Evaluation on Synergetic Innovation Ability of Environmental Protection Industrial Park

Jing Lu¹, Xinfen Wang², Lu Xin¹, Zhijie Xu¹, Zhikai Wang¹ and Yunhao Zhao¹,*

¹Chinese Academy for Environmental Planning, Beijing 100012, China;
²North China Electric Power University, Beijing 102206, China

*Corresponding author e-mail: zhaoyh@caep.org.cn

Abstract. Evaluating the innovation ability of environmental protection industrial park is an important method to promote the construction of the park and master the development status and problems of the park. Based on the theory of synergetic innovation, this research analyzes the technological innovation system of the park, and selects 9 evaluation indexes to build an evaluation model of the park's synergetic innovation capability from three aspects: innovation input, innovation output and innovation support. Using factor analysis method, through horizontal and vertical comparison, this paper evaluates the technological innovation level of Case Parks and Comparison Parks as well as the collaborative development degree of various subsystems, analyzes the main problems in the innovative development of environmental protection industrial parks, and puts forward relevant suggestions for optimization and adjustment.

Keywords: Environmental Protection Industrial Park, Synergetic Innovation Capability, Factor Analysis.

Introduction
In recent years, China's environmental protection industrial parks have been developing rapidly, while there are some phenomena such as "focusing on clustering, neglecting collaboration", "focusing on imitation, neglecting innovation", which eventually lead to prominent problems, such as “homogeneous development”, “not obvious cooperative innovation effect”, and “poor core competitiveness”. Therefore, based on the theory of synergetic innovation, this research constructs an evaluation index system and evaluation method for synergetic innovation of environmental protection industrial parks. Through horizontal and vertical comparative analysis, it evaluates the collaborative development degree of each subsystem in the parks and its impact of the whole system, so as to grasp the problems and deficiencies and put forward adjustment suggestions [1].

1. Synergetic Innovation Theory
Synergetics Theory was put forward by German physics professor Herman Haken. It takes complex system as the basic research object and divides the complex system into several subsystems, and the subsystems are all composed of several elements. Under certain conditions, there is synergy between
each subsystem and each element. Synergetics Theory reveals how complex systems change the disorder state of the system, realizes the evolution and development in an orderly manner, and reveals the internal laws in the process of changing from disorder state to order state [2].

Technological innovation capability is a comprehensive capability system composed of several elements, which is represented by a combination of multiple capabilities such as organization, adaptation, innovation, information and technology acquisition. The so-called synergetic innovation refers to the process in which the subject of cluster innovation and the environment outside the cluster not only compete and restrict each other, but also cooperate and benefit each other, and produce the overall synergistic effect that the enterprise itself cannot realize through complex nonlinear interaction. That is, the process of obtaining innovative resources from the internal and external environment through synergy among innovation subjects, transforming them into goods and services through integration and cooperation, and generating economic benefits [3].

2. Synergetic Innovation Evaluation Index System and Evaluation Method

2.1. Evaluation Index System

Based on the theory of synergetic innovation, this research believes that the evaluation of synergetic innovation capability of environmental protection industrial parks is the process of realizing the maximization of profits in the economic activities of clustering enterprises by constantly exchanging materials, resources and information with the internal and external supporting environment to carry out innovation of technology or products during the development and evolution of each innovation subject in the industrial parks. This paper mainly constructs an index system to measure the synergetic innovation capability of the park from three levels: Innovation input, innovation output and innovation support [4].

(I) Innovation Input

Innovation input is the material and technical guarantee for the formation of innovation capability. It directly reflects the investment of manpower, material and financial resources in the innovation activities of various innovation subjects in the cluster area, and is the material and technical basis for the formation of innovation capability. At the same time, the scale, quality and structural optimization degree of innovation resource investment will directly determine the innovation output scale and innovation efficiency. Among them, the allocation of innovative resources by innovative subjects is the most critical link in the formation of innovation capability in the park [5-7].

