ANALYZING CHARACTERISTICS OF ECO-INDUSTRIAL DEVELOPMENT (EID) PROJECT IN KOREA COMPARING TO ECO-INDUSTRIAL DEVELOPMENT (EID) STRATEGIES IN NORTH AMERICA AND ECO-TOWN IN JAPAN

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Abstract - The present study aims to analyze the characteristics of Korea's eco-industrial development projects by comparing them to EID strategies in North America and the Japanese Eco Town project. To do this, the study uses a variety of literature to analyze EID's definition, main tasks, execution structure, and relationship with regional society, and it analyzes the major characteristics of Korea's EID projects. The characteristics found through this analysis are compared to the EID strategy characteristics of North America and Japan. The analysis results show that there are limitations in terms of cooperation with regional communities when EID strategy is applied to Korea's eco-industrial park projects. As such, this study presents approaches on how to spread Korean eco-industrial park promotion projects via eco-industrial development strategies in order to advance sustainable regional development policies.

Keywords - Eco-Industrial Park, Eco-Industrial Development, Industrial ecology. Resource circumstance, Industrial symbiosis

I. INTRODUCTION

Before the 1990s, the regional development paradigm was focused on the promotion of growth centers and a top-down development approach based on the economical rationalism of the 50s and 60s. A redistribution model was developed during the development of the 70s, and an internal development model was developed based on the regionalism of the 80s. Diverging from the economically centered regional development orientation that existed before the 90s, paradigms for eco-friendly sustainable development have become an important area of interest in regional development theory. In regional development theories, elements such as ecological considerations, the global resource and energy crisis, and climate

Among the various areas of society, the business and industrial sectors are pursuing resource and energy efficiency in industrial systems and making efforts to combine this with regional development in order to take action in regard to sustainable development. On a small scale, these efforts occur in terms of individual businesses, and on a somewhat larger scale, they occur in terms of relationships between businesses and between businesses and regional societies. Among these efforts, aside from those taken by businesses by themselves, cooperative relationships in regional societies which include cooperative relationships between business are called regional resource recycling networks or regional industry symbiosis networks. In industrial symbiosis networks, waste resources which are thrown away by one business are used as raw material by another business via an appropriate process, and when this is centered on an industrial complex which gathers together businesses, it can be called an EIP (Eco-Industrial Park) project. If this is done on a regional level and integrates sustainable regional development and industrial development, it can be called an EID (Eco-Industrial Development) strategy. Through these EIPs and eco-industrial development, businesses and regional societies can achieve sustainable development i.e. harmony between the economy, society, and the environment.

Therefore, in the present study, the characteristics of Korean EIP promotion projects were regulated through policies on conversion to a central government-focused industrial structure which pursues efficient resource and energy use through the construction of cooperative industrial symbiosis networks. These projects were analyzed in terms of legal regulations about EIP, project scope, promotion systems, and relationships with local governments. A comparative analysis was done with similar policies such as North American EIP and EID examples and Japan's Eco Town project. The goal of this is to examine how EID can be strategically expanded so that Korean EID promotion projects go beyond policies for an industrial structure which simply uses energy and resources efficiently and extend to policies for sustainable regional development.

II. LITERATURE REVIEW

2.1. Industrial Symbiosis

Industrial ecology introduces designs which take into account waste material minimization, reclamation, recycling, reuse, and remanufacturing starting when the product's design and raw material are chosen in order to change the linear investment-processing-waste process of conventional industrial metabolism

systems into something similar to the cyclical system found in the natural world. It covers a wide range of fields such as preventing pollution through clean production technology, reducing the use of toxic material, and pursuing ecological efficiency, and it proposes plans for forming existing systems into production systems which can efficiently use resources. Specifically, it is not a method which effects the environment by emitting and throwing out certain materials used in production as waste materials. Instead it uses the concept of a cyclical network organization which separates and reuses material in the production process. Industrial symbiosis is defined as the network of symbiotic relationships between businesses which participate in the cyclical network of industrial ecology.

The meaning of industrial symbiosis can vary from researcher to researcher, but some researchers understand the concept to be distinct from simple byproduct and waste material exchange networks, and they see it as including systems of cooperation between businesses in a variety of fields such as information, relevant infrastructure, personnel, and marketing.

2.2. EIP/EID

The real beginning of the EIP concept was due to the efforts of expert groups, related businesses, and government organizations who worked to take the Kalundborg industrial symbiosis network example and bring it together in North America from the perspective of sustainable industrial development.

