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Applicability of Eco-Industrial Parks in Turkey: The Case of an Organized Industrial District

Gülşen Akman*[1], Zeynep Gamze Mert[2]

ABSTRACT

Industrial ecology aims to adapt the industrial system to the natural system characteristics and tolerance reusing by-products and wastes. The most important area of applications of the concept of industrial ecology is the "Eco-Industrial Parks". In recent years Eco-Industrial Parks have being spreaded worldwide as a new industrial model with social, economic and environmental dimensions of sustainability. There are many eco-industrial parks were developed and new ones are continuing to be developed throughout the world. In Turkey, no eco-industrial parks exists yet. Instead, there are Organized Industrial Districts that correspond to eco-industrial parks. Despite the similarities, there are many differences too. Based on case of XYZ Organized Industrial Zone in Turkey and the proposed methodology, this study offers either an organized industrial zone can be transformed to eco-industrial parks or not. XYZ Organized Industrial Zone is evaluated from perspective of eco-industrial. Eight company were included to evaluation. The results indicate that an existing Organized Industrial Zone can be transformed to an EIP by considering Turkey's political, social, economic, cultural and environmental issues.

Keywords: Sustainable development, industrial ecology, industrial symbiosis relations, eco-industrial parks, organized industrial districts.

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Introduction

Industry is one of the basic components for a sustainable development in urban areas. Along with the industry in late of 1980's the concept of industrial ecology was developed. Industrial ecology aims to adapt the industrial system to the natural system characteristics and tolerance reusing by-products and wastes. The most important area of applications of the concept of industrial ecology is the "Eco-Industrial Parks (EIPs) ".

Eco-Industrial Park (EIP) is a new industrial district model with social, economic and environmental dimensions of sustainability. There are many Eco-Industrial Parks (EIPs) were developed and new ones are continuing to be developed throughout the world.

In Turkey, no industrial parks were established as EIPs. Nevertheless Organized Industrial Districts (OIDs) are the closest areas both in concept and application that correspond to EIPs. This paper offers either an OID can be transformed to EIP or not by considering in the framework of industrial ecology. The built environment design of the EIP which is important aspect in the conceptual model of eco-industrial park development is disregarded through this study.

Key Definitions and Literature Review

After 70's, increasing worldwide resource and energy consumption in all fields of activities has resulted in irreversible destruction of the nature. Then the concept of "sustainability" has been developed, which deals with the issues about the pollution, consumption of natural resources, social inequality and supports the continuous development of environmental, economic and social issues. Local Agenda 21, a Global Action Plan for Sustainable Development, addresses the critical needs to involve all sections of society in all countries of the world(Oh et al.,2005).

In the field of industry, the proposed solutions for environmental preservation problems were essentially based on the prevention of pollution elements In 1970's. The early 80's, the enterprises started to adopt the "environmental management" approach. Then in the middle of 80's, they became award of the concept of "sustainability" and besides, a new concept of "industrial ecology" was taken the agenda.

Frosch and Gallopoulos (1989) stated that "the traditional model of industrial activity - in which individual manufacturing processes take in raw materials and generate products to be sold plus waste to be disposed of - should be transformed into a more integrated model: an industrial ecosystem. In such a system the consumption of energy and materials is optimized, waste generation is minimized and the effluents of one process may serve as the raw material for another process." Graedel and Allenby (1995) explored that "the concept of Industrial Ecology requires that an industrial system be viewed not in isolation from its surrounding systems, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal." The essential aspects of materials and energy exchange between enterprises are often referred to industrial symbiosis. Symbiosis is defined literally as living together. This symbiosis might lead to various environmental advantages, such as a decreased waste production and resource consumption, and the advantage of scale, e.g. in waste collection and waste processing (Lambert and Boons, 2002).

The most important application area of the industrial ecology concept is the "Eco-Industrial Parks". The definition provided by the United States Environmental Protection Agency is the most suitable among the definitions of an EIP. "A community of manufacturing and service businesses seeking enhanced environmental and economic performance by collaborating in the management of environmental and reuse issues. By working together the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realize if it optimized its individual performance only" (Martin et al., 1996).

Eco-industrial parks gained importance last two decades and started to take place in the literature. (Hawken, 1993; Lowe et al.,1995; Lowe and Yong, 2001; Ehrenfeld and Gertler, 1997; Korhonen et al. 2002; Pellenbarg, 2002; Desrochers,2002, 2004; Ayres, 2004; Roberts, 2004; Sterr and Ott,2004; Korhonen and Sankin, 2005). Today many different eco-industrial parks have been established worldwide. And recent studies argue about problems, dilammas and solutions based on the examples of EIP in the several countries.

