# The Vehicle Routing Problem with Simultaneous Pickup and Delivery under Omnichannel Retailing

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**Abstract.** With mobile technology today, different retail formats have increasingly evolved. Traditional offline retailers now include online channels to serve online customers via their own websites and social media. However, in an effort to offer seamless online services within different channels, more and more retailers have ventured into omnichannel retailing. Omnichannel retailing reduces friction in customers' online transactions, including purchases and customer returns, which is a reverse logistics issue that is gaining urgency in online retail.

This research presents the Vehicle Routing Problem with Simultaneous Pickup and Delivery in Omnichannel Retailing (OCVRP-SPD). The classical Simultaneous Pickup and Delivery (SPDP) Problem in Vehicle Routing is a cost-minimizing optimization model with customer nodes having both pickup and delivery demands of multiple products. All deliveries to the customer nodes are fulfilled from the warehouse, while all pickups along the route are delivered back to the warehouse. We extend the SPDP with three features that are explored under an omnichannel format: (1) offline stores are used as fulfillment centers to fulfill online customer orders, (2) the warehouse may also be used as fulfillment centers for some online customer orders, and (3) some online customers have product returns that should be picked up along the route. Two mathematical models are developed to explore via a numerical comparative study the impact of (1) and (2) on the overall optimal routes and costs.

**Keywords:** simultaneous pickup and delivery, vehicle routing, omnichannel, reverse logistics.