- Development of a Multi-Objective Analysis Software for Evaluating Trade-offs between Economic Efficiency and Environmental Impact -
- Focusing on Production and Logistics systems* -

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Abstract

This report describes the development of multi-objective analysis software for evaluating trade-offs between economy efficiency and environmental impact. We focused on a logistics system integrated with multiple production methods characterized by differing production costs (economic efficiency) and CO_2 emissions (environmental impact). To cope with the problem, in practice, we extended our previous approached by hybridizing graph algorithms for the Minimum Cost Flow (MCF) problem with both classical and recent metaheuristic methods. The former derives an optimal scheme of total solution such as allocations of production and paths of location, while the latter deals with a sub-problem known as vehicle routing problem (VRP). Furthermore, by introducing a cost representation for CO_2 emissions, we developed a procedure for multi-objective analysis between cost and environmental impact using a weighting method. Finally, a case study and bench mark with practical problem size were solved successfully using the developed software.

Key words : Software development, Multi-objective analysis, Hybrid of graph algorithm and metaheuristic methods, Trade-off between economy and environment, Logistics system cooperated with production system.

1. Introduction

In recent years, globalization has become a key concept in discussions of economic efficiency. Accordingly, the construction of production and logistics system is increasingly required to incorporate perspectives related to global environmental issues, such as greening and decarbonization (Shimizu, Sakaguchi, and Shimada, 2015). Furthermore, business innovation aimed at service innovation in mature and aging societies is considered one of the factors determining success in intense competition. In modern industries, “Quality, Cost, and Delivery” (QCD) have become the motto for corporate survival. In recent supply chains, there has been a shift from “Quality” to a broader consideration including “Service” and environmental concerns. Along with the spread of the Sustainable Development Goals (SDGs), consumers as well as producers are becoming increasingly conscious of environmental considerations in product selection. Building production and logistics system under these perceptions provides a framework for addressing several issues in today’s social infrastructure. Therefore, the development of flexible and versatile solution methods capable of handling realistic conditions is important. This research aims to develop multi-objective analysis software that support the construction of low-carbon production and logistics system.

2. Problem-Solving Approach

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