Journal of Cleaner Production 141 (2017) 1209–1220

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Network structure in sustainable agro-industrial parks

Gohar Nuhoff-Isakhanyan Dr. *, Emiel F.M. Wubben Dr., Onno S.W.F. Omta Prof Dr., Stefano Pascucci Prof Dr.

ARTICLE INFO

Article history:
Received 18 May 2015
Received in revised form
11 September 2016
Accepted 26 September 2016
Available online 28 September 2016

Keywords:
Inter-organizational networks
Agro-industrial parks
Sustainability performance

ABSTRACT

Recently several agro-industrial parks have been developed as applications of industrial ecology to agriculture, aiming at improved sustainability performance. Grounded in industrial ecology and the literature on inter-organizational networks, this study explores the social structure of sustainability oriented collaborations in agro-industrial parks. Empirical data from sixty four organizations in three Dutch agro-industrial parks are analyzed at network and at organizational level. At network level, the results show that network decentralization comes along with a high density of formal ties. At organizational level, the results show that the organizations in agro-industrial parks are more efficiently positioned (i.e. more positively perceive sustainability performance) in the network of formal ties if they can build ties with other organizations via a small number of intermediary partners (i.e. high closeness centrality) instead of having a large number of direct ties. A decentralized structure of formal ties in combination with sparse interdependency has a relatively positive influence on sustainability improvement perceptions. In conclusion, network decentralization is important for the organizations that avoid dependency on one (or a small number of) central and/or powerful actor(s). The preferable decentralized formal ties and sparse interdependencies were (quantitatively and qualitatively) most evident in the self-organized parks, confirming that, for the sake of sustainability improvements, a self-organized agro-industrial park is preferable to a planned park. With regard to the theoretical contribution, this study opened up a new area of research for waste streams exchanges among co-located heterogeneous companies by examining them as inter-organizational networks in agro-industrial parks. With regard to the practical implications, the study suggests that organizations seeking advanced environmental performance should build ties by optimizing the number of intermediary partners.

1. Introduction

The growing societal demand for more sustainable sourcing, production and waste-management stimulates inter-organizational networks (Albino et al., 2012; Seitanidi and Crane, 2013). Within this context, several sustainability oriented inter-organizational networks have emerged, such as industrial symbiosis (Cohen-Rosenthal, 2000; Lambert and Boons, 2002). While industrial symbiosis is already an established type of inter-organizational network (Jacobsen, 2006; Heeres et al., 2000), other types of networks that connect heterogeneous organizations emerge, for example in agro-industrial parks (Beers et al., 2014; Smeets, 2011). Within the boundaries of agro-industrial parks, organizations are connected to exchange waste, by-product, and share resources and information (Corsaro et al., 2012; Smeets, 2011; Spekkink, 2015). Heterogeneity refers to core organizational activities, such as horticulture, chemical, processing, logistics, food and bio-based production, and provides opportunities to combine diverse but complementary resources (Beckman and Haunschild, 2002; Corsaro et al., 2012) and by that further enhances sustainability. Despite high expectations and major endeavors when realizing agro-industrial parks in the Netherlands, not all socio-economic and environmental opportunities have been exploited (Spekkink, 2013; Smeets, 2011).

Sustainability oriented inter-organizational networks have been intensely discussed in the field of industrial ecology (e.g. Albino et al., 2012; Ehrenfeld and Gertler, 1997). Industrial ecology scholars increasingly pay attention to the network analysis of

* Corresponding author.
E-mail address: gohar.nuhoffisa@gmail.com (G. Nuhoff-Isakhanyan).

http://dx.doi.org/10.1016/j.jclepro.2016.09.196
0959-6526/

symbiotic ties (e.g. Ashton, 2008; Seitanidi and Crane, 2013), according to which inter-organizational networks in agro-industrial parks can be described as compositions of complex inter-organizational ties (Smeets, 2011). A comprehensive approach to study the structure of inter-organizational networks is via the application of social network analysis (Bergenholtz and Waldstrøm, 2011; Schiller et al., 2014). Social network analysis focuses on ties (or lack thereof) and provides appropriate tools to analyze network structures (Borgatti and Foster, 2003; Freeman, 1978).

Inter-organizational networks among co-located heterogeneous organizations are focused on sustainability related activities, such as reduced emissions, renewable energy production, or bio-waste valorization through waste streams processing (Anbumozhi et al., 2010; Mirata and Emtairah, 2005; Spekkink, 2013). Organizations often build network ties to enhance their sustainability performance (Friedkin, 1991; Lozano, 2007; Powell et al., 1996). Decisions to build network ties are usually motivated by expected and perceived sustainable performances by organization managers (Székely and Knirsch, 2005). Managers' expectations and perceptions drive the network strategies that create networks structures. Thus, managers' perceptions regarding sustainability improvement can explain network formation (Kumar and van Dissel, 1996) and network strategies of different organizations (Boons and Roome, 2000).

