



Research article

Critical elements for eco-retrofitting a conventional industrial park: Social barriers to be overcome



Domenico Ceglia^{*}, Mônica Cavalcanti Sá de Abreu, José Carlos Lázaro Da Silva Filho

Federal University of Ceará, Av. da Universidade, 2470, Benfica, CEP 60.020180, Fortaleza-Ceará, Brazil

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ABSTRACT

This paper aims to explore critical elements for eco-retrofitting a conventional industrial park, based on a survey of companies and institutions located in Brazil. The study investigates social barriers to be overcome in promotion of opportunities for waste exchange. Our results indicate that values, trust behaviour, waste cognitive domain and environment engagement are necessary for the creation of an eco-industrial park. Similar values of benevolence and universalism are essential for company engagement to eco-retrofit. Low levels of trust behaviour combining with limited waste cognitive domain prevent firms from establishing agreement on waste exchange initiatives. The findings lend support to the view that social barriers are pre-requisites to engagement among firms in establishing technological and logistical solutions. Serious attention needs to be given to these social barriers because they are not easily overcome in the social and economic context of developing countries.

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1. Introduction

In Brazil, most industrial parks have problems related to waste management. What is lacking includes a waste database, designated waste recycling sites and approved treatment and final waste disposal sites. These gaps are particularly evident in the relatively poor State of Ceará, located in northeastern Brazil. The main industrial site of Ceará state is the Maracanaú industrial park which has 33% of the total industrial production of the state and generate about 70,000 tons of industrial waste per year (Ceará, 2004).

Companies located in northeastern Brazil do not recognize the importance of managing long term environmental impacts and thus they have fewer motives to develop green strategies (Abreu et al., 2010). Moreover, the smaller domestic Brazilian companies tend to not have environmental management systems (Duarte, 2010; SustainAbility, 2006). Duarte (2015) investigated the role of Brazilian managers in dealing with sustainability issues, asserting that although they express commitment to respect people and the natural environment, in fact there is a cultural barrier which involves a “self-serving attitude”.

Therefore, transforming industrial wastes into valued added

products could represent an alternative approach to manage environmental impact with economic and social benefits. It involves developing a network where firms could use wastes from one another, in a symbiotic (win-win) relationship. It means transforming a conventional industrial park into an Eco-industrial Park (EIP). An EIP is an arrangement of enterprises located in the same geographical area where they can exchange resources (water, energy, wastes and material), sharing information, facilities and services, generating symbiotic process among themselves (Chertow, 1999).

In Brazil there are a few EIP initiatives, including in the State of Pará (North region) coordinated by the Natura cosmetic company, Santa Cruz and Paracambi eco-industrial parks in state of Rio de Janeiro, and the Candiota Project in the State of Rio Grande do Sul (South of Brazil). There is a lack of knowledge about the EIP concept together with limited common interests, cooperation and trust among companies (Elabras Veiga and Magrini, 2009). However, especially in developing countries, it is necessary to change the mind set by incorporating green technologies in existing facilities (Li et al., 2015).

The traditional emphasis of eco-industrial park development has been related to identification and overcoming institutional, regulatory, technological, and financial barriers (Geng et al., 2007; Kim, 2007). More recently, Golev et al. (2015) identify other more socially oriented barriers including informational, cooperation, community and commitment to sustainable development. In fact,

^{*} Corresponding author. Avenida da Universidade, 2470, Benfica, 60.020-180, Fortaleza-Ceará, Brazil.

E-mail addresses: ceglia@gmail.com (D. Ceglia), mabreu@ufc.br, mabreu.ufc@gmail.com (M.C.S. Abreu), lazaro@ufc.br (J.C.L. Da Silva Filho).

essential elements for each company to participate in building an eco-industrial park are corporate environmental policy regarding eco-design and waste technology solutions. Madsen et al. (2015) build on these aspect in establishing a guideline for companies to develop industrial symbiosis based on inter-organizational, employee and intra-organizational level.

Critical aspect of the above noted approaches is the cooperation among companies and this requires interaction between people. That is the novelty and significant contribution of our study in addressing the social angle of eco-industrial setting. We investigate how the values, trust behaviour, waste cognitive domain and environmental engagement were correlated among themselves. Then, we probe how these critical elements act as barriers operating outside and inside the firms impede the adoption of eco-industrial park concepts. We identify that overcoming these social barriers would be necessary for companies to share common strategies on implementation of waste-to-energy (WTE) and supply chain toward circular economy system.

Serious attention needs to be given to these social barriers because they are deeply seated in the context of developing countries. By situating the study in Brazil, we contribute to the limited body of knowledge about eco-industrial parks in the light of the particular economic, institutional and social conditions. Even in the relatively unindustrialized state of Ceará, where it is more likely that people hold similar values and beliefs, there is difficulty for firms to agree on common directions.

