Analysis

The Development of Industrial Symbiosis in Existing Contexts. Experiences From Three Italian Clusters

Raffaella Taddeo [a],*, Alberto Simboli [a], Anna Morgante [a], Suren Erkman [b]

[a] University "G. d'Annunzio", Department of Economic Studies, V.le Pindaro 42, 65127 Pescara, Italy
[b] University of Lausanne, Institute for Earth Surface Dynamics, Mouline Area, 1015 Lausanne, Switzerland

ABSTRACT

It is acknowledged that Industrial Symbiosis (IS) is not only a technical phenomenon; socio-relational, organizational, and cultural issues come to light in its development as well. This is much more evident when an IS relies on existing contexts. Industrial networks and clusters have been proven to be one of the best models of local industrial development, and they can be considered also a favorable starting context for IS projects. The relations between traditional and symbiotic networks have been deeply investigated, but the complexity and the scientific and practical implications of the topic render the discussion still open. The present article contributes to this debate by clarifying the dynamics of the IS development in connection with the features of existing industrial clusters. The study proposed uses the results and the experiences gained by the authors in three case studies previously conducted, in order to develop an interpretative framework for assessing the potential and the limits for the development of IS-based scenarios. Empirical evidences show both the role of significant technical factors in designing the IS and the role played by non-technical factors in promoting and preventing its potential implementation.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

In the literature there is much debate on how to make Industrial Symbiosis (IS) effective within different contexts. This issue primarily involves technical factors, influencing the choice of the solutions that can be more suitable than others and thus the form in which the IS may occur. It is also strictly related to how non-technical factors may affect its development. According to Boons and Baas (2006) "*IS activities are shaped by the context in which they occur, described in terms of cognitive, structural, cultural, political, spatial and temporal embeddedness*", the comprehension of the role of such factors can provide both methodological and practical insights toward the IS development (Chertow and Ehrenfeld, 2012; Jensen et al., 2011a).

Local industrial agglomerations can be considered a favorable context for the establishment of symbiotic synergies, due to the geographic proximity and the general tendency to collaboration of companies (Erkman and Van Hezik, 2014; Hewes and Lyons, 2008;

Sterr and Ott, 2004; Wallner, 1999). In accordance with Deutz and Gibbs (2008), the present article uses the term "Industrial Clusters" (ICs) to indicate the various operating forms of such agglomerations, including the renowned Italian *industrial districts*, that since the 70s have become a representative paradigm, at a global level. An extensive literature on economic geography and organization studies highlighted the features of such a model of local development. The studies often focused on the technological and the socio-economic aspects, especially the interactions amongst the local companies and territories (Becattini, 2004; Porter, 1990; Marshall, 1928); the environmental dimension has been less considered. More recently, the IC model has been facing its own limits, mainly imposed by the global competition (De Ottati, 2009; Guerrieri and Pietrobelli, 2004; Lazerson and Lorenzoni, 1999); in this perspective we consider IS to be a great opportunity for its revitalization.

The present article deals with the development of IS in existing ICs, by analyzing the results and the experiences gained from three case studies conducted by the authors in the Italian Region of Abruzzo (Simboli et al., 2014, 2015; Taddeo et al., 2012). Through the framework, we try to clarify: 1) what technical and non-technical factors can affect the potential development of IS in

* Corresponding author.
E-mail addresses: r.taddeo@unich.it (R. Taddeo), a.simboli@unich.it (A. Simboli), morgante@unich.it (A. Morgante), Suren.Erkman@unil.ch (S. Erkman).

such contexts and 2) how they can (positively or negatively) act. The following sections respectively present: the theoretical background of the study; the three case studies previously conducted; the methods and the framework used; the results of the analysis and their discussion. Finally, the conclusions are outlined.

2. Theoretical Background: An Overview

Already in 1996, Cohen-Rosenthal and McGalliard (1996) highlighted the importance of inspiration from studies on industrial networks or clusters for the development of policies in order to stimulate eco-industrial collaboration. In 2003, in investigating the implementation of sustainable development within local and regional economic development strategies, Gibbs (2003) highlighted the need of multidimensional approaches that draw upon economic geography and regional economics on trust, cooperation and "untreated interdependencies" (rules, routines and networks that form the basis of regionally or locally specific material and nonmaterial assets). It is precisely the multidimensionality that is one of the keys for the interpretation of the phenomenon. Mirata (2004) reviewing the factors influencing the development of three IS programs in the U.K. (in the early stages) argued that the nature of the companies and the industrial history of the region influence the progress of the programs, concluding that, a promising approach in developing IS networks is to "*rely on the body of knowledge developed under inter-organizational relationship/collaboration and networking/cluster fields*". The relation between IS and the positive externalities deriving from co-located companies, the so-called "agglomeration economies", has been the focus of an analysis presented by Chertow et al. (2008); the authors outlined how particular industrial configurations can be suited to different types of IS. The difficulties in changing routines embedded in industrial companies' behavior, and the interconnections between the techno-sphere and the social system dimensions has been addressed in a study involving an IS program in Rotterdam (Baas and Huisingh, 2008). A conceptual step forward has been made by Deutz and Gibbs (2008), who wondered if industrial ecosystems could be conceived as environmentally-based variants of traditional ICs. After having examined the similarities and the differences between the two models, they recognized that the different nature and object of the transactions -products versus wastes/scraps- is one of the main limits for the inclusion of industrial ecosystems in a cluster perspective.

