



Review

Toward a research agenda for policy intervention and facilitation to enhance industrial symbiosis based on a comprehensive literature review



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ABSTRACT

The normative question “what role should governmental policy play to facilitate the development of industrial symbiosis?” has received considerable attention of researchers. However, for several reasons the effects of governmental policy actions on industrial symbiosis are still not clear. This article proposes a research agenda to clarify the mechanisms of policy intervention and facilitation of industrial symbiosis based on a comprehensive review of industrial symbiosis literature, focusing on how policy is conceptualized and studied. The results show that existing research lacks an explicit definition of policy, and employs a static conceptualization of policy that is reinforced by comparative statics research methods. We argue that a dynamic process perspective is crucial to reveal the actual mechanisms through which policy intervention and facilitation affect the evolution of industrial symbiosis. Building on this view, industrial symbiosis research is connected with insights from policy sciences, and the case of policy translation of Circular Economy and Eco-industrial Park in China is investigated in order to illustrate that policy is at heart a dynamic process. We conclude with a research agenda proposing that the key to reveal the mechanisms is to identify the sequence of events connecting policy process and industrial symbiosis practices.

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1. Introduction

The interlinked global issues of climate change, environmental deterioration and resource scarcity are at the heart of the field of industrial ecology which has been called the “science of sustainability” (Allenby, 1999, p40). One of the core topics in this field is industrial symbiosis (IS). The generic label of IS covers a variety of practices within countries that involve the linkage of industrial processes in regional industrial systems through by-product exchange and utility sharing. The uncovering of the iconic example of industrial symbiosis in Kalundborg sparked a multitude of actions from governmental officials, firms, NGOs, and researchers. Countries like China, Japan, the United States, and the Netherlands issued governmental policy programs to facilitate and stimulate IS development. Governmental policy here refers to the course of actions of governmental actors to provide intentional guidance to solve the collective issues. In the following sections, the concept of

‘policy’ is used for short,¹ denoting both intervention and facilitation. The attempts to stimulate IS through policies have not gone unnoticed by researchers, who have studied the role policy can and should play in facilitating the practice of IS (e.g., Chertow, 2007; Gibbs and Deutz, 2007; Costa et al., 2010).

Still, the effects of policy on IS practices are not completely clear, especially regarding the actual mechanisms of policy intervention and facilitation and their relation to the diffusion of IS (Boons et al., 2011). This article proposes a research agenda to clarify these mechanisms. Our underpinning of this agenda begins with a comprehensive literature review that shows the way in which ‘policy’ has been studied and treated in IS research, the understandings that have been achieved, and the shortcomings that we see (Section 2). Section 3 then brings in insights from policy sciences to address these shortcomings. In our view, this entails the study of policy as a dynamic process, which is conceptualized in Section 4 using the concept of policy translation. The empirical cases of the development of the concepts of Circular Economy (CE) and Eco-industrial Park (EIP) in China are analyzed to show the added value of viewing policy as a dynamic process. We are then able to provide a research agenda aiming to reveal the mechanisms of policy intervention on IS initiatives.

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¹ See Parsons (1995) and Hill (2005) for the distinction of the concepts of ‘public’, ‘private’, and ‘policy’.

2. Policy research in IS literature

2.1. Research methodology of literature review

Our literature review aims to reveal the current state of academic insight into the role of policy in IS. We focus on academic insight as our purpose is to develop a scientific research agenda. We built a database extracting published articles from the Web of Science (science and social science database), using the following combinations of search terms: “policy & industrial symbiosis/eco-industrial park/EIP”, “government & industrial symbiosis/eco-industrial Park/EIP”, “governance & industrial symbiosis/eco-industrial Park/EIP”, “regulation & industrial symbiosis/eco-industrial Park/EIP”, “institution & industrial symbiosis/eco-industrial Park/EIP”, “law & industrial symbiosis/eco-industrial park/EIP”. This produced a total of 118 items. After removing conference papers that were not accessible to us, we scanned abstracts to remove papers irrelevant to the topic of this research, leaving 37 articles (Appendix A). Following the procedure outlined by Seuring and Müller (2008), relevant articles were selected and classified into categories through an iterative process.

We arrived at a classification into four categories based on the main aim and the treatment of policy in the paper. They are respectively: 1) descriptive overview of policy programs; 2) policy as a mechanism for stimulating industrial symbiosis; 3) evaluation of the impacts of policy programs; and 4) Lessons from practice: lessons learned and policy implications. In the following section, the contents of each category are summarized and analyzed.