Ernest Lowe basically divided researchers' concepts of EIP into two kinds: 1) a tendency to equate it to an industrial symbiosis network, and 2) a somewhat broader concept. The narrow EIP emphasizes the limits of the industrial park through physical spaces and the nature of the byproduct (material, energy, etc.) exchange network between businesses. Korea's act on conversion to an eco-friendly structure regulates EIPs through this approach. Rules which emphasize the regulation of a physical space called an industrial park will classify the industrial symbiosis network between businesses, which goes beyond the industrial park, as an EIN (Eco-Industrial Network). On the other hand, the type which supports a broad EIP concept understands EIPs through an inclusive concept which includes the construction of an industrial symbiosis system which is centered on byproduct exchange between businesses within the park, as well as various kinds of infrastructure sharing, building community cooperation systems, ecological space planning and development, etc. Also, they tend to not be greatly bound to industrial park rules which are limited by location.

Table 1. Definitions of EIP(Korea Industrial Complex Corporation, 2010)

Category	Researcher	EIP Regulation
Narrow EIP	Desrochers (2001)	EIP is a community of businesses which exchange and use their byproducts or energy within a single region.
	Peck and Ierfino (2003)	EIP is an industrial park with a network of connections between businesses and circulation of material and energy which imitates the activities of producers, consumers, and decomposers in a natural ecosystem.
	Act on the Promotion of the Conversion into Environment-Friendly Industrial Structure	EIP is an industrial park specified by Article 21 of the "Act on Industry Location and Development" which minimizes the burden on the environment and maximizes resource efficiency by taking residues and waste material, such as byproducts created in the product manufacturing process, and reusing them as raw material or energy following Article 2 Clause 8 of the act.
Broad EIP	Cote R. P. & Hall J. (1995)	EIP is an industrial system which provides the opportunity to protect natural and economic resources, reduce the cost and burden of production, materials, energy, insurance, processing, etc., improve operating efficiency and quality, worker health, and public image, and create economic income through the use and sale of waste material.
	Lowe E. A, & Warren J. (1996)	EIP is a manufacturing and service business community which seeks to improve environmental and economic results through cooperation in the field of managing the environment and resources including energy, water, and material.

	Lowe E. A. (2001)	EIP means a production and service business community which cooperates on issues such as the environment and resources by being collectively placed within a fixed site in order to increase environmental, economic and social convenience.
	Cote R. P. (2003)	EIP is a cluster of businesses which uses resource-efficient infrastructure, buildings, processing, and purchasing networks to find a balance between producers and waste material decomposition processers while considering ecological limitations.
	Establishment of EIP Demonstration Project Evaluation and Promotion Plan for Projects (Korean Industrial Complex Corporation, 2009)	EIP means an industrial community which seeks economic and environmental results through the sharing of resources (information, material, water, energy), formation of cyclical patterns, and ecological spatial planning and development within the industrial park and surrounding region based on cooperative relationships between businesses as well as between businesses and regional communities within the industrial park and the surrounding region.

EID (Eco-Industrial Development) is a concept similar to EIP which is also described in a variety of ways. The term EID is a more abstract concept than the concept of EIP, and it is used in many cases. In general, rather than being a clearly, officially regulated concept, it is used as an inclusive, loose concept, and as time has passed, it has come to include various meanings (Kim, Mook Han, 2009).

The concept of EID can be understood as meaning all aspects of development that can be achieved by applying ecological and sustainable principles, covering the entire business production environment as well as abstract areas from physical design to energy and resource efficiency, relationships between workers and the surrounding environment, relationships between regional communities and businesses, etc. (Schlarb& Cohen-Rosenthal, 2000).

At the same time, EID can be understood as a framework which inclusively applies the principles of industrial ecology and sustainable growth at a variety of levels such as individual factories, industrial parks, and regions (Cohen-Rosenthal, 2003). It can also mean the development projects which are implemented by using these principles as well as the results of these projects (Kim, Mook Han, 2009; Deutz& Gibbs, 2004; David Gibbs, et al., 2005; Sterr&Ott, 2004). EID can be understood as a subcategory of sustainable development through integrated value systems such as economic, environmental, and social equality. It has been expanded to a development framework which includes organizational principles such as business recycling on the individual business level, mutual organization methods on the business community level, and -- to expand beyond this -- resident lifestyles and industrial systems on the regional level.

