

## Cooperation Decisions in Industrial Symbiotic Relations

Topic: (5.4) Industrial Ecology using IO Tables

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As a cooperative industrial practice, Industrial Symbiosis (IS) is expected to play a major role in implementing circular economy. Firms involved in Industrial Symbiotic Relations (ISRs), i.e., emerging relations for waste exchanges among production processes of originally distinct firms, can enjoy mutual environmental and economic benefits. Moreover, ISRs have a positive influence on both the resilience of firms and the efficiency in exploiting available resources.

Although IS takes place between two production processes of two firms, it makes indirect and induced impacts on the physical and monetary flows through their traditional supply chains triggered by resource use change. Hence, firms need analytical tools tailored to support their decisions whether to cooperate in, and operationalize a particular ISR proposal measuring such impacts. Therefore, such a decision support tool has to regard multiple operational aspects such as presence of competitors and regulations and should be able to dynamically visualize the consequences of taken decisions through entire supply chain. Although methods for analyzing each of these dimensions separately exist, analyzing the cooperation decisions in ISRs calls for joint methods that are able to take into account multiple aspects.

For this account, we apply Enterprise Input-Output (EIO) analysis for modeling the physical flows of resources and exploit game-theoretic schemes for reasoning about cooperation decisions. Hence, according to the cooperation strategies adopted by companies in the game theoretic approach, upstream and downstream supply chain flows are dynamically updated and visualized on input-output tables. Moreover, we study the macro-behavior of ISRs regarding the cooperation decisions by using Multi-Agent-Based Simulations. Our empirical context is based on a circular business case from processing industry.

Our study provides practical insights for firm managers facing the cooperation decisions in possible ISRs. Furthermore, a methodological advance in studying IS is provided by bridging mature fields of input-output analysis and game theory.

**Keywords:** Industrial Symbiosis; Decision-making; Enterprise Input-Output Analysis; Game Theory; Multi-Agent-Based Simulation.