2.2. Four categories and content analysis

We used a further iterative interpretative process to create four categories and ten subcategories according to the policy aspect addressed (Table 1).

2.2.1. Descriptive overview of policy programs

The articles classified into this category are aimed at providing insight into policy programs that facilitate IS. Some of these review a specific policy program (subcategory 1.1). Geng et al. (2012) introduce China's national CE indicator system that guides the implementation and evaluation of CE initiatives. They argue that the indicator system should be more comprehensive to cover economic performance, environmental quality, and social development of sustainable development. They also identify barriers to its implementation: non-standardized data collection, the voluntary character of the indicator system, and the lack of specific goals. Behera et al. (2012) review the Korean EIP Master Plan with a specific focus on the strategies for IS network development in Ulsan. They stress the importance of policy on transforming

conventional industrial complexes into EIPs. Van Berkel et al. (2009b) review the management strategies of Japan's Eco-Town program, as well as the characteristics and motivations for each Eco-town. They find that recycling-oriented legislation, among many other factors, is crucial to the success of Eco-town program.

The second subcategory compares different policy programs (1.2). Costa et al. (2010) analyze the waste management policies at supra-national, national, and sub-national levels in Denmark, UK, Portugal and Switzerland. They find that governmental policy can be the enabling context for IS development through setting clear objectives and supporting business eco-efficient activities, while allowing flexibility for local implementation. Zhang et al. (2010) compare China's two national policy programs regarding EIPs, and find five flaws in the situation that have arisen: (1) the associated governmental agencies of the two programs and their fragmented management strategies create confusion about what an EIP should be; (2) the indicator system used to guide and evaluate EIPs fail to set different requirements because of the large geographical variation of EIPs; (3) a lack of necessary supervision may lead to rhetorical actions in industrial parks; (4) more coherence is needed as some existing policies conflict with EIP construction programs; (5) and unsuccessful planning schemes exist which overemphasize closed loop of materials, rather than the reduction of material and energy consumption. They then argue for a clear division and coordination of agencies in charge, more scientific and operational standards, and investment in research and capacity building. Also, policy instruments such as market-based solutions and public involvement proposed to be adequately adopted.

The third subgroup outlines the evolution of policy programs (1.3). Laybourn and Lombardi (2012) summarize the recent progress of European policies regarding IS, and argue that the concept of IS has direct relevance to a broad policy agenda covering eco-efficiency, innovation, green growth, and economic development. But it is currently not connected to them by policy makers. In their investigation of the CE development in China, Geng and Doberstein (2008) find the following barriers to China's 'leapfrog' from environmentally-damaging development to a more sustainable path: fragmented regulation systems, low cost of discharging waste, and a lack of qualified personnel and budget in the enforcement of environmental regulations. Ren (2007) distinguishes core policy and enabling policy in Chinese policy programs to develop a CE and argues that central government is a main driving force to the development of CE. Mathews and Tan (2011) investigate the same topic from an evolutionary perspective. Based on the comparison of cases in China and several worldwide often cited cases (at the EIPs level), they find that the government plays a vital role in the early stage of EIPs development in China.

Table 1
Four categories of policy research addressed in IS literature.

Category	Subcategory	Selective examples
1. Descriptive overview of policy programs	1.1 review of a specific policy program	Geng et al., 2012
	1.2 comparison between policy programs	Costa et al., 2010; Zhang et al., 2010
	1.3 evolution of policy programs	Laybourn and Lombardi 2012; Mathews and Tan 2011
2. Policy as a mechanism for stimulating IS	2.1 policy as a success factor or barrier to IS	Gibbs and Deutz, 2005, 2007; Mirata 2004; Van Beers et al., 2007; Liu et al., 2012a
	2.2 governance and coordination strategies of specific cases	Brent et al., 2008; Shi et al., 2010;
	2.3 mechanisms underlining and favoring IS	Chertow 2007; Deutz 2009; Costa and Ferrão 2010
3. Evaluation of the impacts of policy	3.1 The development of cases influenced by policy	Lehtoranta et al., 2011; Park et al., 2008
	3.2 Quantitative performance assessment of certain cases influenced by policy	Van Berkel et al., 2009a
4. Lessons from practice: Lessons learned and policy implications	4.1 implications from case studies	Adamides and Mouzakitis 2009; Kim, 2007
	4.2 implications from quantitative assessment of economic and environmental performance of IS	Chertow and Lombardi 2005; Liu et al., 2012b

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