
WHAT HAMPERS THE IMPLEMENTATION OF INDUSTRIAL SYMBIOSIS ON A LARGE SCALE IN ITALY?

Luca Fraccascia^{1,2*}

¹*Department of Computer, Control, and Management Engineering "Antonio Ruberti",
Sapienza University of Rome, ITALY.*

²*Department of Industrial Engineering and Business Information Systems,
University of Twente, THE NETHERLANDS.*

(E-mail: l.fraccascia@utwente.nl; luca.fraccascia@uniroma1.it)

**Corresponding author*

ABSTRACT

This paper is aimed at highlighting the main barriers that hamper Italian small and medium enterprises from implementing the industrial symbiosis practice. Semi-structured interviews have been conducted with top managers of 10 Italian small and medium enterprises. The barriers mentioned by managers have been categorized according to the three IS phases, i.e., willingness, assessment, and implementation. Based on the results, several implications and policy actions are suggested.

Keywords: Industrial symbiosis; barriers; semi-structured interview; small and medium enterprise.

Introduction

Although industrial symbiosis (IS) is widely claimed to potentially enhance the efficiency of production systems [1], creating economic [2] and environmental [3] benefits simultaneously – supported by several success cases around the world [4,5] – the number of companies known to adopt such practice is still too low [6]. The literature has conducted several studies aimed at highlighting the barriers hindering the implementation of IS [7,8] and at suggesting policy actions to overcome them [9,10]. Nevertheless, there are no studies specific to the Italian case.

This paper is aimed at filling this gap by highlighting what hampers the implementation of IS on a large scale in Italy, with a particular focus on small and medium enterprises (SMEs), which are currently more than 50% of companies in Italy. The paper is organized as follows: Section 2 presents the methodology, Section 3 addresses the results, and Section 4 is devoted to discussion and conclusions.

Methods

The research considered a sample of 10 companies, selected because they are known to adopt circular economy practices, mentioned by the "100 Italian Circular Economy Stories" report [11]. Companies have been selected so that all the three main geographic

areas of the country (i.e., Northern, Center, and Southern Italy) are represented. For each company, a semi-structured interview has been conducted with a top manager, aimed at collecting information on the following topics: (1) the business model adopted by the company; (2) the extent to which the main concepts of IS are known inside the company; (3) past projects, even failed, aimed at implementing IS; and (4) which barriers to IS implementation have been encountered (in case the company had already conducted at least one IS project) or are perceived to exist (in case the company did not already conduct IS projects). All the interviews have been recorded and transcribed.

Results

Figure 1 displays the results coming from the interviews. Barriers have been categorized according to the three phases of IS, i.e., the willingness to adopt such practice, the assessment of potential benefits, and the implementation of the IS project. In the following subsections, the barriers found are presented.

