Managing stochastic supply and demand in an inventory routing problem

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Abstract

In this work, we address a stochastic inventory routing problem under supply and demand uncertainty. In this problem, a supplier must simultaneously determine the visit schedule, the replenishment quantities, and the vehicle routes to perform those deliveries while taking uncertainty into consideration and minimizing the total cost of the system. We consider the problem with a single product in a discrete and finite multi-period planning horizon, where the distribution network consists of a single supplier and multiple customers. We introduce several two-stage stochastic programming formulations for different recourse actions, such as lost sales, backlogging, and extra supply under a capacity reservation contract setting. In the first case, the supplier incurs a lost sales penalty each time a customer demand is not fully satisfied. In the second case, we allow demand backlogging, which permits the supplier to recover from previous failures. Finally, in the capacity reservation setting the supplier can contract a supplementary external provider such that any amount of a reserved capacity is ready when required. To solve this problem, we present a branch-and-cut algorithm as well as a hybrid method based on the combination of the progressive hedging method and an iterated local search metaheuristic. We perform extensive computational experiments to provide managerial insights into the behavior of the solutions provided by the formulations under different conditions. We also show that our hybrid method is able to provide good feasible solutions within reasonably running times.

Keywords: inventory routing, stochastic supply, stochastic demand, mathematical formulation, hybrid method.

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