The research by Oh et al.(2005), analyzes the Daedok Technovalley Development Project to draw out transferable lessons for future eco-industrial park development. The results demonstrate that some limitations are still apparent in the aspect of symbiotic industrial network construction, cultural identity creation and material flow planning. Gibbs and Deutz(2005) contribute some critiques of industrial ecology by focusing on the key problems and dilemmas drawing upon with ten empirical works conducted in the USA. The study by Fang et al.(2007), analyzes 15 cases in China and they demonstrate that closed loops involving chains and industrial symbiotic webs are the technological key and core of successful initiatives in the application of industrial ecology. The survey by Park et al.(2008), shows Ulsan industrial complex has been evolving from conventional industrial complexes to eco-industrial parks by spontaneous industrial symbiosis. The study by Domenech and Davies(2011) applies Social Network Analysis(SNA) to the industrial symbiosis network in Kalunborg(Denmark) to understand the structural characteristics of the network.

The most well-known eco-industrial park is in Kalundborg, which is a harbor city in Denmark with a population of 20.000. In this eco-industrial park, environmental and economic benefits were provided by the reduction in the natural resource consumption and emissions and by the reuse of waste materials. Eco-industrial park practices are very few in developing countries and there has not been established any sample application in Turkey yet.

In Turkey, OIDs are regarded as a tool for industrial sustainable development. Its implementations were started in 1962 and after 80s continued to be subject to legal regulations. Today Law number 4562 which is in force defines the OIDs (Organized Industrial Districts) as follows,

"Goods and services production zones whose borders are registered and which is formed by supplying the land parcels on the basis of particular systems and allocated for the industry, determined according to the requirements and also operated as per provisions of the OIDs Law, with the necessary infrastructure services and the social facilities, techno parks, and also with small production and renovation units, trading, education and health units, research and development regions for the purposes of ensuring that the industry is structured in the approved fields, directing urbanization, preventing environmental problems, allocating resources rationally, benefiting from knowledge and information technologies, placing and developing all kinds of industries according to a certain plan" (Mert and Akman, 2011).

In Turkey recent years, various studies have been started about the EIP applications. The most important of them is Şenlier and Albayrak(2011)'s study. It identifies the application potential of EIP in Turkey analyzing OIDs in Kocaeli.

Research methodology and evaluation framework

According to Koenig(2005), eco-industrial parks are developed in three basic forms: **Transformation** of an existing industrial park, **revitalization** of previously used sites (brownfields development) and **new industrial site** development.

This study focuses on transformation of an existing organized industrial district to an eco-industrial park. Based on scenarios related EIP (Martin et al.,1999) and Arslanbey OID case, this paper proposes a transformation methodology and describes the stages of

transformation of OID to EIP. The flowchart of transformation of an existing OID to an eco-industrial park is shown in Fig.1.

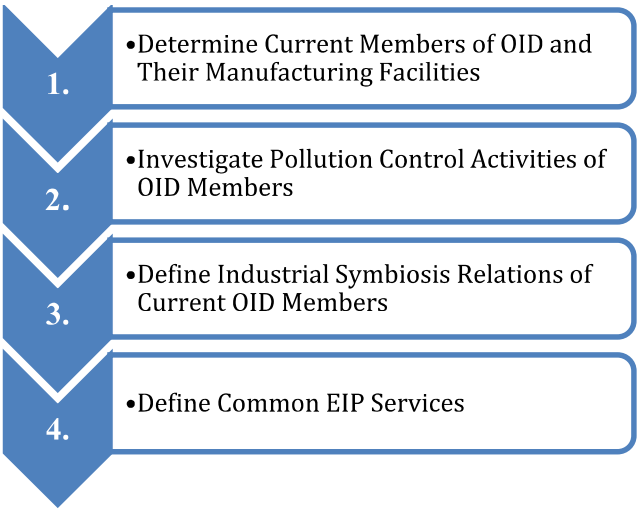


Figure 1. Flowchart of transformation of an existing OID to an eco-industrial park

Stage 1.Determination of Present Members of OID and Their Manufacturing Facilities

In this stage, present members of the OID and major activities of companies are determined. It is possible to divide OID's members into 3 groups: companies, service providers and related institutions and organizations. "Which institutions and organizations are related with OID management? Which companies are active in OID?" questions are to be sought.

