Study on Maturity Model Construction of Industry-University-Research Synergetic Innovation in University

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Abstract

Based on the connotation and characteristics of industry-university-research (IUR) synergetic innovation in universities, this paper analyses the composing dimensions of its maturity and ranks it according to the perfection degree of the dimensions. On this basis, this paper puts forward the maturity model of synergetic innovation in universities and defines the key processes of the synergetic innovation ability maturity of different levels.

Keywords

Industry-University-Research (IUR), Synergetic Innovation, Maturity Model

Introduction

The IUR (industry-university-research) synergetic innovation in universities refers to the innovation activities conducted within a university, between different universities, among universities, research institutions and enterprises, as well as among university teachers, researchers in research institutions, enterprise producers and managers to make significant progress on scientific research and technological development through investment of their superior resources (Teece, 1986), (Howe, 2009), (Baldwin, 2010).

There are many problems in the IUR synergetic innovation in China such as lack of innovative ideas, poor ability of resources allocation and integration, unfavorable transformation of research achievements and unsound system and mechanism (Li Zhongyun, 2012). The most important factor that affects the efficiency of the university synergetic innovation is not external environment, but the transformation of resources into ability. The IUR synergetic innovation ability mainly includes the ability of interaction between the internal factors of a university and that between university s and other relevant subjects (Huber, 2002), (Lee, 1996). The study on synergetic innovation ability is of great significance for transformation of resources into ability among the innovation subjects, establishment of long-term synergetic innovation alliance of governments, university s and industries as well as improvement of scientific research capacity of university s (Slaughter, 2004). However, there are few researches on evaluation of the comprehensive development level of the IUR synergetic innovation in universities. This paper introduces maturity model into the study on the IUR synergetic innovation in universities and puts forward the maturity model of IUR synergetic innovation with maximization of the synergetic innovation ability as the goal.

Concept, Connotation and Characteristics of IUR Synergetic Innovation Maturity

Concept and Connotation of IUR Synergetic Innovation Maturity

The concept of IUR synergetic innovation maturity refers to the ability level of overall synergistic effect achieved through complex nonlinear interaction between innovation elements after organic coordination and distribution by university s, which cannot be achieved with any separate element. It is a kind of ability level of synergetic innovation and innovative achievements of university s, which is clearly defined, managed, measured and controlled. The IUR synergetic innovation maturity model can help the university s evaluate their synergetic innovation ability and manage and improve the synergetic innovation process in time. It embodies the gradual
improvement of synergetic innovation of university s step by step (Duan Jingjing, 2011), (Bonaccorsi, 1994), (Sun Xinbo, 2012), (Raju, 1995).

In order to maximize synergetic innovation effect, it is necessary to design an evolutionary path for the IUR synergetic innovation to improve the ability in proper order gradually. The maturity model should have the following functions: to discover and confirm the present situation and to find problems; to provide specific method of improving synergetic innovation for the innovation subjects by comparing the similarities and differences between reality and the model; to achieve the goal of perfection and improvement of performance by elevating the IUR synergetic innovation in universities to a higher level in the maturity model.

**Characteristics of IUR Synergetic Innovation in Universities**

On the basis of literature research, the characteristics of IUR synergetic innovation in universities are summarized as follows in this paper:

1) **Mutual Benefit and Win-Win**

The universities’ need for knowledge distribution and enterprises’ need for technological innovation knowledge source constitute the market of supply and demand of synergetic innovation. Participating in synergetic innovation is an effective way to achieve a win-win situation among the innovation subjects. Compared with the collaboration between enterprises, non-competitiveness in respect to economic gain is the advantage of the IUR synergetic innovation. Li Jinhai et al. believe that only when there is common interest among the synergetic parties and the advantage, risk and benefit sharing mechanism is fully embodied, can the interest subjects of synergetic innovation project break the organizational boundaries and achieve the organizational synergy (Li Jinhai, 2013).