Networking, both social and material, is a common theme of recent studies concerning the development of IS in existing and long-standing industrial contexts (MacLachlan, 2013). Some of them have deepened the role of tacit and explicit knowledge and ICT tools in order to enhance collaboration (Grant et al., 2010), others have focused on the approach of the embeddedness, associated with the concept of trust (Doménech and Davies, 2011) or proximity (Schiller et al., 2014), for the application of Social Network Analysis (SNA). Furthermore, the role of external factors and agents in the emergence and evolution of IS have been faced, outlining the effects of governmental interventions (Costa et al., 2010) through policies and legislation or the combined action of top-down (planned/goal directed) and bottom-up (self-organized/serendipitous) mechanisms (Paquin and Howard-Grenville, 2012) for the facilitation of the IS development.

Some authors focused their efforts on defining analytic frameworks. Most of all, we agree with the approach followed by Jacobsen and Anderberg (2004) and Ashton (2009). The former, in a study based on the Kalundborg eco-industrial park, proposed an analytical scheme focusing on three different aspects of the development of IS in existing networks: physical preconditions and possibilities (concerning the identification of the energy and material flows within the network); economic and environmental effects (concerning the potential benefits deriving from the IS

collaborative action and exchanges); central conditions and mechanisms behind the development of IS networks (concerning other contextual factors than physical and economic ones that can influence the creation of IS). Ashton (2009), in assessing regional industrial ecosystems, considers functions, economic transactions, policy context and social interactions and the role of external forces in driving changes. The interpretative framework that is proposed in the present article takes into account these settings, adapted to the analyzed context and the specific conditions of the study.

3. The Context and the Previous Case Study Research Conducted

This section describes briefly the empirical contexts and the three previously conducted studies. More details about the methods, the tools used and the data detected in each case study are available in the original articles (Simboli et al., 2014, 2015; Taddeo et al., 2012) and the related annexes.

The ICs analyzed respectively operate in the chemical, automotive, and agri-food industries. They are all located in the Italian Region of Abruzzo (Fig. 1).

Their main features are described in Table 1.

The first case study conducted (BCS) was related to an exploratory research project, funded by the local government for the revitalization of the chemical site (Taddeo et al., 2012). The results obtained and the experience gained during this first study led the authors to replicate the research, in the form of academic studies and in collaboration with local stakeholders, in the two other contexts, whilst maintaining the methods and the structure of the original research (Simboli et al., 2014, 2015). In all cases long-standing ICs in the maturity stage have been selected. Each study was conducted in two phases: a literature review, and an on-site survey. Mixed methods have been used: quantitative for the analysis of the technical aspects of the symbiosis (data from local databases and questionnaires administered) and qualitative for the other aspects investigated (data from focus groups and meetings). The questionnaires were developed with reference to the scheme drawn up by Heeres et al. (2004). The meetings and focus groups were convened and managed by the local partners, with the support of researchers, involving the most important companies of the three contexts. They were held at the beginning, in the middle and at the end of projects, in order to present the progress made, encourage and support an exchange of views and initiatives amongst the various stakeholders involved. The role of the researchers was active as regards the collection of the first type of data and as participant observers for the others. The analysis of all the case studies ended at the stage of the IS scenarios design; two pilot tests have been conducted on specific solutions. Both qualitative and quantitative data obtained were used to set the framework and for the analysis presented hereafter.

4. The Interpretative Framework

4.1. Approach

The empirical evidence of the aforementioned case studies prompted us to further investigate some aspects related to our research. In particular, besides the technical factors, non-technical factors, defined as "embedded" in the context (Schiller et al., 2014; Doménech and Davies, 2011; Costa and Ferrão, 2010) have been considered. We deemed this further deepening capable of providing both methodological and applicative contributions for IS studies and for the policies of sustainable local industrial re-development, especially in countries, such as Italy, where long-standing ICs are widespread.