Unfortunately, the available literature often discusses inter-organizational networks either across supply chain partners or among homogeneous actors, although the sustainability performance is claimed to have association with the network structures and network strategies (Ahuja et al., 2009; Baum et al., 2000). Inter-organizational networks and sustainability performance of organizations are frequently discussed in the literature (Ashton, 2008; Santoyo-Castelazo and Azapagic, 2014; Schiller et al., 2014), but the relations between these two concepts have not so far been studied empirically. The objective of this study is, therefore, to explore network structures of inter-organizational ties that can enhance perceptions of sustainability performance in agro-industrial parks.

To meet the study objective, a multiple case study approach was used combining quantitative and qualitative methods (Morgan, 2013). Through quantitative methods, the network structures and managers' perceptions of sustainability performance, as well as the relation between these two were studied. Through qualitative methods, the findings were complemented with deeper insights to provide a better understanding (Eisenhardt, 1989). This study brings the concept of waste streams exchanges among co-located heterogeneous organizations to a new field of analysis by examining them as inter-organizational networks in agro-industrial parks.

Three agro-industrial parks in the Netherlands, including 64 organizations in total, were included in the study sample. The Dutch cases were chosen because the Netherlands is active in initiating and developing agro-industrial parks. Moreover, the Netherlands is the world's third largest exporter of agricultural products, and recognized for being a frontrunner with techno-managerial innovations in this industry (Ministry of Agriculture (2008)).

The following section presents recent scholarly discussions on inter-organizational networks and sustainability performance perception. Section 3 elaborates on the methods used for data collection and data analysis. Section 4 presents the results, and Section 5 discusses the results followed by main conclusions in Section 6.

2. Social structure for inter-organizational networks

Agro-industrial parks encompass complex inter-organizational networks of heterogeneous organizations that are geographically proximate (Baas, 2011; Smeets, 2011). Inter-organizational networks are defined as collaborations between more than two organizations (Albino et al., 2012; Bergenholtz and Waldstrøm, 2011), in contrast to collaborations among entities within a single organization. Due to the complexity of network structures in agro-industrial parks, two levels of network analysis are differentiated: network level and organizational level (Albino et al., 2012; Wasserman and Faust, 1994).

2.1. Network level

At the network level, agro-industrial parks are conceptualized as planned or self-organized networks, in which geographically co-located organizations create networks for waste streams exchanges (Baas, 2011; Smeets, 2011). While planned networks can be formed under certain institutional settings, self-organized networks often involve informal ties (Chertow and Ehrenfeld, 2012). In line with social network theory, the structure at network level can be described by the concepts centralization and density (Ahuja, 2000; Bergenholtz and Waldstrøm, 2011; Wasserman and Faust, 1994).

Centralization gives an indication of the power distribution among the collaborating organizations (Wasserman and Faust, 1994) and encompasses the degree to which networks are managed by hierarchies (Ahuja, 2000). Decentralized structures indicate well-balanced power distribution among the collaborating organizations may prevent conflicts and attain more agreements (Lawler and Yoon, 1993). Considering the heterogeneity of collaborating organizations in agro-industrial parks, it is expected that decentralized structures indicating similar embeddedness of organizations within the network, may further expand the networks. Decentralization, however, may cause inefficiencies and so requires extra resources for network maintenance, especially in large networks (Provan et al., 2007).

Density indicates the proportion of actual to total potential ties (Burt, 2000; Rowley, 1997). High density may facilitate knowledge diffusion, stimulate imitative behavior, and shorten cognitive distance among heterogeneous organizations (Rowley, 1997). High density, however, can also create network inefficiencies, increasing network redundancies (Burt, 2000). Dense networks are considered to be beneficial, especially in heterogeneous networks such as agro-industrial parks, to overcome opportunism, to reduce large cognitive distance, to avoid opportunistic behavior, and to breed trust (Gilsing and Nooteboom, 2005). Therefore, dense networks are expected to suit to agro-industrial parks encouraging sustainability performance.

In sum, centralization and density of ties indicate the embeddedness of organizations within the networks and the degree to which the inter-organizational network structure can influence physical exchanges (Ashton, 2008). To understand the network ties of organizations nested within agro-industrial parks, the research considers network structures at organization level.

2.2. Organizational level

At the organizational level, the focus is on bilateral ties and centrality of individual organizations (Bergenholtz and Waldstrøm, 2011; Provan et al., 2007). Bilateral ties among heterogeneous