

**OPEN VEHICLE ROUTING PROBLEM WITH MOVING SHIPMENTS
AT THE CROSS-DOCKING TERMINAL**

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Vehicle Routing Problem (VRP) plays a vital role in supply chain (SC) management. The cross-docking (CD) strategy was introduced in the 1930s to reduce up to 70% of warehousing at traditional distribution centres in SCs. The research on integrating VRP with CD (VRPCD) was initiated in 2006. Open VRP (OVRP) is one of the variants of VRP, and it is more suitable for organizations which outsource the fleets of vehicles from third-party logistics (3PL) companies. In this study, one of the internal operations at the CD terminal (CDT), moving shipments (MS) from receiving doors to the shipping doors of CDT, is integrated with VRPCD. Consequently, this study considers open VRPCD with MS at CDT (OVRPCD-MS). As an additional feature in this study, two sets of fleets of vehicles with two different capacities are added for pickup and delivery processes separately. Furthermore, the service cost at each customer and at receiving and shipping doors of CDT is considered when calculating the total cost of transportation. Moreover, the asymmetric distance between any two customers is assigned by incorporating a characteristic of one-way routes between cities in real-life transportation. The objective of this study is to minimize the total transportation cost which incurs travelling costs between customers, service cost at customer points, service cost at the receiving and shipping doors of CDT, cost of moving shipments inside the CDT and finally, the cost of hiring fleets of vehicles from 3PL. To solve the OVRPCD-MS problem, a mixed integer linear programming (MILP) model is developed. The programming model was implemented in LINGO (version 18) optimization software. The branch and Bound algorithm is employed to solve ten small-scale instances generated randomly. The applicability of the proposed MILP model is observed. The required fleets of vehicles to be hired and the run time to reach the optimal solution is determined. The study revealed that the average run time is exponential for small-scale instances. Thus, it can be concluded that this proposed model can be used for the last time in the planning of similar, small-size instances. At the same time, the combinatorial nature of VRP makes OVRPCD-MS as NP-hard problem. Therefore, this study recommends that heuristic or metaheuristic methods are more appropriate for the medium and large-scale instances of OVRPCD-MS to reach near-optimum solutions. This further recommends incorporating additional constraints to the OVRPCD-MS model, such as time windows for each customer, budget allocations for fleets of vehicles and temporary storage capacity at CDT to cover a broader spectrum of a study under investigation.

Keywords: Cross-docking, Moving shipments, Open vehicle routing