synergy innovation chain that was research institutes research, incubators in-

cubate, and the industrialization. This was also known as “the Trinity”.

3.2. “The Trinity” Synergy Innovation

“The Trinity” focused on the generic technology, critical and forward-looking scientific problems in the industrialization of Nantong. It collaborated research institutes’ research, incubators’ incubation, and the industrialization with NITI and formed a comprehensive technology innovation chain.

Research and import science and technology in the light of regional industrialization. The research from the institutes is the core of “the Trinity”. In order to meet the needs of scientific technology, NITI imported research teams and technology required teams to establish research institutes. It assigned requested technology to different research institutes and provided them with relevant services. Based on the requested technology, institutes utilized platform to operate research. NITI found branches in different villages and towns to provide services so that the whole area within Nantong would benefit from research achievements. Right now, NITI imports intelligent equipment and architecture research institute, textile science and materials engineering technology research institutes.

Improve the efficiency of technology incubation and transfer. The incubator is the support of “the Trinity”. The incubator comes from the equipment that incubates eggs. In the paper eggs mean technology. The incubator refer to space which provides facilitates for research, production and offices, gain supports from policies, law, finance and extension. Its purpose is to support the new technology to be experimented. NITI strictly perform mechanism, improved efficiency. Firstly, NITI expanded synergy innovation line. During the pre-incubation time, NITI cultivate the nursery garden for developing entrepreneurship; during the post-incubation, creates an accelerator; when the incubated outcomes are ready, it will send them to industrial parks in different villages and towns. For instance, for gazelle-like enterprises, which have intellectual property rights, high market share, and a great potential for branding, NITI will mark them as potential well-incubated targets. Secondly, NITI expanded synergy innovation line to create new incubators. It encourages different incubators to expand in different forms, and more and more technological enterprises will be influenced. For example, NITI finds related technologies; put their achievements to link new platforms. NITI builds an exhibition center to show significant scientific and technological achievements and industrial achievements; and it always exhibits the latest technological achievements in related fields and patented technology products; holds project presentation; provides place for impelling major industries to incubate and industrialize in Nantong. Thirdly, NITI exported incubation services outside. NITI is the research and innovation center of all industrial development in Nantong whose technological achievements and research service platforms are serving for all enterprises in Nantong. NITI has a mutual beneficial and long-term stable cooperation with other surrounding industrial parks. At the same time, it introduces incubated enterprises to related industrial parks.

The technology transferring system in NITI contains Nantong University Technology Transfer Center, Nantong Higher Education Technology Transfer Center, and China Innovation Stage-Nantong branch. In 2016, 12 projects were in incubation, which were from enterprises outside.

Establish and Develop S & T industrial Bases. The multiply of industrial bases are the expansion of “the Trinity”. According to the cooperation agreements of industrial parks, incubated enterprises will enjoy infrastructure and services provided by the industrial parks; they will also experience the supportive policies on land, financing, market, tax, and government services. Industrial parks will help enterprises to blend into relevant industries in order to agglomerate. There is an intention to cooperate with Nantong Economic and Technological Development Zone, Nantong High-tech Zone, Nantong Binhai Industrial Park, further. The focus of the cooperation will be on the co-construction of Intelligent Building Industrial Park, New Material and New Energy Industrial Park, and Ocean Industrial Park.

3.3. “The Trinity” Synergy Innovation Mechanism

The institutes, incubators, and bases are three different nodes on the S & T industry chain. NITI integrates the three nodes as a whole through strategies, services, and benefits (Figure 2). Strategy synergy is the foundation and guarantee of both service synergy and benefit synergy; it determines the direction of “the Trinity”. Service synergy blends into every link of synergy innovation research, incubation, and bases; it obtains dynamic service capacity and the coordinative ability. Benefit synergy goes through strategy synergy and service synergy; it is the source.

Strategy synergy of “the Trinity”: for China, the synergy innovation of IA collaboration is developed during traditional industrial stage. The strategy synergy is primitive; communication among enterprises, universities, and institutes is not smooth; the level of technology research and innovative cooperation

