Critical Reviews of EIP development strategies for problems of industrial complexes in Korea[1]

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ABSTRACT

Industrial complexes have been regarded as important tools of industrial policy in Korea. In the process of industrial development, some industrial complexes have been blamed as major causes of environment-related problems. In response to social and environmental requests, researchers and policy makers have tried to introduce a new type of industrial complexes, which can deal with environmental problems and economic efficiency at the same time.

'Eco-industrial Park(EIP)' projects have already started up by the central government in Korea. EIP approaches based on industrial ecology are dealing with firms' production systems and environmental management by forming networks of mutually beneficial symbiosis that mimic natural ecosystem.

The government has already developed 5 EIPs and is planning on developing more EIPs across the nation. Throughout the EIP developments, we came to know that there have been some issues and problems in the national EIP development projects. Throughout years of experiences and researches, several important problems in recycling of resources are known because our EIP projects are implemented only on the basis of industrial parks. Recycling networks in Korea are very restrictive and relatively less effective. Also companies have seldom been interested in government-supported EIP projects, due mainly to the related laws and regulations. It has made the participation in the projects of companies less attractive to them,

The purposes of this article are to give a general view of EIP policy and its problems and give the government better ideas of solutions needed to invigorate recycling network to work more efficiently. The purpose of this paper is to emphasize that several aspects of policies and laws governing EIP should be revised to implement the new recycling system. This trial can be much of help with shrinking EIP projects and waste exchange activities leading to cyclical society.

Ⅰ. Introduction

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Problems caused by industrial complexes haven't been significantly settled so far, even though governments and industries have made a lot of efforts. Sometimes they brought about environmental accidents leading to serious conflict between locals and factories. Still industrial complexes have been regarded something unwanted and unpleasant.

With the increased environmental consciousness and strengthened environmental regulations, new approaches to industrial complexes were really needed. These days we could see the newly developed ideas applying natural ecosystem to industrial world. They are called this Eco-industrial Parks. This idea was provided by Industrial Ecology approach in the early 1980s.

The concept of EIP has been thought to be very ambiguous because of lack of generalized or standardized EIP models. Sometimes EIPs are mistaken with other types of industrial complexes like techno-parks, science-parks. EIPs have their own distinct hallmarks as compared with other types of industrial complexes.

Table 1. Comparisons between EIPs and industrial complexes

-	**Traditional ICs**	**EIPs**
Goals	Industrial Growth	Sustainable Industry
Characteristics of industries	Smokestack industry	Environmentally friendly industry
Strength of networks	Weak	Strong
Environmental regulations	End-of-pipe regulation, Direct regulation	Precautionary prevention, Indirect regulation
Viewpoints of waste	Object of disposal	Inefficiency, Potential resources, Underused resources
Relations with technology	Weak	Strong
Relations with locals	Weak	Very strong
Citizen participation	Very limited	Active
Land use	Strict land use	Mixed land use, Compact land use
Types of Regulations	Command and control	Consequentialism
Inter-companies relationship	Vertical relationship	Vertical-horizontal relationship
Types of industrial policy	black-spot policy	eco-industrial policy
Structure of industry	Artery industry-centered	Vein industry-supplemented

EIPs offer significant economic, environmental and social benefits, both to individual companies, as well as to a collection of companies. Drawing on historical and contemporary examples, proponents of EIP networks chart the following benefits: (1) Environmental benefits

linked to improved resource use efficiencies, reduced use of non-renewable resource and reduced pollutant emissions; (2) Economic benefits emerging from reductions in the resource inputs costs in production, reduction in waste management costs and from the generation of additional income due to higher values of by-product and waste streams; (3) Social benefits by generating new employment and raising the quality of existing jobs and by creating a cleaner, safer, natural and working environment(Lowe E.A, Warren J.L., Moran S.R, 1997).

However, there are several major barriers that have to be overcome. Perhaps the most significant of these is that whilst the concepts have been in existence for several centuries, ″planned/designed″ EIPs have not, and so still need time to be a proven and sustainable option. As suggested, the emphasis for the EIP should, however, be on a system approach, rather than focusing on specific streams. Clearly, there are a number of issues to be taken into account, however, the significance of each of the driving and limiting factors identified will vary depending on the geographical, social, political, environmental, economic and institutional context within which the EIPs are being developed.

Ⅱ. EIP projects in Korea

The Korea government started the EIP projects in 2003 coming up with the master plan on the EIP development by KNCPC on behalf of the Ministry of Knowledge Economy. In 2005 the government accepted three EIP projects, Banwol-Siwha, Ulsan, and Yusoo project as parts of national EIP projects. Two complexes, Chunggu EIP and Pohang EIP were added to the pre-existing EIP projects the following year. These five industrial complexes have been supported financially to make up industrial symbiosis of their own industrial sites since then.

