Integrated Intermodal Logistics Network Design

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Abstract

Intermodal freight transportation uses at least two different transportation modes to move freight loads that are in the same transportation unit from origin to destination without handling the goods themselves. The increasing shift to intermodal transportation and the growth of freight transportation demand have resulted in a higher demand for intermodal freight transportation that has been projected to grow even faster in the next few decades. Satisfying this emerging demand will require enhancing the capacity of current intermodal facilities or even the construction of new intermodal facilities. This research addresses the intermodal logistics network design problem. To obtain the maximum performance of the intermodal logistics network, two relevant decisions corresponding to the route and mode selection for freight loads were integrated with the facility location problem within the integrated intermodal logistics network design (IILND) problem.

To address the IILND problem, two mathematical formulations were developed. One considered making decisions about arcs of the network while the other considered making decisions about routes for origin-destination flows in the network. The arc-based formulation modeled the effect of consolidating freight loads at intermodal terminals on the transportation cost by a stepwise function that relates the per container transportation cost to the amount of flow between two nodes. A heuristic approach that combines a genetic algorithm and the shortest path algorithm was developed to efficiently obtain high quality solutions for the arc-based formulation.

Unlike the arc-based formulation, the route-based formulation modeled the effect of consolidating different loads at intermodal terminals on the transportation cost and time using constant discount and delay factors, respectively. Moreover, a composite variable formulation was used for the route-based formulation to incorporate route feasibility constraints within the definition of the composites and avoid explicitly adding them to the model. Two solution approaches were developed to find optimal solutions for the route-based formulation, namely a decomposition-based search algorithm and an accelerated Bender's decomposition method.

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