Stage 2.Investigation of Pollution Control Activities of OID Members

In this stage, recycling and pollution prevention activities of companies carried out independently are investigated. In this context, pollution control activities of OID's members, treatment of wastes, whether companies have ISO 14000 certification and use of preliminary waste water issues are to be sought.

Stage 3.Definition of Industrial Symbiosis Relations of Present OID Members

This stage determines organic/symbiotic relationships of companies in OID with the other ones inside and/or outside the OID seeking types of waste products, use of wastes of other companies as input material.

Stage 4.Definition of Common EIP Services

OID members benefits from various services during production activities. The management and provision of these services from a single source would be more economical rather than separately. These common services should be provided by the management of OID.

At this stage, the answers of the following questions are to be sought;

- What services are provided to the members by the board of OID?
- Are the services sufficient in transformation of OID to EIP?
- What other common services should be provided by the board of OID?

The data presented in this paper are based on a survey of 8 large companies interviewed in Arslanbey OID.

Case Study: XYZ Organized Industrial District (OID)

XYZ OID is established on 142 hectares. Now, 17 companies are in operation in XYZ OID with 2800 people are employed totally. Although most of the companies are SMEs, there are three large companies having significant contribution to Turkish economy. These manufacturing firms operate in the fields of iron and steel, tire, plastics and non-ferrous metal industries, and they export to Europe, USA and Middle East.

Stage 1.Determination of Present Members of OID and Their Manufacturing Facilities

This stage includes determination of present members of Arslanbey OID. The members of Arslanbey OID, companies, service providers and related institutions and organizations, are presented in Figure 2.

Sectors, employee number, products, and operating period of the companies are given in Table 1. There are 3,4 and 1 companies large, medium and small-sized respectively.

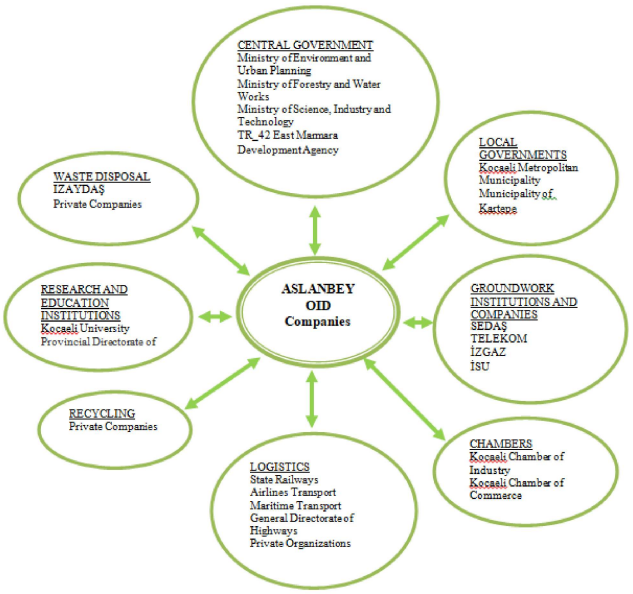


Figure 2. Institutions and Organizations Related with the OID Management

Stage 2.Investigation of Pollution Control Activities of OID Members

In this stage, pollution control activities and wastes generated by 8 companies are determined as shown in Table 2. Among these companies only two of them have ISO 14000 Certification, three of them have preliminary wastewater treatment system and one of them has cogeneration system.

Stage 3.Definition of Industrial Symbiosis Relations of Present OID Members

The symbiotic relations between the companies involved in this study are shown in Fig. 6. In general, symbiotic relations are established with the companies out of OID. There is one symbiotic relationship between Company B and Company C. Company C produces hot water in manufacturing processes then pumps the water to Company B that uses the water for heating of offices. The cool used water is pumped back to Company C again.

Stage 4.Definition of Common EIP Services

In Arslanbey OID, only rain water, waste water and electrical networks as technical infrastructure and administrative building as social infrastructure were established and any common services regarded with management of wastes, environment, telecommunication, R&D, training are not providing.
This is not sufficient services in transformation of OID to EIP. The services required by the companies are shown in Figure 4.
Primarily, waste recycling center, fire center, waste collection center, logistic contact center, health center, training center, R&D center and energy producing center should be established.

Conclusion

Eco-industrial parks have being spread worldwide in recent years as sustainable industrial development areas. In Turkey, Organized Industrial Districts are regarded as a tool for industrial development. Despite the similarities between EIPs and OIDs there are many differences too.