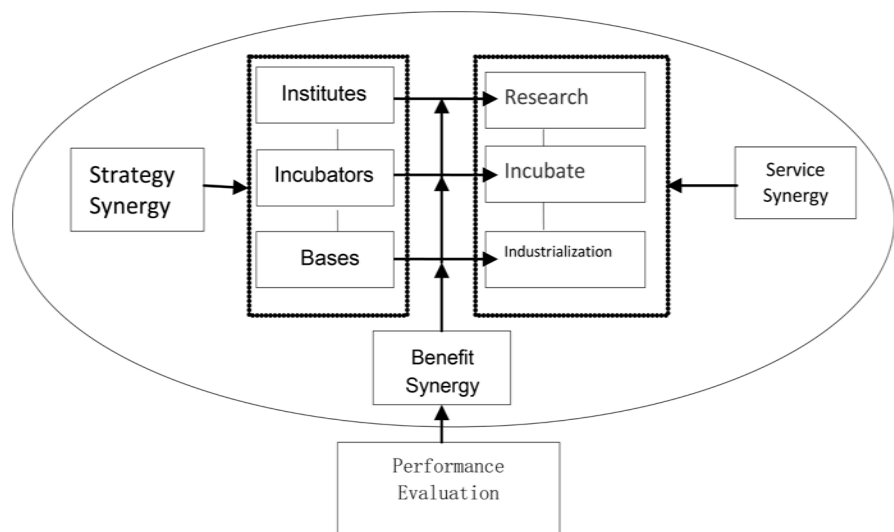


Figure 2. “The Trinity” synergy innovation mechanism.

is low [14]. Institutes, incubators, and bases are entities of independent economic interest. Their strategic targets are different, as a consequence, the expected goals will be different; the integration of the three nodes is difficult. NITI uses strategies to make institutes, incubators, and bases concentrate on generic technology and critical and forward-looking scientific technology of Nantong industrial development. NITI ensures the development direction of science and technology. It needs to perform strategy synergy in the following facets: firstly, “the Trinity” synergy innovation should position on major industry and relevant areas. According to industrial development plans of Nantong, NITI’s Industrial Technology Research Center investigates and summarizes, and demonstrates issues based on different categories of enterprises; it establishes the generic technology and critical and forward-looking scientific technology in major industries. NITI imports research institute, sci-tech teams, or the technology. Secondly NITI is to formulate the development plan. Institutes, incubators, and bases participate into the plan and understand the overall development goal of NITI.

Service Synergy of “the Trinity”: On the basis of the industrial plans of Nantong, NITI links research, incubation, and bases. NITI services for three parts. The first is to attract high-caliber professionals. People are the most important factor of technology innovation. Universities and institutes have a big number of teachers and post-graduate education students; they can provide the transformation of technology innovation [15]. NITI is neither a university, nor supported by powerful enterprises. What’s more, the remoteness of Nantong does not have a strong attraction to the high-tech talents. However, through the interaction between internal and external talents, it increases the communications and gatherings of high-tech talents. Until 2016, NITI has one person in Thousand Talents Program, one person in Hundred Talents Program, four people in Innovative and Entrepreneurial Talents of Jiangsu, three in Doctor Group, and fifteen people in Nantong Top Talents. The second is to establish S & T research service platforms. Synergy innovation led by college students has impeccable infrastructure and advanced research facilities and resources; they can continuously expand scientific research place [15]. NITI does not have many technology innovation resources that can be shared on platforms, mechanism does not function well, and technology innovation barriers cannot be removed easily [16]. The upfront investment in technological research is large, so institutes do not have enough platforms to conduct research. NITI, on the one hand, makes use of the research facilities from Nantong Universities; on the other hand, it establishes platforms, such as co-constructed or independently constructed platforms; it negotiates with large enterprises and makes them build platforms. NITI provides platforms which are built by enterprises and research institutes with facilitation services and helps them to get more government financial subsidies for the establishment and operation of the platforms. 10 public research platforms are built by 2016. The third is to develop financial services. The three nodes in synergy innovation all face the dilemma of money shortage. NITI creates an open and three-dimensional financing system. It attracts VC

firms to invest in the technological research, the transfer and transformation and industrialization. NITI co-founded Nantong Yida Innovative Entrepreneurship Investment Company with Jiangsu Advanced Technology Investment Company to invest high-tech incubator project that having self-owned intellectual property right. According to the enhancements in talents, capital and R&D, the three nodes can be combined together, form a virtuous circle entity.

Benefit Synergy of “the Trinity”: More than 50 percent of failures in IA co-operation are due to unreasonable profit distributions; in practical, the imperfection of IA cooperation mechanism, distribution system in innovative objects has become a significance restraining factor [17]. The synergy usually produces unexpected consequences; it highly relies on the reliance and joint commitment. The synergy party should take the other party’s benefits into consideration, just like treating their own benefits. The benefit synergy emphasizes the cooperating on accomplishing the common goal based on risk sharing and benefit sharing, as well as a fair and honest cooperation environment. In benefit synergy, IA helps the three nodes deal with their individual benefit and their rational interest relationship with “the Trinity”. When initial funds were transmitted to the three nodes in research projects form, the benefit distribution of scientific achievements will be determined by negotiation. If the three nodes’ achievement does apply to the regional enterprise and solves scientific problems, the percent of benefit distributions can be lower. After operating and practicing for decades, the faith and ability of risk sharing between three nodes has been increased. “The Trinity” spread the three nodes’ risk into IA, increasing their expected returns. In addition, it also expands the profits space in technology innovation.

