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A method for controlling enterprises access to an eco-industrial park

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ABSTRACT

Member enterprises have a vital effect on the stability and system efficiency of an eco-industrial park (EIP), and a selection and control for them is an important part. This paper proposes a new method which is an establishment of both an access indicator system and an extendable optimal degree evaluation model. The indicator system comprises seven primary indicators and twenty-seven secondary indicators. The first three primary indicators, matching the existing industrial chains or not, park capacity and park environmental performance improvement, are proposed from the perspective of an EIP. The others including eco-design, economic benefit, utilization of resources, and pollution control, are suggested from the point of view of enterprises. This new access indicator system provides a basis for evaluating candidate enterprises. The extendable optimal degree evaluation which was proposed by Prof. Caiwen is a method to assess the satisfactoriness of all the indicators and to assign an optimal degree order to each candidate enterprise accordingly. There are four steps to conduct the evaluation after establishing the access indicator system: (1) selecting correlation function; (2) calculating correlations; (3) assigning weights and current values of indicators; and (4) calculating the optimal degree of all the candidate enterprises. The enterprises can be ranked based on optimal degree results. The highest-ranked enterprise should have the highest priority of entering the EIP. This study provides the specifics of applying the method by examining the case of Yantai Economy Technology Development Zone EIP (YTEIP) in Shandong province. The method provides a practical tool for controling enterprise access to an EIP. However, the reasonability and validity of indicators and effectiveness of the established method of extendable optimal degree evaluation merit further studies.

1. Introduction

Industrial ecology (IE) has recently attracted an increasing interest from both the academia and practioners. As a policy tool, IE offers opportunities and solutions to the sustainable development problems with a social or community perspective, particularly through the promotion and development of eco-industrial parks (EIPs) (Gibbs and Deutz, 2005, 2007; Perry and Ong, 2004). Since the success of Kalundborg, Denmark as a preeminent modern case of the eco-industrial networking, eco-industrial parks have sprung up all over the world. A number of eco-industrial projects are in the planning or development stages in North America, South America, Europe, Asia, and South Africa (Grant, 2000; Lowe, 2001; Veiga and Magrini, 2009; Morikawa, 2000; Oh et al., 2005). The National Government of China has begun to promote eco-industrial development with demonstration sites for EIPs since 1999. The State has approved the development of 27 EIPs by December 2008(SEPA, 2009), and accumulated a lot of practical experiences and lessons. Some problems arise with the development of EIPs, the outstanding ones are the instability and poor symbiosis in an EIP (Wang and Yin, 2005; Fang et al., 2007; Zhao and Zhang, 2008). Some scholars point out that China needs to make further progress in academic research in industrial ecology because the research results play key roles in eco-industrial development (Fang et al, 2007). Roberts (2004) points out that there was a range of challenges/difficulties highlighted in the EIP development both within China and abroad. Also our interviews with EIP managers and observation of some EIPs show that the major challenges/difficulties/problems in China are (1) a lack of prevention measures against the risk of an eco-industrial development; (2) difficulty to accurately measure the development and functioning of the EIP; (3) unclear roles of govornment and public bodies in the development and operation of EIPs; (4) insufficient management systems and practices; and (5) a misunderstanding of the nature of eco-industrial parks. They are similar to those revealed by Chiu and Yong (2004) in their study of EIPs in Asia.

With the development of EIPs practices, research on theories and practices of EIPs has become a focus in the IE field. The existing research has explored the concept of EIP, developing mode, planning and constructing, evaluation indicators, stability of industrial ecosystem and industrial symbiosis mechanism (Audra et al., 1998; Lowe and Evans, 1995; Lowe et al., 1996; Roberts, 2004; Cai et al.,2006; Gibbs and Deutz, 2005, 2007; Duan et al., 2005; Eilering and Vermeulen, 2004; Oh et al.,

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2005; Raymond et al., 1998; Jacobsen, 2009; Wu, 2007; Wang and Yin, 2005; Zhao and Zhang, 2008). However, EIP development is yet in its infancy throughout the world. New problems and challenges appear continuously. Wu (2007) shows that many local governments introduced EIP businesses to enhance economic growth regardless of the form of the eco-chains and networks of enterprises. It resulted in severe negative contests for projects between EIPs. As enterprises in the park enjoy a series of preferential policies, many enterprises are willing to enter an EIP. Thus, it is challenging for EIP stakeholders and developers to select suitable member firms so that EIP stability and systemic efficiency can be enhanced. In this paper we propose a simple method to measure how suitable an enterprise is with regard to the integration into a developing eco-industrial park in terms of enhancing its stability and systemic efficiency.