In Korea of 2011, EIP projects which are on the second phase of the national EIP strategy are on the track. The distinct feature on the second steps of EIP development is a hub-spokes strategy, which is the world first attempt in the EIP history. To make Hub-Spoke network, other three industrial complexes, Myeonggy·Noksan, Sungseo, Kusan·Kukgang complex, joined the existing five hub EIP complexes. After all hub-spoke EIP networks in Korea consist of eight major complexes and three or four small-medium sized complexes surrounding them. Korean government and experts are expecting this EIP hub-spoke network to invigorate industrial symbiosis and thus contribute the win-win situation of the environment and economy.

Table 2. EIP Hubs & Spokes (2011)

Region	No. of HUBs	No. of Spokes	Regions	No. of HUBs	No. of Spokes
Busan	1	3	Gyeongbuk	1	4
Daegu	1	3	Chungbuk	1	4
Ulsan	1	4	Chunbuk	1	4
Gyeonggy	1	4	Chunnam	1	4

Actually it is evaluated that the first phase of EIP projects in Korea achieved a lot of benefits economically and environmentally. For example, a total of 45 by-product exchange networks have gained almost 13 million dollar economic profits so far.

Table 3. An example of Economic, Environmental Outcomes (case of Ulsan Industrial Complex)

Field	**Name of projects**	**Economic effects** (million/yr)	**Environmental effects** (Ton/yr)
Energy exchange	Steam supply by Incineration plant	$6.0	Reduction of 55,500 CO_2
	Waste heat supply of incineration plant	$3.0	Reduction of 14,810 CO_2
By-products exchange	Firming agent for sludge	$2.6	-
	Organic by-products	$1.4	-

*KICOX, 2011, Model Cases of EIP projects in Korea

Though we could get lots of outcomes, still there have been a lot of problems to solve and some hurdles to overcome so that the EIP projects in Korea make a great stride in the right direction.

Ⅲ. Reviews on some industrial symbiosis studies

Industrial symbiosis-related policy researches in Korea started in the late nineties, government-supported EIP projects fueled researches on industrial symbiosis, which led to various studies regarding EIPs and industrial symbiosis.

Especially Choi Jeongseok(1998, 1999, 2002, 2004, 2010) ushered in industrial symbiosis strategy and proved the effectiveness of industrial symbiotic networking in both economic and environmental aspects. Lee Jaejoon & Lee Sangmoon(2003) proposed several EIP

development strategies that fit for Korea's industrial world. Oh Deogsong & Kim kyungbae(2002) suggested a new kind of industrial estate design modeled on EIP mechanism. Ban Youngwoon(2008, 2009) also worked out a few important EIP tactics. Park Hoongseok tried to spread the case of Ulsan EIP project to other industrial parks at home and internationally. Besides there have been a lot of researches and studies as to industrial symbiotic network projects. Most of them have been focused on EIP policies or put emphasis upon new business practices which have obviously been making contributions to the development of Industrial Complexes and industrial symbiosis.

On the other hand, KNCPC(2003), an organization that had been charge of EIP projects at the very first has brought out a series of working papers on symbiotic networks. Taking over the national EIP projects from KNCPC, KICOX has supported not a few EIP policy projects up to this time. Among them, the policy report of 2008 came up with a new idea, which paved the way for building the world′s first Hub-Spoke EIP model. On top of that, KICOX has accepted an epoch-making EIP strategy suggested by some experts and has been trying to change the current EIP projects into low carbon oriented projects.

Internationally Journal of Industrial Ecology has been taking the lead in research fields of industrial symbiosis, EIPs, waste & by-product exchange etc. In particular a research paper by Raymond P. Côté and Tsuyoshi Fujita(2009) dealing with evaluation of state-run EIPs, an article of C. Block, B. Van Praet, T.(2011) about carbon-neutral strategies of EIPs and Pierre Desrochers′s study (2001) as to symbiosis of cities and industry were viewed as significant for Korea′s industrial symbiosis approach.

Ⅳ. Problems and Strategies for improvement of EIP projects

1. An outline of survey and interview

I conducted a questionnaire survey and interviews with experts of local EIP divisions to find out problems and get some information on policy implications. The survey with questionnaires was conducted upon 80 EIP experts with a help of KICOX from March 15th to April 2nd in 2011(KICOX, 2011). The questionnaires consisted of three categories(policy awareness, hands-on issues and policy improvement) with 18 questions. I got 43 responses included threw wrong answers. I interviewed with ten experts from five local EIP divisions so that I could investigate some problems of EIP projects.

Throughout the intensive survey, five major problems and policy implications around EIP projects were obtained and several hot issues of law and regulatory aspects. The outcomes of survey and interview are as in the following.

