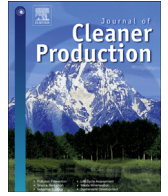




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Local industrial systems towards the eco-industrial parks: the model of the ecologically equipped industrial areas

Raffaella Taddeo

University "G. d'Annunzio", Department of Economic Studies, V.le Pindaro 42, 65127, Pescara, Italy

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ABSTRACT

Local Industrial Systems (LISes) are historically considered as one of the referential models for the socio-economic and technological development of a territory, widespread in European countries and especially in Italy. In recent years, some limits may be expressed mainly due to the persistent and growing global competition. Industrial Ecology (IE) proposes more sustainable models for the local development, mainly in the form of the so-called Eco-Industrial Parks (EIPs). This article analyses, in the framework of IE, the Ecologically Equipped Industrial Area (EEIA); introduced in 1998 by a national law, it currently represents the most significant model for the sustainable local industrial development in Italy. In the first part of the article, the place-based approaches to IE are described, highlighting the potential of the EIPs model and the delay in its diffusion within the Italian contexts. In the second part, the article examines the concept and the main features of the EEIAs, as defined by the national and regional regulations, and their role in the evolution of the LISes towards the EIP model. The results highlight that the main potential and limits of the EEIAs model are respectively related to i) the centralised management of the services, spaces and systems, the shared infrastructures and services within the area, and the administrative simplifications for the companies involved; ii) the long time investments returns, the regulatory limits related to the exchange of wastes, and an excessive inflexibility of the top-down approach followed in its development.

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1. Introduction

Industrial Ecology (IE) considers the economic systems in analogy with the biological systems and proposes approaches and solutions aimed at achieving environmental, economic and social benefits. Among them, those defined as "place-based" refer to geographically limited contexts (Deutz and Gibbs, 2008). The general reference model is represented by the industrial ecosystem. This was formalised in the late 1990s (Frosch and Gallopoulos, 1989) and it evolved over time in various forms. As recognised (Baptista, 1998; Roberts, 2004; Wallner, 1999), the development of this model can be favoured by the geographical proximity and the inter-firm relationships that naturally arise in territorial agglomerations of firms such as the industrial districts, clusters or networks. The development path of such a model can be characterised by various factors, some of which are recognised as critical. The main factors concern the establishment of symbiotic relationships among the companies involved, limits in information sharing, the lack of financial support, organisational complexity, legal and

regulatory constraints, issues related to trust and cooperation among firms (Zhu et al., 2015; Simboli et al., 2014; Taddeo et al., 2012; Doménech and Davies, 2011; Sakr et al., 2011; Tudor et al., 2007; Boons and Baas, 2006). In the case of existing and long-standing contexts, problems of adoption, acceptance and diffusion of the change can also emerge (Taddeo et al., 2012). In Italy, despite the large presence of LISes (especially in the form of industrial districts), there are no operating EIPs. However, in 1998, an Italian law proposed a model of eco-compatible local industrial development, based on shared services, utilities and common infrastructures, named Ecologically Equipped Industrial Areas (EEIAs), that is currently under implementation by some regions. This article aims at understanding the EEIA potential and limits in bridging the gap between the traditional models of local industrial development and the industrial ecosystems, as conceived in the framework of IE.

The article is structured as follows: the next two sections describe the background of the study and the methods used: in particular, a focus on the place-based approaches to IE is proposed and a recognition on the principal models of local eco-industrial development has been carried out. In Section 4 and Section 5 respectively, the Italian model of EEIAs and the regional

E-mail address: r.taddeo@unich.it.

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regulations are described and analysed. In Section 6 the main results of the analysis are discussed; finally, conclusions are drawn.

2. Place-based approaches in the field of industrial ecology

Place-based approaches to IE suggest solutions to improve the socio-economic and environmental performance of communities of co-located companies, through a collaborative and synergic management of the flows of materials, energy, by-products and wastes; they are mostly based on the concept of Industrial Symbiosis (IS). IS describes such mutual exchanges among companies (Chertow, 2000; Deutz and Gibbs, 2008). Symbiotic activities can be applied at different levels: according to Roberts (2004), they can involve a single firm or organisation (*micro level*); companies co-located in the same area (*meso level*); and finally, to a broader level, the entire regional or national production system (*macro level*). Chertow (2009) proposes three different levels of analysis: *spatial* (geographical extension), *temporal* (evolution of industrial characteristics) and *organisational* (dimension and nature public/private of companies), that can coexist in time and space. The spatial scale is considered one of the defining features of an industrial ecosystem; its relevance comes into play in matching flows of materials, energy, water and information across the involved entities. In particular, the greatest benefits are achieved at the meso level, where the clustering of complementary companies provides complexity of functions (Roberts, 2004).