The transformation methodology proposed in our study and Arslanbey OID case indicate us an existing OID can be transformed to an EIP by considering the following points:

- Collaboration among the OID members – central and local governments, companies, service providers, R&D institutions, training institutions, non-governmental organizations and communities- should be involved.
- An "Eco-efficiency center" included all the members should be established in academia.
- An industry education program is needed to awareness.
- Administrative and legal regulations should be reorganized to support EIP development.
- A EIPs information system should be established to monitor rapidly, decide accurately and manage efficiently of industrial areas.
- An eco-industrial network should be established including the other OIDs and the companies out of OIDs.

Thus considering Turkey's political, social, economic, cultural and environmental issues, this study contributes to develop the methodology and strategies for EIP development in Turkey adapting the EIP principles and characteristics to existing OID.

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Table 1. Some characteristics of companies

Company	Sector	Employee number	Products	Operating period	Operating period in Arslanbey OIZ
Company A	construction and isolation	18	Waterproofing membrane	Less than 5 years	Less than 5 years
Company B	Machine and Die	150	Tire curing machines and dies	6-10 years	6-10 years
Company C	Tire	300	Tire	11-20 years	11-20 years
Company D	Metal and Steel	300	Hot Rolled Pickled (HRP) Steel Cold Rolled Full (CRF) Steel Cold Rolled(CR) Steel Hot Dipped Galvanized (HDG) Steel Pre-Painted Galvanized (PPG) Steel	21-30 years	6-10 years
Company E	Aluminum	75	Aluminum disk, aluminum flake, aluminum rolls, aluminum sheet	Less than 5 years	Less than 5 years
Company F	Wood Industry	1200	MDF, Door, Glue	21-30 years	6-10 years
Company G	Metal-automotive supply industry	75	Processing of Metal Sheets and Body parts of an automobile	Less than 5 years	Less than 5 years
Company H	Metal	195	Steel Construction building elements, tank, silo, elevator, cyclone	11-20 years	6-10 years

Table 2. Wastes and Pollution Control Activities of the Companies

Company	Industrial Wastes	Pollution control	ISO 14000 Certification	Reuse, recycling, disposal
Company A	-			
Company B	The hydraulic oil			Reuse
Company C	Chemicals Wood and plastics palets Semi product wastes sewage sludge Burn fats Metal scrap Waste		X	Reuse, recycling, disposal
Company D	Iron oxide Ferrous Chloride Sawdust Grinding (Bor oil mixed) 5% detergent water Cleaning Thinner Sewage sludge Paint and oil barrels Rolling Oil	Waste water pre-treatment		
Company E	Aluminum Dross Emission foam			recycling, disposal
Company F	chip Wood sawdust Paint / coating	Waste water pre-treatment Cogeneration		reuse
Company G	Steel Plate waste Hydraulic oil and skid Mixed other oils (boron)	Waste water pre-treatment	X	recycling, disposal
Company H	Paint cans The hydraulic oil			disposal