2.3Trends and Distinctions in Related Studies

In the late 90s and early 2000s, before EIP construction projects had begun, initial studies on EIP were mainly focused on strategies for EIP development, the possibility of converting individual industrial parks in EIPs, and ways to improve laws and policies to create EIPs (Choi Jeongseok,1998; Choi Jeongseok 1999; Choi Jeongseok, 2002; Choi Jeongseok 2004; JeongSukyeong& Oh Deokseong, 2002; YeomJeongseop& Choi Jeongseok, 2002; Kim Heungsun& Kang Jeonghun, 2004; Kim Jeonggi& Kim Heungsun, 2005; KimgJongil et al., 2005; SeoKwangseok and Park Kyeongju, 2005; Lee Jaejun& Choi Jeongseok, 2003; Mun Seokung,2003; MunSeokung 2004; KenitchiTogawa, 2003). The research papers of this time period mainly introduced theories and examples from autonomous EIPs such as Kalundborg as well as North American EIP projects, and analysis was actively performed on Japan's Eco Town example. However, the studies of this time period were from before EIP projects were promoted in Korea, so they remained at the level of discussing theoretical application possibilities, and the analysis of North American and Japanese examples could not be compared to the characteristics of Korean EIPs.

In 2005 demonstration projects were being implemented, and the studies on the EIPs that were being announced could mainly be divided into studies which evaluated the latent possibilities of actual industrial symbiosis networks, focusing on various individual materials (Song Inhyeop& Park Jehun, 2006; Kim Donggyu et al., 2009; Kim Hyeonju et al., 2008; Kim Yongsu et al., 2008) and studies which presented the industrial symbiosis network characteristics of individual demonstration project parks and EIP promotion strategies (Lee Sangyun& Kim Jeongun, 2006; Park Heungseok& Lee Sangyun, 2008; Park Sangu et al., 2010; Lee Taeho& Ban

Yeongun, 2010). Rather than discussing the overall characteristics of Korean EIPs or promotion approaches, these studies focused on analyzing the characteristic of small-scale industrial symbiosis networks at individual industrial parks.

Efforts to analyze the general characteristics of Korean EIPs and present new strategic promotion approaches for EIPs began to occur as EIP construction projects showed regular results and issues were raised with the continued promotion approach for the future. These studies compared the characteristics of EIPs in Korea, China, and Japan (Kim Eunsu et al., 2007), developed evaluation indices for the possibility of building EIP networks (Ban Yeongun et al., 2010), and proposed that Korean EIP construction must be improved in terms of specialized personnel training and project fund support based on actual examinations of stage 1 EIP demonstration projection promotion and a survey of experts (Kong Hyeongok et al., 2011).

In 2013, stage 3 EIP projects were occurring and studies examining Korean EIP project characteristics (Han Jaegu et al., 2013; Park Junmo& Kim Hyeongu, 2014; Kim Dodam& Ban Yeongun, 2014; Choi Narae& Ban Yeongun, 2014; Kim Taeho& Ban Yeongun, 2015) appeared, focusing on individual regional projects. However, there weren't enough studies comparing these projects to advanced cases, and the EIP model's attributes were lacking, so they did not present approaches for overcoming Korean EIP projects' limitations.

The present study examines the characteristics of Korea EIP construction projects from a legal basis, looking at various aspects such as the project promotion system. It analyzes Japan's Eco Town program and North American (particularly United States) EIP development, which has a different approach than Korean EIP development and is linked to regional development. It examines how current Korean EIPs can diverge from the framework of simple policies for improving energy and resources efficiency in industrial parks and the industrial sector in order to grow into regional development policies which improve sustainability at a regional level

III. SCOPEAND ANALYSIS METHODSOFTHE STUDY

As for this study's scope, the analysis of Korea EIP characteristics is focused on a project that went from a stage 1 EIP demonstration project in 2005 to being a stage 3 project until it closed in 2016. The North American EID examples are focused on examples in the United States and Canada. The study also analyzes the promotion status and development strategies of Japan's long-running Kalundborg and Styria projects.

The studies' approach divides the EIP concept into broad EIP and narrow EIP as it is variously understood at actual sites by researchers through theoretical observations, and by doing this, it approaches Korean EIP projects' characteristics in terms of project scope. To do this, it performs an analysis via the relevant laws, project content, and promotion systems. To examine the characteristics of Korean EIP projects, the study reviews the EIP project-related laws and regulations from 2005 on, the EIP project-related annual reports and project plans published by the Korea Industrial Complex Corporation, and relevant service reports.

By analyzing North American EIP development examples and Japan's Eco Town example from an ecological regional development perspective, observations are made on planning elements and promotions systems for applying EID through regional development strategies, and a discussion is had on how to apply these things under the current conditions of Korea's EIP project promotion.

IV. COMPARISONOF ECAMPLESIN KOREA, NORTH AMERICA, AND JAPEN

4.1Korea's EIP Projects

The Ministry of Trade, Energy, and Industry is the EIP promotion organization which manages national industrial parks, and the Korea Industrial Complex Corporation (KICOX), which promotes project-related policies on the location of the nation's industry, was designated as the EIP managing organization. However, continual problems occurred due to problems with KICOX such as labor conditions and internal rules, and this became a big obstacle to smoothly promoting projects. Also, KICOX, which was entrusted with tasks related to projects by the Minister of Trade, Energy, and Industry had a structure which created unavoidable difficulties in establishing cooperative relationships with other ministries such as the Ministry of Environment and Ministry of Land, Infrastructure and Transport, which were needed for EIP promotion projects outside of the Ministry of Trade, Energy, and Industry.