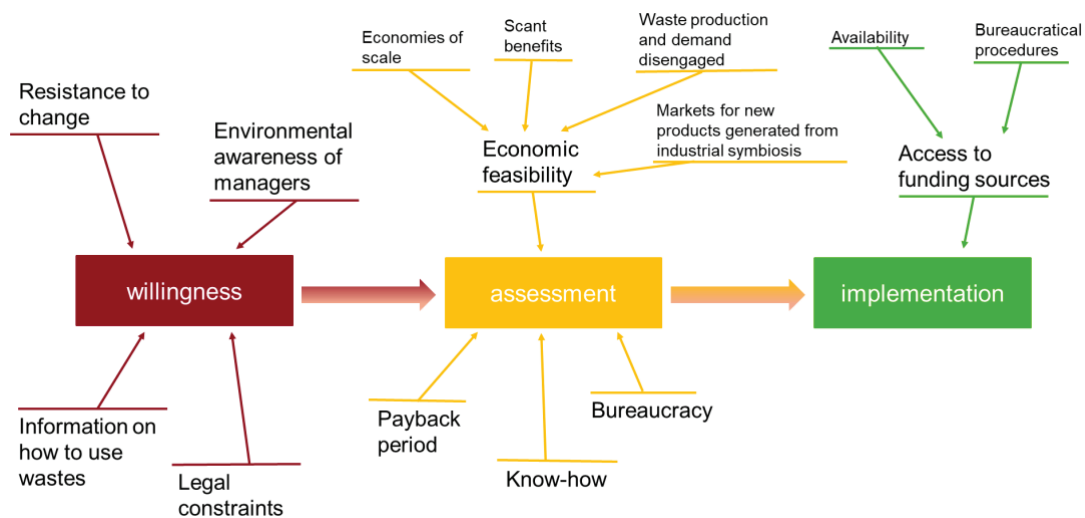


Figure 1. Barriers hampering the industrial symbiosis phases (willingness, assessment, implementation).

Willingness to explore industrial symbiosis

Several barriers were found to hamper the willingness of companies to explore IS. A first barrier concerns the resistance to change. Introducing IS into the company business model usually requires the introduction of new routines and practices, and potentially even the update of the existing ones. In this regard, companies with high resistance to change are usually less willing to explore IS opportunities. Another important factor that impacts on the willingness to implement IS is the environmental

awareness of managers. Although the literature highlights that the main driver towards IS is the chance to gain economic benefits from the symbiotic practice [12], managers with low awareness of the environmental problems seem to be less prone to explore IS. From the technical perspective, the lack of information about how to use wastes makes IS opportunities unknown to companies. Finally, there are some constraints, from the legal perspective, that affect the willingness of companies towards IS. IS relationships might require specific authorizations to be implemented, which might be long and expensive for companies to obtain.

Assessment of industrial symbiosis opportunities

According to the results from the interviews, the economic feasibility is the most important barrier in the assessment phase of IS, obstructing the shift to the implementation phase. Accordingly, some IS projects are unfeasible from the economic perspective or the economic benefits are considered not enough by companies. The low economic feasibility (or even the economic unfeasibility) is due, in turn, to several issues. First, one-to-one IS relationships might involve low quantities of wastes, which are not enough to fully exploit the economies of scale. Accordingly, the additional costs required to treat wastes before they can be used as inputs, as well as the logistic costs, are not minimized and these costs erode the potential economic benefits for companies. One issue that contributes to exacerbating this problem is the decoupling between waste production and waste demand, which is a problem largely discussed in the literature [13,14]. Indeed, such a decoupling further reduces the quantity of wastes that can be exchanged in IS relationships, thus hindering the optimization of the operations required for IS. An additional barrier arises for those companies which generate new products through IS – readers interested to deepen such an IS business model are referred to Albino and Fraccascia [15]: the market could be not ready enough for these products, which therefore register a low market demand.

Unfortunately, the economic feasibility is not the only barrier arising from the assessment of IS. In this regard, results from the interviews highlighted that the investments required to start IS projects might be characterized by high payback periods, which play an important role in discouraging the companies. Indeed, companies might want to prefer investing in other projects, characterized by lower payback periods. This issue is of key importance for SMEs, which might have limited capital to invest. A further barrier towards IS is the access to the know-how required to implement and manage IS projects, from both the technical and operational points of view. SMEs might not have such know-how internally, thus being forced to achieve it outside the company, which requires additional costs – that, in turn, erode the potential economic benefits from IS. Finally, the bureaucracy (i.e., the procedures required to activate and operate the IS relationships) is again perceived as a strong barrier.

Implementation of industrial symbiosis projects

Concerning the implementation of IS projects, almost all the companies mentioned the access to funding sources as a strong barrier. The access to funding sources can be obstructed by two issues: (1) the limited availability of funding sources, due to a scant number of competitive bidding processes or a limited amount of money destined to each of them; and (2) the difficulty to take part in the competitive bidding process, due to the bureaucratic procedures required for the access.

Discussion and conclusions

This research was aimed at highlighting the main barriers perceived and experienced by Italian SMEs concerning the adoption of the IS practice. These barriers hinder the phases of willingness, assessment, and implementation of IS. Several elements for discussion can be highlighted here.