(II) Innovative Output

Innovation output is the final result obtained by the innovation subject of the park through optimization of the allocation of innovation resources that is, carrying out a series of innovation activities, under certain environmental support. It is also the symbol of the formation of innovation capability of the park. On the other hand, the innovation output performance directly affects the innovation input and the organizational operation of the innovation subjects, and affects the clustering of innovation resources.

(III) Innovation Support

The innovation environment mainly includes policy environment and economic environment. A good innovation policy environment can stimulate the innovation enthusiasm of the innovation subjects and give full play to the innovation potential of the innovation subject, which is a very key factor to enhance the innovation ability. Institutions such as finance, intermediaries, incubators and industrial alliances play a supporting role. Among them, financial institutions can solve capital problems for enterprises [8].

2.2. Factor Analysis

Factor Analysis is a multivariate statistical method using dimension reduction method for statistical analysis. It is the development of Principal Component Analysis. It was first proposed by Choles Spearman, a British psychologist in the 20th century, and applied to the study of pedagogy and
psychology. The purpose of factor analysis is to study the internal relationship of correlation matrix, and, without losing information or as little as possible, divide many variables into several groups according to the correlation to form grouping variables which are used to explain the original variable relationship. The correlation between variables in the same group is stronger, while the correlation between variables in different groups is weaker. According to grouping, each group of variables can form a common factor and independently serve as a model variable. The precondition of using Factor Analysis is: First, the number of factors is less than the number of original variables; Second, the factors can reflect most of the information of the original variables; Third, the factors are linearly independent of each other. The advantage of Factor Analysis is that the analysis process is objective and the analysis results can be sorted [9].

3. Empirical Analysis
In this research, Yixing Environmental Protection Science and Technology Industrial Park is selected as the research object (Case Park), and its relevant original data from 2015 to 2017 are collected through field investigation or questionnaire as support to vertically compare the annual change trends of each innovation element and the relevant indicators of the Case Park. Meanwhile, five other high-tech industrial parks (Comparison Parks) in Jiangsu province are selected for comparative study, to horizontally analyze the shortcomings and gaps of the Case Park in synergetic innovation development, thus suggestions for optimization and adjustment are put forward.

3.1. Index Selection
Based on the above analysis, combined with the availability and quantification of each index, the following 9 indexes are selected to form the Evaluation Index System for the synergetic innovation capability of environmental protection industrial parks in this paper, as shown in Table 1.

**Table 1. Evaluation Index System for Synergetic Innovation Capability of Environmental Protection Industrial Parks**

| Primary Index          | Secondary Index                  |
|-----------------------|----------------------------------|
| Innovation Input      | Number of cluster enterprises $X_1$ |
|                       | Number of cluster high-tech enterprises $X_2$ |
|                       | Number of research institute $X_3$ |
|                       | Number of employees $X_4$         |
| Innovative Output     | Operating income $X_5$            |
|                       | Number of patents granted $X_6$   |
|                       | Number of brands owned $X_7$      |
| Innovation Support    | Number of national science and technology incubator $X_8$ |
|                       | Number of industrial alliance organizations $X_9$ |

3.2. Data Processing and Analysis
In order to avoid meaningless comparison between data caused by different dimensions, z-score standardization method is adopted to carry out isotropic and standardized processing on the original data. SPSS25.0 was used for statistical analysis of the selected 9 indexes. According to the calculation results of common factor variance, the common factor variance of each variable is larger, which
indicates that the extracted common factor has a higher degree of explanation for each variable, so Factor Analysis can be carried out on the data. In order to investigate the importance of variables to factors and make comprehensive evaluation, factor scores were calculated. The factor score is calculated according to the factor score matrix and variable observation values [10].

According to the model formula, the single factor score and factor comprehensive score of the six industrial parks are calculated, as shown in Table 2.