As for selecting suitable member firms to increase EIP stability and systemic efficiency, some scholars have mentioned the topic in their own research. However, to the best of our knowledge, little has be done on the subject. Lowe (2001) in his EIP Handbook for Asian Developing Countries points out that diversity recruitment should be taken, but no detailed method has been put forward. Lowe and Gengyong mentioned briefly in their book that some EIP projects, like Arecibo EIP in Puerto Rico and Burlington EIP in Canada, are followed by waste and by-product exchange network strategies to recruit member firms, also park managers should have a role in ensuring the quality of participants (Lowe and Geng, 2003). Chinese scholars (Zhang et al., 2004) proposed an indicator system for greening investment-recruitment of industrial parks, and entry requirements in terms of environmental factors. In the indicator system, the requirements for enterprises are the four broad indicators including eco-design, economic benefit, utilization of resources, production of pollutant, environmental management, energy and water consumption, technology and equipment level. They applied the indicator system to evaluate the level of greening investment-recruitment in Suzhou-Singapore Industrial Park by a fuzzy methodology. Another domestic sholar, Zhang (2005), proposes an indicator system for projects selection and establishes a multilevel fuzzy inference evaluation model. The indicator system comprises four broad indicators including ceonomy, eco-environment, eco-network and society. In short, the findings domestic and overseas which have been achieved applying an indicator system to determine businesses access to an EIP are in very small amount in the literature.

Our literature review shows that (1) researchers have made some helpful attempts to selecting enterprise access to an EIP and paid much more attention to the indicators of pollutants emission and resources use in the indicator systems established; (2) factors such as the park ecological carrying capacity, industrial chain improvement and enterprises'environment-based designs have not been considered well by previous studies; (3) some indicator measures are not practical in operations like satisfaction for government administration and mass integration.

An EIP has great stablility and systematic efficiency when each member enterprise is suitable and compatible. But the selection of member enterprises for an EIP is often influenced by subjective factors such as personal preferences and professional knowledge of recruiters. A valuable approach of quantitative evaluation for candidate enterprises can partly reduce negative impacts on the EIP system. We attempt to establish an evaluation model using extendable optimal degree evaluation theory which provides a practice tool for EIP managers, based on the analysis of the existing outcomes and investigation of some developing EIPs in China. To be more specific, our objectives are (i) to establish an access indicator system for candidate enterprises (ii) to provide a quantitative method for evaluating the suitability of an enterprise integrating into an EIP to enhance its stability and systemic efficiency. This method is applicable to the industrial parks towards ecological industry development.

2. Methodology

2.1. Access indicator system

2.1.1. Principles and criteria of indicators selection

Although the object and the goal of evaluation methods vary, researchers typically have concensus in the principles and criteria for selecting indicators, such as practicability principle. Kurup et al. (2005) highlight the priciples of relevance, practicability and appropriateness. We adopt the following criteria for selecting indicators:

- Comprehensive: In choosing scale indicators, we should consider the various factors including the capacity of an EIP to incorporate a new enterprise and the characteristics of an enterprise including resource use and pollutant production.
- Available: The indicators selected should be measurable and easy to obtain.
- Relevant: The indicators selected are relevant to the goal of EIP development and enterprises' future.
- Practical: The measurement and monitoring of the indicators are practical and reliable given the resources available to the business and the park.

2.1.2. The access indicator system

We conducted our research in three phases. The first phase involved the identification of twenty eco-industrial parks and subsequently obtaining basic background information on the characteristics of each initiative through email, fax, telephone survey, field research and second-hand literatures conducted between October 2008 and May 2009. Because of the limitation in time and distance, we have investigated on site only five parks that are close to our city. They are Yantai economy technology development zone EIP (YTEIP), Weifang marine chemical industry high-tech development zone EIP (WFEIP), Lubei EIP (LBEIP), Suzhou high-tech development zone EIP (SZEIP), and Tianjin TEDA economy technology development zone EIP (TJEIP). The second step is to obtain a better idea of the EIPs current situation and to identify factors affecting the success of the EIPs by combining the data from twenty EIPs. Finally, we propose an access indicator system for enterprises into an EIP to enhance its stability and systemic effeciency (Table 1) based upon the four principles listed in the previous section.

It is worth noting that all the candidate firms are qualified with regard to national and local industrial policy, industrial planning and environmental acceptability. So the proposed EIP access indicator system does not include indicators related to the three factors.

Regarding the indicator system, access indicators are set from two perspectives—park-based and enterprise-based respectively. There are seven primary indicators, twenty-seven secondary indicators (also measure indicators) in the indicator system, which constitute a hierarchical structure. At the top of the structure, seven primary indicators are the key factors to consider by stakeholders of EIPs. At the bottom of the structure, twenty-seven secondary indicators measure the profiles of each primary indicator. Because the type of the measure indicators has vital effects on the selection of correlation functions, the indicators should be classed according to certain principles. We classify these indicators along two dimensions. First, they can be classified into two catogories based on their indicative function: positive indicator (P) and negative indicator (N). The positive indicator is the one that increases with its value; the negative indicator is the one that decreases with its value (see Table 2). Second, they can also be classified as a quantitative indicator (L) and a qualitative indicator (X) (see Table 2). Thus the measure indicators can be classified into four types: positive and quantitative indicators (PL), positive and qualitative indicators (PX), negative and quantitative indicators (NL) and negative and qualitative indicators (NX).