In Korea's EIP promotion projects, the broad EIP concept, which is centered on consistent industrial symbiosis networks and goes through the demonstration project and main project stages, is made into a model and promoted. Projects for building and managing networks between individual businesses while excluding approaches that involve existing industrial parks' spatial, ecological, and environmental aspects make it difficult to have an approach which is integrated with relevant projects such as restoring industrial parks or developing their structures. At the same time, a project promotion and management system centered on the central government and managing organizations that focuses on businesses and industrial parks cannot review the meaning of industrial parks in the region and link this to projects that are expanded by regional-level EID.

V. COMPMARISONWITHUNITEDSTATES' EID STRATEGYAND JAPEN's ECO TOWN PROJECT

One of the major characteristics of regional EIP promotion strategy in North America is it is not just an industrial symbiosis network but includes planning elements from a variety of unofficial fields which consider the regional environment and ecosystem in order to pursue a variety of projects which apply industrial ecology principles inclusively. This is seen more clearly in cases where new industrial parks are developed as EIP or EIP is introduced in the process of restoring dilapidated regions. It is important to have a discussion about how to achieve harmony among the integrated planning and design elements in all fields, both official and unofficial, during the process of developing a new industrial park as an EIP from the beginning of the process

The Eco Town project was basically promoted in connection with regional economic revitalization and regional development policies. It also partially introduced planning elements in unofficial areas such as eco-friendliness and rainwater use at the factory level, wind power and solar heat, greenbelt and wetlands protection, etc. At the same time, the Eco Town project also combined waste material circulation networks as well as town plans, city plans, and district environmental plans. Of course, these plans basically tended to focus on industry and the environment, and there is the criticism that they were limited to these areas, including waste material processing, etc., without any consideration of city spatial structures, etc.

Cases in which business and regional interests are linked, such as linking residential waste material to businesses' waste material processing and reuse networks, shows that the project went beyond a network between businesses within industrial parks and became an integrated waste material exchange network at the regional level. At the same time, Eco Town was basically significant as an environmental industry promotion policy (Kenichi Togawa, 2003), but it was also able to incorporate the characteristics of regional development and regional recycling by taking on the form of town planning through participation by the region's residents and promotion systems which passed through local governments. planning.

Category	North American EID	Japanese Eco Town
Project Scope	Pursues the application of an inclusive industrial ecology principle including the construction of byproduct exchanges and industrial symbiosis networks Recycles and reuses industrial park and regional waste material Uses renewable energy and makes energy use efficient Builds other public infrastructure Emphasizes greenbelt and wetland protection and ecological construction plans in new EIP. Develops brownfield land for industrial use through mixed land use	Creates various material circulation networks for manufacturing, farming, and service businesses Actively uses waste heat energy based on a waste material processing policy Builds regional waste material circulation systems for industrial waste material Includes unofficial planning elements such as eco-friendliness at the factory level and rainwater use in some cases, as well as the introduction of solar heat, etc.
Promotion of Regional Society Participation	Expands the participation of the region's residents through EID strategies connected to regional development (infrastructure, land use) Focuses on creating jobs, strengthening regional economy Forms committees for resident participation from the EIP development planning stage (Devens)	Implements town plans, city plans, and district-level environmental plans as Eco Town projects Achieves partial resident community participation in the process of connecting residential waste material to businesses' waste material processing and recycling networks Allows voluntary participation of academia-industry or private businesses
Promotion and Management Systems	Supported by the central government Promoted by various organizations such as private business, local governments, and regional public development organizations Combines research support organizations (clean production support center,	Supported by the central government (the project combines industry economics and the environment) Led by local government. Businesses, universities, research centers, and regional communities participate

CONCLUSION

North America's EID strategy and Japan's Eco Town project reflect the interests of regional citizens through regional community participation and project areas which combine regional communities and the business sector, and they have locally-oriented promotion systems. Compared to these approaches,

Korea's EIP projects are considered to be overly centralized, and their promotion is limited to the business sector, so they have a limited ability to create systems of cooperation with regional communities. In the future, it will be necessary to reorganize EIP projects' promotion systems toward a regional focus and strengthen the regional project groups' autonomy. Systems of cooperation with local governments and regional communities must also be strengthened. In doing this, it is necessary to go beyond the scope of projects which build simple industrial symbiosis networks and advance to the level of regional eco-industrial development.

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