2) **Diversity**

The complexity of synergetic innovation is determined by the diversity of synergetic innovation subjects, elements and accomplishing means in structure. Wu Kai believes that the university synergetic innovation is constructive collaboration conducted by governments, enterprises, university s, research institutes and intermediaries to seek a series of common social and economic goals, which can be regarded as a complex system containing a variety of social factors with obvious diversity (Wu Kai, 2013). The end result of synergetic innovation is collection of synergistic effects which cannot be realized through any one separate element.

3) **Integrality**

Synergetic innovation is organic combination of innovation subjects and elements. The targets, functions and innovative ways of the subjects are of uniform integrity (Hu Yong, 2014). The synergetic innovation is an integral whole composed of multiple branch systems. The branch systems participate in the synergetic innovation jointly and play their roles respectively, so as to achieve the synergetic innovation effect gradually.

4) **Nonlinearity**

Synergetic innovation refers to the process of overall synergistic effect produced through complex nonlinear interaction between cluster innovative enterprises and external environment competing with and restricting each other as well as collaborating with and benefiting from each other (Hu Enhua, 2007). Only by avoiding the interference and influence between the innovation elements to form nonlinear relationship between the elements, can they work the best during the synergetic innovation process.

**Composing Dimensions of the IUR Synergetic Innovation Maturity**

The third-generation theory of technological innovation built by Freeman & Lundvall et al. highlights the organizational, cultural and market dimensions of the innovation system.

On this basis and with reference to the relevant previous research on the IUR synergetic innovation in universities, the paper presents the specific information of these three dimensions of the IUR synergetic innovation system.
Organizational Dimension

According to the realization approach, the synergetic innovation can be divided into internal and external synergetic innovation. The subject of internal synergetic innovation is the industrial organization itself and the realization of the internal synergetic innovation depends on the interaction between the internal elements, while the realization of external synergetic innovation mainly relies on the interaction between the industrial organizations and other relevant subjects (Zhang Gang, 1997). The empirical analysis on the internal innovation synergy mechanism of an enterprise and its influential factors shows that technology, organization, culture, strategy and system have significant influence on the synergetic innovation performance (Bai Junhong, 2008). During the external innovation, namely, the interaction between the industrial organizations and other relevant subjects, Lv Haiping et al. believe that lack of managerial and synergetic ability is the main obstacle to combination of industry, education and research and that even the technological innovation activity is conducted by a single organization, it often fails due to poor internal organization (Lv Haiping, 2004). The innovation activities can be conducted in a broader organizational space through penetration and integration among the organizations, so as to promote the integration and movement of resources and maximize the innovation value (Rao Yanting, 2012).

Based on the above point of view, the organizational dimension is defined as follows: Enterprises, university s and governments break the organizational barriers through interaction of their own internal elements and deeply cooperation with each other to achieve self organization from disorder to order. It is a necessary step for the enterprises, university s and governments to realize organic combination and make it become a mature, stable and idealized cooperation model gradually.

Market Dimension

Wu Yue and Gu Xin propose that with the rising market competition, the synergetic innovation may focus more on the synergetic innovation behavior with enterprises, university s and research institutes as basic subjects under the synergetic support of governments, technology service agents, financial institutions and other relevant subjects with more emphasis on the complementation of superior resources and advantageous ability of the subjects (Wu Yue, Gu Xin, 2012). Based on the analysis on university -dominated synergetic innovation dynamic mechanism and the existing problems, Li Zuchao and Liang Chunxiao point out that the market pull is one of the dynamic factors of the university -dominated synergetic innovation and that the university s should have not only research strength, but also marketing strength in respect of market forecasting and product sales (Li Zuchao, Liang Chunxiao, 2012). Jensen R.A et al. point out that if the scientific research in university s is not geared to the industrial demand, it will be difficult for the enterprises to evaluate the market value of the scientific research achievements of university s and this will cause displacement of technological supply and demand and increase of knowledge transaction costs (Jensen, 2003). Based on this, market dimension is defined as follows: various economic relationships between the producers and consumers of innovation achievements and consumer demand faced by the synergetic innovation subjects and affecting their research orientation.