Projects, which have been developed up until now, show different features depending on the context, in which they are tested or implemented, and with regard to the characteristics and needs of a given production area and the companies and organisations involved (Wilson et al., 1998). Table 1 shows and briefly describes the main projects.

2.1. The EIP as referential model

The Eco-Industrial Park or estate (EIP) is recognised worldwide as the referential model in the adoption of the principles and tools of IE at a local level. It concerns an industrial park developed and managed as a community of companies, aimed at achieving high environmental, economic, and social benefits as well as business excellence, through mutual collaborations and synergies. The best known example of EIP and a reference case for similar projects is represented by the long-lasting experience of the city of Kalundborg (Jacobsen, 2006). An EIP can be considered as a model of excellence in the integration of the three dimensions of sustainability (economic, environmental and social), to achieve synergies among the economic development, the natural environment and local communities. The path for the development of an EIP includes a set of activities to be implemented at every phase, from planning, siting, up to operation. These activities may involve the identification of objectives and strategies; building local support;

determining ownership; involving stakeholders; a new design or a redevelopment of the production area and infrastructures; the promotion of cleaner production; the identification of activities for the pollution prevention; the efficient and synergic use of resources; the cooperation among companies (Lowe and Geng, 2003). From a technical and operational perspective, Lowe et al. (1996) identify some of the main technical (physical) requirements that an EIP should have. These are listed and briefly described in Table 2.

An EIP can arise spontaneously, implementing a bottom-up approach generally resulting from the initiative of companies, motivated to improve their performance in terms of cost reduction, increased income, expansion of business, through the resources exchange. In other cases, however, the development of an EIP can be planned through a top-down approach and generally driven by institutions and bodies of local government, research centres, or universities. In contrast to the planned EIPs, the spontaneous ones currently have greater success in terms of growth and development over time (Gibbs and Deutz, 2007), as well as they are more strong and resilient, able to respond more effectively to market dynamics (Chertow and Lifset, 2008). In addition, an EIP may arise as a new industrial site, also called *greenfield*; it may affect the involvement and reindustrialisation of the abandoned or in-crisis industrial area, namely *brownfield*, or the conversion of currently operating industrial sites.

2.2. The development of EIPs in local industrial systems

According to some authors, IE is intrinsically connected to the notion of clusters or, more in general, of inter-firm networking (Baptista, 1998; Gibbs, 2003; Roberts, 2004; Velenturf and Jensen, 2015; Wallner, 1999). The model of LISes is somehow related to the models proposed by IE (and especially EIPs), mainly thanks to the geographic proximity of companies and to the general tendency to system synergies (Deutz and Gibbs, 2008; Hewes and Lyons, 2008; Sterr and Ott, 2004; Wallner, 1999). Proximity is recognised as one of the factors able to trigger interaction mechanisms that can rapidly spread and exchange the local know-how, thus favouring the processes of imitation, learning, the rapid adoption of new technologies and the spreading of innovations (Belussi, 2006). The Italian LISes, especially in the form of industrial districts, have become the expression of the relation existing between the companies and their territories and describe a different paradigm. According to this paradigm, producing does not only mean transforming inputs into outputs through specific technical procedures at precise time intervals, but rather creating together the knowledge, the values and the good practices, both economic and social, needed to continue doing so (Becattini, 1990). Therefore, LISes combine two of the three elements of a sustainable production model: the economic and the social dimensions cannot be separated due to the close intertwinement of the variables involved

Table 1
Some examples of IE-based projects for local industrial development.

Name of the initiative	Main features
Eco-industrial Park or Estate (Côté and Cohen-Rosenthal, 1998; Ehrenfeld and Gertler, 1997)	Exchange of waste, by-products, energy, water
By-product synergy networks (Mangan and Olivetti, 2010)	Exchange of waste, by-products, energy, water
Sustainability network (Strebel and Posh, 2004)	Voluntary cooperation among different stakeholders
Recycling network (Schwarz and Steininger, 1997)	Reuse of waste and by-products
Circular economy (Yuan et al., 2006)	Efficiency and optimisation in the use of natural resources
Product recovery network (Walter and Spengler, 2004)	Network of companies for disassembly
Resources recovery park (Cal Recycle, 2011)	Reuse, recycling, composting at a central facility
Ecosite (Ecolink, 2003)	Management of natural resources and ecosystems; promotion of new technologies

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