First, the lack of information about the potential usage of wastes could be overcome by making ad-hoc databases available to companies, created by reviewing the IS projects described in the literature, as well as all the other success cases of IS. The problems related to the economic feasibility could be mitigated by encouraging the transition from one-to-one IS relationships to IS networks, where the high number and heterogeneity of the involved companies might favor higher quantities of wastes available to be exchanged, as well as can mitigate the negative effects due to the disengagement between demand and supply of wastes. Concerning the new products made through IS, further studies are required in order to investigate the consumers' acceptance of these new products, as well as to highlight the determinants impacting on the willingness to buy them. Finally, several policy measures can be suggested to highlight the above-mentioned barriers, such as providing financial and bureaucratic support to companies that (explore to) implement IS and make easier the bureaucratic procedures required to implement IS and take part in competitive bidding processes.

Acknowledgments

This work has been developed in the framework of the project titled "Fattori critici di successo per lo sviluppo della simbiosi industriale in Italia: accelerare la transizione verso l'economia circolare", financially supported by Sapienza University of Rome.

References

1. L. Fraccascia, V. Albino, C.A. Garavelli (2017). Technical efficiency measures of industrial symbiosis networks using enterprise input-output analysis. *International Journal of Production Economics*, 183, 273–286.
2. D.C. Esty, M.E. Porter (1998). Industrial Ecology and Competitiveness. *Journal of Industrial Ecology*, 2, 35–43.
3. M. Martin (2020). Evaluating the environmental performance of producing soil and surfaces through industrial symbiosis. *Journal of Industrial Ecology*, 24, 626–638.
4. T. Domenech T, R. Bleischwitz, A. Doranova, D. Panayotopoulos, L. Roman (2019). Mapping Industrial Symbiosis Development in Europe: typologies of networks, characteristics, performance and contribution to the Circular Economy. *Resources, Conservation and Recycling*, 141, 76–98.
5. A. Neves, R. Godina, S.G. Azevedo, J. Matias (2020). A comprehensive review of industrial symbiosis. *Journal of Cleaner Production*, 247, 119113.
6. R. Lombardi (1997). Non-technical barriers to (And drivers for) the circular economy through industrial symbiosis: A practical input. *Economics and Policy of Energy and the Environment*, 1, 171–189.
7. T. Tudor, E. Adam, M. Bates (1997). Drivers and limitations for the successful development and functioning of EIPs (eco-industrial parks): A literature review. *Ecological Economics*, 61, 199–207.
8. A. Golev, G.D. Corder, D.P. Giurco (2015). Barriers to Industrial Symbiosis: Insights from the Use of a Maturity Grid. *Journal of Industrial Ecology*, 19, 141–153.
9. Y. Tao, S. Evans, Z. Wen, M. Ma (2019). The influence of policy on industrial symbiosis from the Firm’s perspective: A framework. *Journal of Cleaner Production*, 213, 1172–1187.
10. W. Jiao, F. Boons (2014). Toward a research agenda for policy intervention and facilitation to enhance industrial symbiosis based on a comprehensive literature review. *Journal of Cleaner Production*, 67, 14–25.
11. Enel-Symbola (2018). 100 Italian Circular Economy Stories. Available from: [100 Italian Circular Economy Stories - Symbola](#)
12. D.A. Lyons (2007). Spatial Analysis of Loop Closing Among Recycling, Remanufacturing, and Waste Treatment Firms in Texas. *Journal of Industrial Ecology*, 11, 43–54.
13. G. Herczeg, R. Akkerman, M.Z. Hauschild (2018). Supply chain collaboration in industrial symbiosis networks. *Journal of Cleaner Production*, 171, 1058–1067.
14. L. Fraccascia (2019). The impact of technical and economic disruptions in industrial symbiosis relationships: An enterprise input-output approach. *International Journal of Production Economics*, 213, 161–174
15. V. Albino, L. Fraccascia (2015). The industrial symbiosis approach: a classification of business models. *Procedia Environmental Science, Engineering and Management*, 2, 217–223.