



Analysis of operations research methods for decision problems in the industrial symbiosis: a literature review

Emre Yazıcı¹ · Hacı Mehmet Alakaş¹ · Tamer Eren¹

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Abstract

Industrial symbiosis (IS) is an approach that aims to use resources efficiently by cooperating between independent enterprises in raw materials, energy, and similar sectors. As a result of cooperation, businesses gain economic, environmental, and social benefits. Especially in recent years, IS applications have become widespread due to the problems experienced in the supply of resources. The presence of more than one enterprise in cooperation creates a complex network structure in IS applications. In this complex system, many decision problems are encountered in establishing and effectively maintaining the industrial symbiosis network. Operations research techniques are at the forefront of the methods used to solve decision problems. This study examined studies using operations research techniques in industrial symbiosis. Studies were divided into four classes according to the methods they used: exact methods, heuristic methods, multi-criteria decision-making, and simulation. In the literature review, the studies in the Web of Science (WOS) database are systematically presented by scanning with the determined keywords. As a result of the study, it was analyzed which method was preferred and where the methods could be applied in industrial symbiosis.

Keywords Industrial symbiosis · Operations research · Decision-making

Introduction

Industrial symbiosis (IS) was first used by Frosch and Gallopoulos (1989) to express that the wastes of one enterprise can be used as input for another enterprise (Frosch and Gallopoulos 1989). IS aims to integrate the sustainability approach into environmental and economic systems (Ehrenfeld and Gertler 1997). It is an exchange synergy that provides financial and competitive advantages by exchanging raw materials, energy, water, and by-products of geographically close and independent enterprises.

The realization of the industrial symbiosis approach in industrial areas is called an Eco-industrial park (Chertow 2000). The first example in the world was developed organically by two independent enterprises in 1972 in Kalundborg, Denmark. By the end of the 1970s, other businesses in the region were affected by this synergy. The surrounding companies, including farms, cement factories, and acid factories, were included in the change process. Apart from Kalundborg, there are successful applications in the world. For example, the National Industrial Symbiosis Program (NISIP), a UK-based organization that facilitates IS, emerged in 2005 in the UK. With the industrial symbiosis application, 2.9 million tons of waste and by-products were exchanged annually in Kalundborg. At the same time, cost savings of 1.1 million pounds were achieved with 15,000 participating enterprises in an annual process in England. These successful examples have been included in Finland, Canada, and Japan (Turken and Geda 2020).

Economic and environmental gains are obtained in the applications of IS. However, the problems that emerged during the implementation phase attracted the attention of researchers. Most researchers think industrial symbiosis networks are complex (Bollinger et al. 2015; Guedes

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Operations Research Methods Problems

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Problems in Basic Operations Research Methods for Management Randolph W. Cabell, Almarin Phillips, 1961

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An Introduction and Problem Solving of Statistical and Operations Research Methods Dr. Darshanaben Dipakkumar Pandya, Dr. Geetanjali Amarawat, Dr. Abdul Hamid Qureshi, Dr. Sheshang D. Degadwala, 2023-05-03

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