In this context, we seek to answer the following research question: *What type of social barriers limit the eco-retrofit of the Maracanaú industrial park?* This study surveyed companies to identified traditional barriers, such as lack of trust and environmental engagement among companies but also psychological and cognitive issues. We intend to understand to what extent there are shared values, trust and cognitive domain on waste among firms surveyed and investigate whether they are able to engage with each other in a waste exchange process.

The next section outlines social barriers that need to be recognized in retrofitting an industrial park. Empirically, we run a survey with 29 interviewees, including 24 managers of Maracanaú industrial park and 5 other representatives with responsibility related to public policies. Then, we continue with the descriptions of the results leading to insights on how social barriers can affect the concepts of an eco-industrial park. Finally, we present the main conclusions and limitations of our study.

2. Social barriers to eco-retrofit of an industrial park

Achievement of eco-industrial park requires tight social interconnections which are based on individuals, organizations, culture, values and institutions. Cohen-Rosenthal (2000) confirms that the exchange of materials is based more on interactions among people and organizations than on mass flow considerations. It is necessary to change attitudes about wastes and build a greater awareness around the need to manage it (Tudor et al., 2007).

a. Values embedded in managerial behaviour

Schwartz (1994) presented ten human values: 1) Self-Direction: independent thought and action, choosing, creating, exploring; 2) Stimulation: excitement, novelty, and challenge in life; 3) Hedonism: pleasure and sensuous gratification for oneself; 4) Achievement: personal success through demonstrating competence according to social standards; 5) Power: social status and prestige, control or dominance over people and resources; 6) Security: safety, harmony, and stability of society, of relationships, and of self; 7) Conformity: restraint of actions, inclinations, and

impulses likely to upset or harm others and violate social expectations or norms; 8) Tradition: respect, commitment, and acceptance of the customs and ideas that traditional culture or religion provide the self; 9) Benevolence: preserving and enhancing the welfare of those with whom one is in frequent personal contact (the 'in-group') and 10) Universalism: understanding, appreciation, tolerance, and protection for the welfare of all people and for nature.

Schwartz (2012) also argued that human relations based on values such as universalism and benevolence embedded into managers' behaviours influence positively environmental and social practices. Ring and Van de Ven (1992) claimed that networks among companies are powerful carriers of new norms, values and practices. It is necessary to have governance mechanisms that can constrain opportunistic behaviour and enhance trust. Schwarz and Steininger (1997) argued that the human relations among company managers can lead to common solutions to waste reduction with enhanced economic and environmental benefits.

Some studies confirm a relationship between values and environmental issues showing that universalism and benevolence values are more important than power, achievement and hedonistic ones (Stern et al., 1993; Dietz et al., 1998; Stern et al., 1995). A causal relationship between universalism and a sustainable behaviour can facilitate the achievement of the long-run goal of sustainability (Thøgersen, 2010). There is some evidence that universalism is more strongly related to social and environmental behaviour than benevolence (Axeirod, 1994). According to Chertow and Ehrenfeld (2012), retrofitting an existing industrial park into a ecological one requires shared norms and values of a type that are not yet widely embedded among companies.

b. Building trust relationships among companies

Almasi et al. (2011) and Ehrenfeld and Gertler (1997) stated that basic antecedents for an eco-industrial park were trust, good communication and geographic proximity between firms. Trust means that "when one party to the relation believes the other party has incentive to act in his or her interest or to take his or her interests to heart" (Hedstrom and Bearman, 2009, p. 220). Building trust relationship among companies which accept to exchange information and resources among them can help to make the symbiotic process possible (Schwarz and Steininger, 1997).

According to Chertow and Ehrenfeld (2012), norms among companies need to be shared to achieve a common consensus about resource exchange inside an industrial park. Gibbs (1965) defined trust as common feeling among people following informal or formal rules, sanctioned or not. Trust becomes the norm when is shared and accepted among group members. Trust exists when someone lets down their guard, refraining from taking precautions against an interaction, even when other the party act in a manner that could justify precautions (Elster, 2007).

According to Currall and Judge (1995), trust among companies is characterize through four dimensions: 1) open and honest communication (i.e. companies may disclose self-damaging information, accurately and not distorted); 2) entering informal agreements (i.e. there is no written document with penalty and influenced by risk from possible lack of trust by others); 3) coordination of tasks (i.e. complementary resources, information or skills) and 4) maintain surveillance over the counterpart (i.e. surveillance behaviour manifest low level of trust and companies feel need to keep watch over the counterpart).

c. Changing waste cognitive domain

Barriers to industrial symbiosis could be manifested through the

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