

Environmental Impact of Long-Combination Vehicles in Full-Truckload Transport Planning

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Full-truckload (FTL) transport, where goods typically occupy an entire trailer, is a cornerstone of freight transport. Its heavy-duty vehicles account for roughly 6% of Europe's greenhouse gas emissions. Long combination vehicles (LCVs), which combine multiple trailers behind a single truck, offer opportunities to consolidate FTL shipments, reduce costs, and thereby lower emissions. However, their effective use requires complex planning, driven by the large number of different truck and trailer types that can be combined in driving configurations. We introduce the Full-truckload Pickup and Delivery Problem with Configurations (FTL-PDPC), a real-world pickup-and-delivery problem that explicitly models vehicle configurations. We present a Large Neighborhood Search (LNS) heuristic to solve the problem, and more importantly, we apply our LNS at Van der Wal, a European FTL carrier with typical FTL operations. We model Van der Wal's transportation equipment with varying connectivity, LCV licensing, loading capabilities, and other operational attributes, resulting in a total of 444 vehicle configurations that have to be considered by their planning department. We also set driver-configuration-order compatibilities together with the planning experts at Van der Wal, ensuring practically-relevant solutions. Our study shows that the LNS reduces CO₂e emissions by 11.54% compared to current operations. Additionally, disallowing LCVs would increase emissions by 34.65%, while standardizing equipment would decrease emissions by another 11.71% beyond the current improvement, highlighting the substantial environmental benefits of LCVs and equipment standardization.