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Integrating Forward and Reverse Logistics in Vehicle Routing Problem with Cross-docking

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Abstract. A closed-loop supply chain is one of the vital parts for maintaining the success of enterprises, where forward and reverse logistics are integrated to eliminate wastes (e.g., transportation costs). However, previous studies related to the Vehicle Routing Problem have almost overlooked this integration. This research therefore introduces a variant of the Vehicle Routing Problem with cross-docking (VRPCD) by simultaneously considering three additional factors: (1) various types of vehicles in terms of their capacities and unit travel costs; (2) multiple cross-docks; and (3) the integration of forward and reverse logistics. In particular, the flows of the network consist of distributing goods from suppliers to customers and returning unsold goods from customers to associated suppliers. A mathematical programming model is formulated with the objective of minimizing the total travel and operational costs. For small-scale instances, commercial software is able to generate the optimal routing plan for the proposed network. We also apply a Simulated Annealing (SA) algorithm with five classical neighborhood moves to solve the problem. SA obtains optimal solutions for small-scale instances (i.e., 10 and 30 nodes) and better solutions for largescale instances (remaining sets) (compared to the solutions provided by the GUROBI solver). Finally, sensitivity analyses are conducted to highlight the positive impacts of the integration of the forward and reverse flows.

Keywords: Closed-loop supply chain, Forward/Reverse Logistics, Cross-dock, Vehicle Routing Problem.