2. Information on waste and Database for waste recycling

Because waste policies of Korea are focused on treating environmental emissions, all kinds of waste-related statistics and their DB systems are related with end-of-pipe management or pollutant treatment by rules. Besides, as environmental statistics have been collecting on an administrative district basis, it is extremely difficult for industries and EIP organizations to know real and exact state of waste they could use in recycling network(Forbes R.M, Peter R. W, Marina F, Peter Hindle, 2007).

While EIP projects have been carried out, one of the biggest problems with recycling networks between companies was lack of data and information available for symbiosis. The survey also proved that problem, showing that 72.5%(29 experts) of respondents answered insufficient data and information on wastes and by-products as the most formidable obstacle in EIP projects.

As a matter of fact, the current statistics industrial and environmental are believed to have several problems when viewed from the side of industrial ecology. Understanding and information on industrial process or raw materials of factories are prerequisite for the industrial symbiosis. But unfortunately those kinds of information and data are usually not available for other companies at all. That's because companies don't want to let other companies know about their production process and products.

Now, it is necessary to establish new statistics and DB system for industrial symbiosis. The easiest way to ameliorate to solve statistics and DB problems is amending the existing environmental statistics into more available for any companies that want join symbiotic relationships. That contains adding waste and by-product information of Industrial complexes to Environmental Statistics Year Book(ESYB) and Annual National Waste Statistics(ANWS) respectively. New statistics and DB will have to embrace 279 industrial complexes which account for all industrial complexes made by national and local government.

On the other hand, EIP workers and researches said that the annual Korea Industrial Complex Dictionary(KICD), one of important data sources on industrial complexes, does not have environmental statistics. It means that it's very difficult to analyze both the economy and the environment of industrial complexes simultaneously in terms of industrial ecology. Therefore modifying the existing industrial complex statistics including KICD is urgently needed to help Korea's EIP strategy.

3. EIP Projects restricted spatially by the regulations

Many EIP experts have been pointing out that the EIP projects in Korea had a problem

regarding policy applications. A state-run organization, KICOX, in charge of Korea′s EIP projects, has been very consistent in carrying out an EIP policy in line with the Ministry of Knowledge Economy. It has never allowed local EIP project units to spend money on other than designated industrial activities or non-industrial complexes(Sudhakar Y, Tran Chau Nhi, Hungsuck P, 2011).

Consequently very important aspects of industrial complexes, like pollution prevention, parks and green area, energy-saving facilities, landscape, restoration etc., have been looked down on. This is believed to be one of barriers preventing EIP policy from being spread out on other realms.

The way of thinking that EIP developments should be limited to specific industrial area can be blamed for a hindrance to the betterment of EIP strategy. Place-specific EIP strategy as in Korea cannot be a great help to industrial complexes made up small & medium sized factories, small-sized, and specialized complexes. That′s because they can′t expand their symbiotic relations beyond the boundary of industrial complexes.

If we think of the general state of industrial complexes in Korea, the restriction of EIP business realm on industrial process in special area becomes one of important problems. More over 30% of 279 industrial complexes of developed and managed by national or local government is evaluated as being obsolete or needed redeveloping. These industrial complexes are now becoming a source of environmental conflict and they are subjected to a threat to close recently.

Therefore when we develop EIPs from now on, we should find out good methods to reduce environmental pollution by devising spatial design skills in non-industrial process realm. This kind of efforts may help make problematic industrial complexes environmentally friendlier and in the end can make contributions to reciprocal and cooperative relationship between industry and residents.

Although the focus of collaboration in most EIP projects has been on developing inter-firm exchange of by-products or energy, some experts state that this is only one part of EIP strategies. More areas for co-operation in Korea′s EIP projects should be identified so that EIP strategy can obtain the desired results that everyone can accept. In this respect, some EIP exports in Korea are planning to expand the EIP projects by co-operating with experts of other fields.

In fact, these challenges can be successful when they are backed by law. For example, to put those challenges into practice, landscape provisions of industrial complexes should be added to the current ″Industrial Complex Development Act″ and ″Act on Industrial Conglomeration Activation and Building Plants″.

4. Lack of motivation to participate in symbiotic networks

It is believed that one of major reasons why companies have distastes for EIP programs is lack of incentives for encouraging them to join the programs. The survey this time also came to the same thing with 35%(14 experts) of the respondents.

Clarifying incentives for taking part in EIP projects carries an important meaning to stimulate industrial symbiosis. Incentives are part of the crucial problems that EIP projects are now facing. It is recommended that government give some incentives for the participatory companies, which can be financial assistance, deregulation, R&D supports, tax break, infrastructure etc.

Throughout various economic, environmental incentives, we can boost the odds of companies' participation in EIP projects, resulting in stable recycle chains.

