Two-stage Robust Optimization for Collaborative Distribution Network Design Under Uncertainty

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Abstract : This research focuses on the establishment of horizontal cooperation among companies to enhance their operational efficiency and competitiveness. The study proposes an approach to horizontal collaboration, called coalition configuration, which involves partnering companies sharing distribution centers in a network design problem. The paper investigates which coalition should be formed in each distribution center to minimize the total cost of the network. Moreover, potential uncertainties, such as operational and disruption risks, are considered during the collaborative design phase. To address this problem, a two-stage robust optimization model for collaborative distribution network design under surging demand and facility disruptions is presented, along with a column-and-constraint generation algorithm to obtain exact solutions tailored to the proposed formulation. Extensive numerical experiments are conducted to analyze solutions obtained by the model in various scenarios, including decisions ranging from fully centralized to fully decentralized settings, collaborative versus non-collaborative approaches, and different amounts of uncertainty budgets. The results show that the coalition formation mechanism proposes some solutions that are competitive with the savings of the grand coalition. The research also highlights that collaboration increases network flexibility and resilience while reducing costs associated with demand and capacity uncertainties.

Keywords : logistics, warehouse sharing, robust facility location, collaboration for resilience

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