3.4. Performance Evaluation of “the Trinity” Synergy Innovation

In order to form a better synergy innovation mechanism and establish a synergy innovation network to support company’s technology innovation and industrial upgrading and be more competitive, IA have its “Unique Skills” [16]. Comparing with other synergy innovation technology, the unique skill of “the Trinity” is transferring the three nodes into an organism and making “ $1 + 1 + 1 > 3$ ” become true to some extent. It specifically reflects on the following two aspects.

“The Trinity” has higher efficiency of technology transformation. In accordance with “Guangming Daily”, China’s transferring rate of scientific and technology achievements is only 25%, and the really industrialization accomplishment rate is only 5%. The contribution rate of scientific-technical progress is less than 4%, while the rate in developed countries is more than 60%. It reflects the low efficiency in synergy innovation; the scientific and technological achievements didn’t support the development of economy efficiently. Although several technology innovation are taking parts in “the Trinity”, NITI is doing a good job in the promotion of resource integrating, the allocation of benefits and the construction in technology innovation public service system. It has higher innovation level and management efficiency. Until 2016, there are 11 technology institutes in NITI achieved 102 intellectual properties. During 2013 to 2016, the

Intelligent Building and Intelligent Equipment Institute brought around 20 relevant companies gathering together. The material engineering department from Nantong University creates 4 companies successfully, including Nantong Giant Material Technology Co. Ltd.

“The Trinity” gives considerations on both social and economic benefit:

The synergy innovation of IA cooperation is a kind of synergy innovation which is dedicated on solving one enterprise’s technological difficulties. The economic benefit is more distinct in terms of IA cooperation. The synergy innovation of “the Trinity” is for local industrial transformation and economic development; its major consideration is the whole benefit which means social benefit to IA cooperation. The synergy innovation of IA cooperation is designated for solving one enterprise’s or an industry’s technological difficulties; after technology innovation, the beneficiary is individuals from IA cooperation; the social benefit is not very obvious. NITI gets profit by serving enterprises (including technology and training services), commercial real estate economy, technology transfer, and return on equity. By 2016, the total assets of NITI have increased from 200 million RMB to 644 million RMB; owner’s equity has also increase for 367 million RMB; liability ratio is decreasing gradually year by year and the capability of self-operation is getting stronger and stronger.

In a view of Ronald Coase’s theory of enterprise institution, “the Trinity” Synergy Innovation is the substitution of market with enterprise. “The Trinity” is the synergy of institutes, incubators, and bases market integrated into NITI, which means the substitution of the three markets with NITI. Because of the existence of NITI, it has the cost of operating “the Trinity” Synergy Innovation, and is bigger than the cost of synergy innovation of IA cooperation. NITI has been developing and existing for over a decade, it can be backward inducted that the existence of NITI may have increased the cost of operating the organization, but the increased cost is should be way less than the increased benefit that NITI may have brought to the local technology research, technology transfer efficiency; in another word, “the Trinity” Synergy Innovation implemented by NITI has its market value.

4. Conclusion and Future Research Direction: Synergy Innovation Undeveloped Areas

In “the Trinity”, the institutes are to research; incubators are responsible for the incubation; and bases put the incubated research into practices. It avoids generally problems existed in synergy innovation of IA collaboration by analyzing strategy synergy, service synergy, and benefit synergy. After operation, the efficiency of synergy innovation has increased. In comparison with synergy innovation of IA cooperation, NITI makes progress which is also a type of innovation.

The development from Technological Innovation and Entrepreneurship Community to NITI demonstrates that the market gradually goes on the track of technology innovation according to the economic development trend and the needs for technology. Government has somehow leading roles. When Chinese S

& T innovation is in slow-paced development; when local finance is powerful, attempts to solve common problems in regional enterprises, and impel industrial transformation through technology innovation, the semiofficial enterprises which are supported by local finance and operate like an enterprise, could be a shortcut to synergy innovation. Under the circumstances of market-oriented economy with Chinese characteristics, some of these methods could be a way to represent synergy innovation.

The paper only uses NITI as an example to analyze and draw conclusion from it. NITI locates at a comparatively more developed area; local financing power is strong and can support imported S & T research institutes, technology as well as incubators and the development of industrial bases. However, if local financing power is a little weak, how to use an effective form to impel IA cooperation and seek for local industrial transformation and technology innovation, is the next research direction.

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