Industries′ participation in EIP projects will be on the rise when they can see environmental or economic performances gained from symbiotic networks. In the survey, 27.5% of respondents agreed to the importance of their own confidence in EIPs′ outcomes. Solutions to this problem might come from mutual learning about symbiotic relationship, not from just public relation as to what EIPs really are. That′s because industrial symbiosis will be more effective and successful when the relationships are made by mutual-adaptation to the wheels within wheels of up-streams and down-streams.

5. Regulations on the location of recycling industries

Unlike natural ecosystem, because there are not decomposers that mediate food chains and facilitate symbiosis in industrial world, it is almost impossible to root up waste problems in closed loops like industrial parks or estates. Environmental industries, in industrial ecological terms, industrial decomposers are prerequisite to the working of industrial symbiosis from the viewpoint of a closed system approach.

In Korea, industrial laws are prohibiting industrial decomposers from locating in industrial complexes for fear of pollution. Because Waste Management Act looks upon them as a kind of polluters, they feel pressured not to get involved in industrial symbiotic relationship so that they can avoid being taken responsibilities for pollution. Consequently, wise and smart use of wastes is shrinking and wastes have to make a long journey to be reused.

Recently experts have been seeking several solutions about discriminative environmental policy to waste-related companies. First of all, a policy believed most efficient is that waste-treatment industries should be categorized into manufacturing industry so that they can get diverse benefits and asset the same rights as other industries.

6. Absence of regionally based recycling network

It's better to link industrial complexes with recycling networks of regions than to see them as isolated islands. One reason for EIP projects not to get welcomed by locals or local governments is due to the lack of connections between industrial symbiotic programs and local communities. Actually when industrial complexes play a pivotal role for symbiotic relationship associating domestic wastes with industrial processes, we can expect much of cyclical regional economy. This can be extended to Eco-industrial Network(EIN) beyond EIPs, followed by environmentally sound regional economy.

As of now, EIP projects have rarely taken the view that neighboring areas and household wastes could be part of their symbiotic relationships, thanks to the policy that the projects have to do with industrial processes within the boundaries of industrial parks. It's time to adjust the current EIP projects to a sought-after concept of co-operating household wastes and industrial parks.

Recently Ministry of Environment has been trying to accumulate recycling industries in some special areas in the hopes of boosting scale economies in waste management and tapping into waste recycling networks nationally. To that end, the government has the plan that wastes and by-products generated in a region should be recycled in that region at first, and then they should go into recycling networks of other areas(Korean Ministry of Environment, 2011). This refers to, so called, integrated waste management systems. But the problem is how to link industrial symbiosis with domestic wastes into a recycling network. In response to this issue, I'm going to put forward a proposal of kind of a new strategy, the regionally based recycling networks.

This network means the web-based regional waste management system that regional traits and administrative districts can be taken into consideration and detailed information on major recyclables can be put together on a spatial basis(Environment & Civilization, 2012). Waste managers can have control over wastes by keeping up with waste stream of a region, while waste users are able to secure recyclable wastes with ease through this system. The regionally based recycling systems are believed that they can ameliorate one serious situation where companies that belong to a network have been complaining of difficulties obtaining sufficient wastes or by-products that can be used as materials in their recycling processes(Korean Ministry of Environment, 2012).

Ⅴ. Conclusions and some suggestions

Obviously there are not a few legal obstacles to building regional symbiotic relationship centered on an industrial complex. It's because current laws have resorted to the end-of-pipe management with little thought of symbiotic networks. This naive managerialism hasn't and

won′t be a help to an integrated waste management environmentally and economically(Sai Liang, Lei Shi, Tianzhu Zhang, 2011).

An integrated approach to environmental management and industrial regulation is needed to encourage by-products exchange network. But still environmental regulations aim to control pollution media such as water, air, soil etc., and manage individual factories and polluters.

Companies, in EIP networks as well, have a lot of obligations to comply with very strict regulations while raising the productivity and reducing the pollution at the same time. This explains a primary reason why industries are reluctant to join the EIP programs.

Currently there are 18 laws regarding the environment and five laws dealing with industrial complexes in Korea. Among these laws, in particular, four Acts (Waste Control Act, Act on the Promotion of Saving and Recycling of Resources, Act on the Promotion of Industrial Clusters and Plant Establishments, Act on the Promotion of Change into Environmentally Friendly Industrial Structure) are closely related to symbiotic networks. According to this study's implications, in the short term it's better to remedy some shortcomings of EIP strategies from a perspective of industrial symbiosis.

In the long run, it might be way effective when a special law in charge of industrial symbiosis between industrial complexes and their local communities is rolled out. However, in reality, amendments of those four laws are preferred if the difficulty of enacting legislations for industrial symbiosis like EIP projects. Now it will be crucial for the two strategies, an EIP policy of Ministry of Knowledge Economy and a regionally based recycling tactic of Ministry of Environment. This kind of combined approach can pave the path for achieving the integration of region, economy, and the environment.

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