Table 2. Factor Score and Comprehensive Score of the Industrial Parks

| Year | Industrial Parks                          | $F_1$ | $F_2$ | F     |
|------|------------------------------------------|-------|-------|-------|
| 2015 | Wuxi High-tech Zone Intelligent Sensor Innovative Industrial Cluster | 1.217 | 0.543 | 0.980 |
|      | Jiangyin High-tech Zone Special Steel New Material Industrial Cluster | -0.603 | -0.857 | -0.693 |
|      | Changzhou High-tech Zone Photovoltaic Industrial Cluster | -0.827 | -0.988 | -0.884 |
|      | Suzhou High-tech Zone Medical Devices Innovative Industrial Cluster | -0.905 | 1.643 | -0.009 |
|      | Suzhou Industry Zone Nanometer New Materials Innovative Industrial Cluster | -0.548 | -0.227 | -0.435 |
|      | Yixing Environmental Protection Science and Technology Industrial Park | 1.290 | -0.339 | 0.717 |
| 2016 | Wuxi High-tech Zone Intelligent Sensor Innovative Industrial Cluster | 1.263 | 0.559 | 1.015 |
|      | Jiangyin High-tech Zone Special Steel New Material Industrial Cluster | -0.598 | -0.859 | -0.690 |
|      | Changzhou High-tech Zone Photovoltaic Industrial Cluster | -0.801 | -0.997 | -0.870 |
|      | Suzhou High-tech Zone Medical Devices Innovative Industrial Cluster | -0.837 | 1.826 | 0.100 |
|      | Suzhou Industry Zone Nanometer New Materials Innovative Industrial Cluster | -0.445 | -0.212 | -0.363 |
|      | Yixing Environmental Protection Science and Technology Industrial Park | 1.425 | -0.368 | 0.794 |
| 2017 | Wuxi High-tech Zone Intelligent Sensor Innovative Industrial Cluster | 1.251 | 0.555 | 1.006 |
|      | Jiangyin High-tech Zone Special Steel New Material Industrial Cluster | -0.596 | -0.859 | -0.689 |
|      | Changzhou High-tech Zone Photovoltaic Industrial Cluster | -0.786 | -1.004 | -0.863 |
|      | Suzhou High-tech Zone Medical Devices Innovative Industrial Cluster | -0.805 | 2.085 | 0.211 |
|      | Suzhou Industry Zone Nanometer New Materials Innovative Industrial Cluster | -0.379 | -0.137 | -0.294 |
|      | Yixing Environmental Protection Science and Technology Industrial Park | 1.685 | -0.363 | 0.965 |

4. Results and Suggestions

The research results show that Yixing Environmental Protection Science and Technology Industrial Park, the Case Park, has a higher level of synergetic innovation compared with the other 5 industrial clusters horizontally, second only to Wuxi High-tech Zone Intelligent Sensor Innovative Industrial Cluster. Through the three-year vertical comparison from 2015 to 2017, the comprehensive score of
Yixing Environmental Protection Science and Technology Industrial Park has increased, indicating that its synergetic innovation level is continuously improving. Through single factor analysis, we can see that Yixing Environmental Protection Science and Technology Industrial Park has a high score of first principal component factor, while the index scores of investment in scientific research institutions, brand output and incubator support represented by the second principal component factor are relatively low, with a negative score, which is far lower than the average level, thus making the comprehensive score relatively lower.

Yixing Environmental Protection Science and Technology Industrial Park has been maturing in recent years with the number of enterprises and research institutes introduced into the park increasing. However, due to the lack of effective cooperation mechanism between industry, university and research institutes and the lack of relevant policy support for technology transfer, the transfer efficiency of its new technology is not high, resulting in the overall innovation capability of the park far from reaching the optimal level. Therefore, it is recommended to optimize from the following aspects: (1) Implementing the industry-university-research synergetic innovation mode to promote technological innovation in the Park. Through cooperation, enterprises will feedback market information to scientific research institutions. Scientific research institutes will timely optimize and adjust research objectives to ensure theoretical research value and full application value; (2) Giving full play to the role of innovation support in technological innovation. In the process of technological innovation in industrial parks, institutions such as finance, intermediaries, incubators and industrial alliances play a supporting role; (3) Perfecting the government's supporting function in technological innovation. Various supportive and normative policies issued by the government on environmental protection industry can improve the innovation vitality of environmental protection enterprises.

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