

The sweet spot of industrial symbiosis, industrial sustainability, and circular economy: a proposal of integration via performance measurement

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Abstract

Purpose

Industrial Symbiosis (IS), Industrial Sustainability (Sust) and Circular Economy (CE) play a pivotal role for the industrial sustainable transition (Baldassarre et al., 2019; Trianni et al., 2017). The three concepts are strongly interrelated (Subramanian et al., 2021; Yu et al., 2021), and an industrial firm moving towards a sustainable transition cannot overlook synergies and trade-offs among them (please refer to Figure 1 for an overview of the literature's contributions).

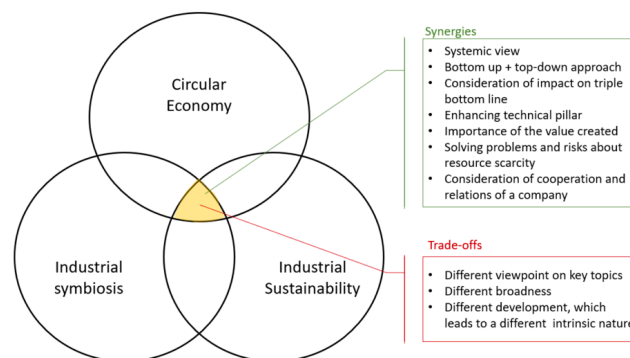


Figure 1. Synergies and trade-offs among IS, Sust, and CE. Authors' elaboration.

Industrial firms moving towards a sustainable transition must be aware of their current state and should evaluate their progress: they should thus measure their related performance in an effective manner (Neri, 2021). Considering the relationships among IS, Sust, and CE, synergies and resource-savings can derive from tackling their evaluation simultaneously and in an integrated manner. This study provides a

framework helping firms in tracking IS, Sust, and CE related performance from the abovementioned perspective.

Approach

A systematic search and literature review are conducted to investigate the extant knowledge about performance measurement systems for the evaluation of IS, Sust, and CE and several gaps are identified, above all for the integration of the three. To overcome selected gaps, this study develops a framework for the measurement of IS, Sust, and CE related performance. The framework is developed to be (Neri, 2021): scalable, providing different levels of application; holistic, suitable for application within single firms and industrial systems - as supply chain or districts; integrated, having IS, Sust, and CE as main axes. The indicators included in the framework are selected based on the frequency of appearance; capability to represent; generalizability; the interest for industrial decision-makers; provision of operative performance; consideration of economic, environmental, and social aspects. Case studies conducted in four manufacturing firms from different sectors provided a preliminary validation of the model.

Findings

The developed framework allows for the presence of two levels of depth, resulting scalable according to the firm's characteristics. The two levels present a decreasing number of indicators while guaranteeing the greatest information provided. The indicators span among IS, Sust, and CE in a balanced manner, focusing on the single areas and their intersections as well. The indicators offer a proper balance for integration within the industrial systems in which a firm operates.

The firms involved in the validation resulted satisfied with the proposed framework. It is deemed complete, useful, and valuable help to reduce the complexity of understanding the interrelations among IS, Sust, and CE.

Practical implications

The proposed framework is of relevance for practitioners to foster and support their sustainable transition. Additionally, the framework provides a complete overview of the overall industrial system, thus not addressing only the single firm.

Scholars are provided with a solid framework for further development. Particularly, broader empirical applications in industrial systems are recommended.

Contribution

The research's contribution lies in the development of a scalable, holistic, and integrated framework for the measurement of IS, Sust and CE related performance, together with a first preliminary empirical validation of it.

Keywords: Industrial Symbiosis, Sustainability, Circular Economy

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