RESOURCE INVENTORY FOR FOSTERING INDUSTRIAL SYMBIOSIS PRACTICES

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INTRODUCTION
From the technical perspective, the most relevant condition for the development of Industrial Symbiotic Networks (ISNs) is the match between supply and demand of reusable resources, e.g., wastes [1]. However, ISNs’ vulnerability to perturbations in the amount of both produced resources and required inputs negatively affects such a match [2]. In order to deal with this problem, when demand is lower than supply, providers can stock the reusable resource rather than disposing.

AIM OF THE STUDY
This study is the first attempt to investigate the strategy of resource stocking in ISNs. In particular, this study is aimed at assessing the environmental benefits obtainable in case ISN firms adopt such a strategy.

METHODS

• This study adopts a multiagent-based simulation approach: we design a model where agents are the firms within the ISN and links among agents are ISRs. The model simulates the spontaneous creation and operation of an ISN over time
• Different environmental scenarios defined by the following parameters:
  – waste market dynamicty (WMD), modeled as the standard deviation of demand and supply of wastes compared to the mean value (negative impact on the match between demand and supply)
  – average firms’ degree of centrality (DOC) in the ISN normalized by the total number of firms in the ISN (positive impact on the match between demand and supply)
• All the physical and monetary flows among firms are modeled by adopting the Enterprise Input-Output (EIO) approach [1]
• The model is applied to a case study involving marble producers and concrete producers [4]. Simulations are run for 40 time periods and replicated 200 times. At the end of each simulation, we compute:
  – the amount of resources exchanged in absence of stocking strategies in comparison to the amount of produced reusable resources
  – the amount of not-exchanged (but disposed) resources as a result of lacking inventories in comparison to the amount of produced reusable resources

THE AGENT-BASED MODEL

• Agents take decisions based on their willingness to cooperate, which takes into account [5]:
  - The net economic benefits stemming from the symbiotic relationship
  - The path dependence
• Each firm is willing to cooperate with another firm only if its WTC is higher than a threshold value [3]
• Costs arisen from the IS relationship (e.g., waste transportation, waste treatment) are shared between firms, which can autonomously negotiate the share that each of them has to pay
• Firms can take three main decisions:
  - Try to renegotiate the current cost-sharing policy
  - Interrupt the IS relationship in which they are involved
  - Try to create a new IS relationship with a new partner

RESULTS

Environmental benefits created without inventories (a)

Environmental benefits lost because of no inventories (b)

DISCUSSION

• The percentage of not-exchanged resources because of missing inventory strategies in ISNs ranges between 0.8% and 11.71% and it is much higher when the WMD and the DOC are high
  – The practice of stocking wastes in ISNs can significantly reduce the negative effects of the WMD, which is recognized as an important barrier to the development of new ISRs [3]
  – This practice appears to be barely useful when the ISN is characterized by low DOC. In such a case, firms should concentrate on building social relationships and trust among them instead of dealing with technical issues [6]
• Further developments will address the economic implications of resource inventory for firms, in order to assess the extent to which such a practice could enhance the economic benefits for firms

REFERENCES


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