Cultural Dimension

Siegel Donald, Waldman David and Atwater Leanne & Link Albert point out that the knowledge exchange and transfer between enterprises and IUR alliance may be influenced by cultural factors (Siegel, Waldman, Atwater Link, 2003). Wu Yue and Gu Xin propose that social morality, value conception system and trust between innovation subjects may have significant impact on the cooperative behavior of the subjects who are in partnership with each other by means of equity or contract (Wu Yue, Gu Xin, 2012). Li Xueling and Gu Xin point out that the organizational climate is the externalization of organizational culture. It influences the innovation ability of the organization by influencing the organization members’ attitude, belief, motive and behavior and eventually has an effect on the synergetic innovation performance (Li Xueling, Gu Xin, 2013). Stanley E. Fawcett, Stephen L. Jones and Amydee M. Fawcett point out that trust is the core of synergetic innovation ability and that the synergetic innovation driven by trust can improve the organization's ability required in this era of intense changes (Fawcett, Jones and Fawcett, 2012). Based on this, the cultural dimension is defined as follows: all human factors influencing the operation of synergetic innovation mechanism, including values, moral standards, trust and aspirations both
inside and outside the organization.

**Construction of IUR Synergetic Innovation Maturity Model**

With reference to the SEI capability maturity model (Bonaccorsi, 1994) and based on the concept and characteristics of IUR synergetic innovation in universities and the composing dimensions of the synergetic innovation maturity, this paper builds the IUR synergetic innovation maturity model with the perfection degree of the dimensions as the ranking boundaries of the synergetic innovation maturity.

**Maturity Levels of IUR Synergetic Innovation in Universities**

According to the characteristics of the composing dimensions of the IUR synergetic innovation maturity in different stages, the synergetic innovation maturity is divided into 5 levels from low to high as follows: initial, defined, quantitatively managed, strategic and control level.

1) **Initial Level**

The stage in which each link is in the state of disorder and the subject elements have no clear concept of innovation dimensions is the initial stage of IUR synergetic innovation.

Initial level refers to the initial phase of development of IUR synergetic innovation. The synergetic innovation maturity model in this stage is characterized by the following features: Firstly, the synergetic innovation system is in the stage of formation and the synergetic innovation subjects are linked with each other due to their needs for complementary resources or government’s guidance. Secondly, the relationship between the subjects is not clear. There is still doubt about whether the synergetic innovation system can be sustained. There is no specific implementation plan or resource allocation in each system. The subjects have not broken organizational dimensions due to lack of internal and external synergetic innovation and interaction between the organizations. There are no specific characteristics of market and cultural dimension. Therefore, the overall level of IUR synergetic innovation in this stage is low. Thirdly, the production of innovation achievements only depends on personal ability, experience and enthusiasm. The investment costs and achievement quality are uncontrollable.

2) **Defined Level**

The stage, namely the cognitive process of synergetic innovation, in which the characteristics of organizational dimension can be seen and the IUR synergetic innovation strategy and mechanism are basically matched with the key business goals is the defined-level stage.

The defined-level stage is characterized by the following features: The subjects of IUR synergetic innovation reach a preliminary consensus on specific objectives. The definition of consensus reached to satisfy the consumer demand in market dimension is gradually revealed. In order to realize the expected goals and show the value of IUR synergetic innovation, the subject members reach an agreement to ensure the normal development of the synergetic innovation. The agreement specifies the way of cooperation, code of conduct and allocation mechanism between the subjects. From the perspective of realization way, the subjects have achieved both internal and external synergetic innovation and started to conduct regular communication of fund, technology and staff in this stage. The characteristics of organizational dimension have been fully embodied. In spite of the specifications established for the synergetic innovation, fuzzy budget, unsound synergetic innovation network, inadequate communication between the subjects still restrict the realization of the synergetic innovation effect. This stage is the preparatory phase of IUR synergetic innovation in universities to exert effect.