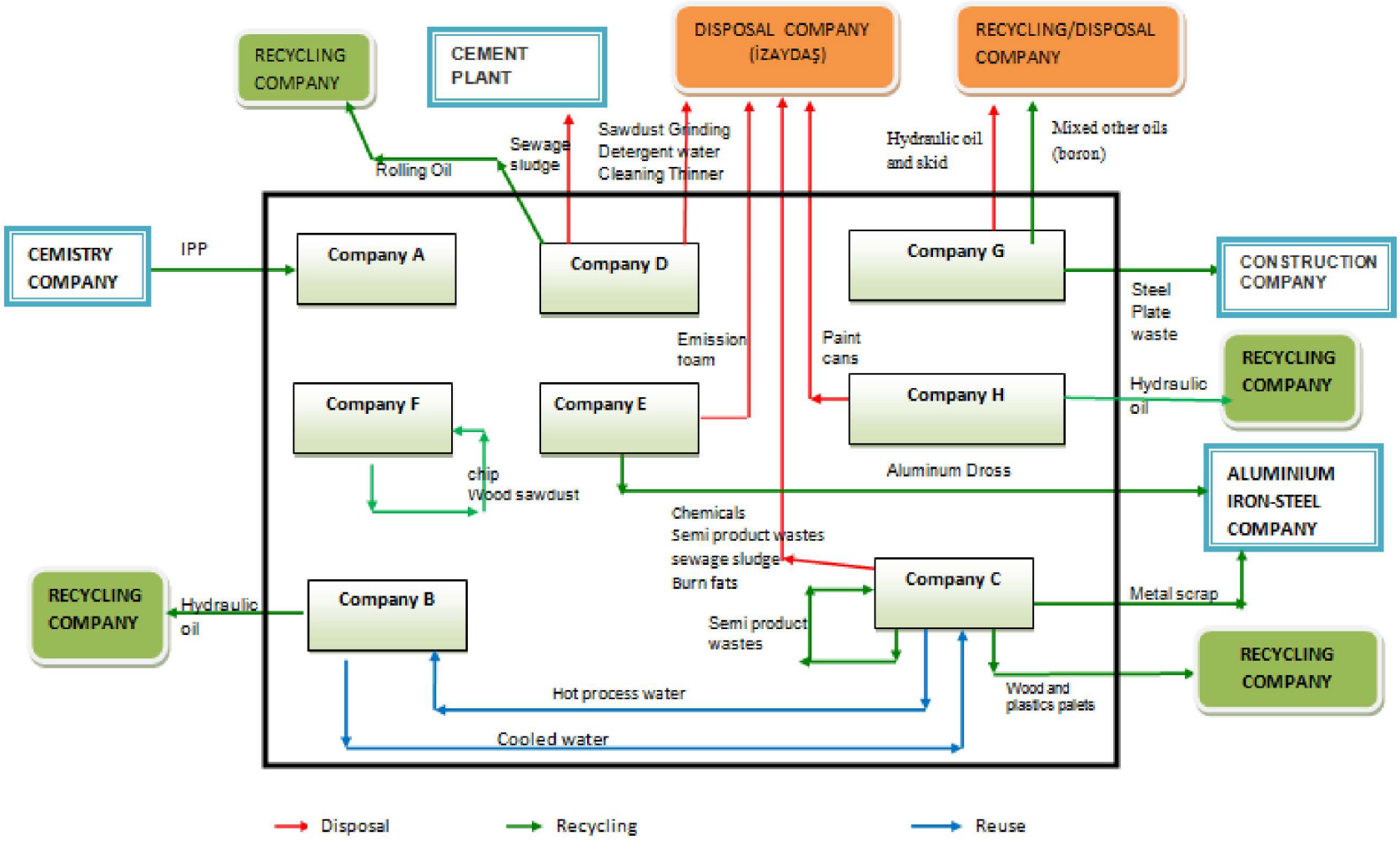


Figure 3. Symbiotic relationships in Aslanbey OID

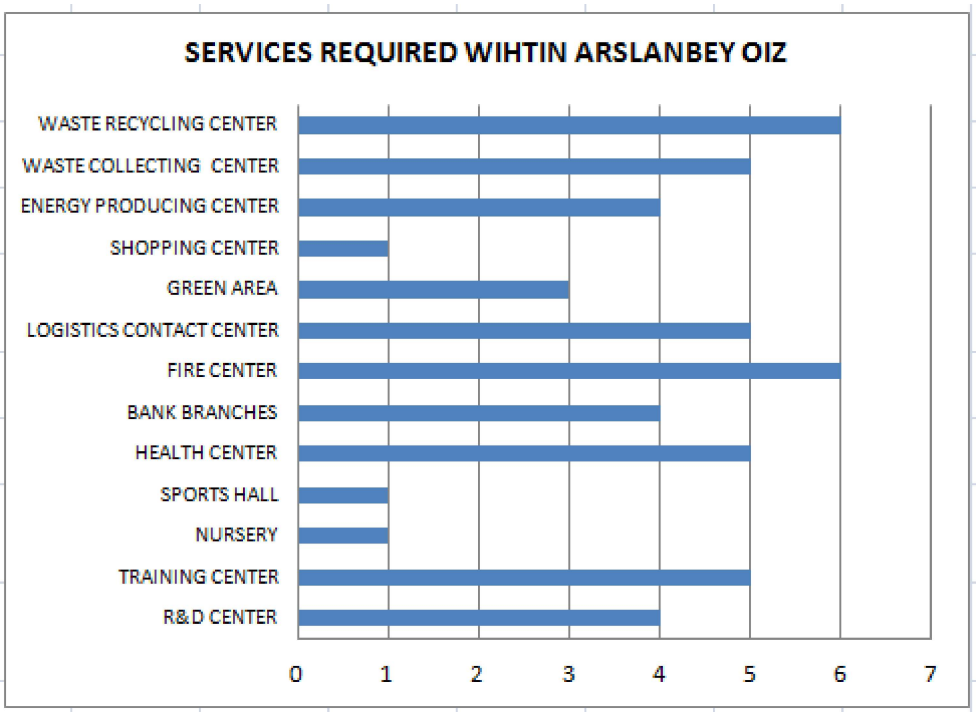


Figure 4. Common Services Required by OID members