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# An Adaptive Large Neighborhood Search Heuristic for the Pickup and Delivery Problem with Time Windows and Scheduled Lines

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## Abstract

The Pickup and Delivery Problem with Time Windows and Scheduled Lines (PDPTW-SL) concerns scheduling a set of vehicles to serve freight requests such that a part of the journey can be carried out on a scheduled public transportation line. Due to the complexity of the problem, which is NP-hard, we propose an Adaptive Large Neighborhood Search (ALNS) heuristic algorithm to solve the PDPTW-SL. Complex aspects such as fixed lines' schedules, synchronization and time-windows constraints are efficiently considered in the proposed algorithm. Results of extensive computational experiments show that the ALNS is highly effective in finding good-quality solutions on the generated PDPTW-SL instances with up to 100 freight requests that reasonably represent real life situations.

*Keywords:* Freight transportation, Pickup and delivery problem, Heuristic algorithm, Scheduled lines

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## 1. Introduction

A successful integration of passenger and freight transportation creates a seamless movement of people and freight. This integration achieves socially desirable transport options economically viable in urban areas as it reduces the impact of congestion and air pollution (Lindholm and Behrends [21]). Actual integration is already being observed in long-haul freight transportation (e.g., passenger aircraft and ferries). Norwegian Hurtigruten carries freight and people efficiently and seamlessly in the region of Northern Europe (Levin et al. [18], Hurtigruten [16]). However, short-haul passenger and freight (i.e., small packages) transportation is rarely integrated, although these services largely use the same infrastructure.

This paper investigates opportunities and the feasibility of using available public transportation vehicles, which operate according to predetermined routes and schedules, for transporting freight.

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