3) **Quantitatively Managed Level**

The stage in which the innovation subjects conduct cooperative research and development under the guidance of specific market-oriented aims and with emphasis on quantitative control of synergetic innovation process by standardizing synergetic innovation process and improving quantitative management method of IUR synergetic innovation is the quantitatively managed stage.
The quantitatively managed level has the following characteristics: The enterprises and university s establish a long-term and effective standardized management system and the subjects of synergetic innovation invest their key resources including fund, staff and technology. The relatively sufficient innovation fund and market conditions can be really matched with the university s’ need for financial support through reasonable system and effective measures. Thus, the superior resources of the synergetic innovation subjects can be reallocated to realize certain expected goals. The standardized management system can be used to predict and control the relevant expenses scientifically, to ensure the successful resource sharing, and to avoid potential crisis during synergetic innovation. However, the issues about profit distribution and deeper communication and coordination in this stage become more prominent.

4) **Strategic Level**

The stage in which the organizational and cultural support environment of IUR synergetic innovation is built and the strategy, talents, technology and fund of synergetic innovation are integrated effectively to obtain some market returns through optimization of synergetic innovation process is strategic-level stage.

The strategic level has the following characteristics: With development of technology and pursuit for more benefits, the subjects of synergetic innovation are no longer satisfied with the old operation system and initial target. They start to constantly expand the cooperative areas and deepen the level of synergetic innovation, so as to obtain increasing returns from IUR synergetic innovation in universities. During this stage, the subjects of synergetic innovation must establish long-term objectives and clear strategic planning based on their previous cooperation and common aspiration to break the barriers between university s and other innovation subjects, fully release the vitality of talents and technology, explore the synergetic innovation system suitable for different needs and offer public service between enterprises and universities, so as to achieve win-win results.

5) **Control Level**

The stage in which the existing model can be adjusted according to the external environment and internal conditions of IUR synergetic innovation in universities with certain ability of long-term self improvement and regulation of the dimensions is controlled-level stage.

The control level has the following characteristics: The synergetic innovation has been on track and matured gradually. The innovation subjects have obtained corresponding target profits. In order to seek for system optimization further, the enterprises and university s reflect on the problems encountered in previous innovation process and sum up the law, and make evaluation on the synergetic innovation system, so as to make optimization and improvement against new problems at any time in respect to the exchange efficiency of talents and fund and rationalization of resources allocation. In this stage, the synergetic system has been complete and the enterprises and university s have already had strong adaptive capacity. Faced with sudden crisis, they can make prompt adjustments. Although the innovation subjects have obtained maximum benefit, they still need to keep transparency of resource sharing and use their own existing innovation advantage or that under creation to maintain the balance of the whole system and realize long-term and well-ordered maintenance of the innovation system.

**Key Processes of IUR Synergetic Innovation Maturity Model**

To point out the key processes of IUR synergetic innovation in universities can help the IUR synergetic innovation alliance with university s as main body to improve the synergetic innovation ability effectively. On the basis of above research results, each level of the synergetic innovation maturity model is decomposed into 3 phases, including key process area, key practice type and key practice. According to the classification standard of model framework for IUR synergetic innovation maturity level, the paper proposes the targeted strategy and problems which must be solved during the process of synergetic innovation turning into the next level from a certain level.

This paper defines and proposes the specific key processes and problems for each stage of IUR synergetic innovation maturity (shown as Fig. 1). The realization degree of these processes directly determines the achievement situation of corresponding synergetic innovation maturity level.
Conclusion

The IUR synergetic innovation maturity model based on systemic thinking describes the dynamic development process of the IUR synergetic innovation ability and can be used directly to evaluate the IUR synergetic innovation level. Moreover, this paper offers a clear improving and evolutionary path to the IUR synergetic innovation subjects by comparing the similarities and differences between the current situation and model of the IUR synergetic innovation in universities, so as to achieve the goal of improving the IUR synergetic innovation ability effectively.

FIGURE 1. KEY PROCESSES OF MATURITY MODEL OF IUR SYNERGETIC INNOVATION BY LEVEL.
With the deepening of theoretical research and practical exploration on IUR synergetic innovation in universities, the IUR synergetic innovation maturity model will certainly become the important theory and method of evaluation and management of IUR synergetic innovation level and also the important tool to improve the IUR synergetic innovation ability.

The IUR synergetic innovation maturity model proposed in this paper is still in its theoretical stage and the key processes defined in this paper might be not perfect enough with inaccurate description. All of these require further thinking and improvement in the following studies.

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REFERENCES


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