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# In-port routing and scheduling with stochastic travel times in chemical shipping

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## Abstract

In chemical shipping, the tankers can spend up to 40% of their voyage duration in ports. Apart from the time needed for ordinary port-call operations, such as loading/unloading cargoes, tank washing and inspection, much time spent in ports is wasted queuing for service at terminals. Proper in-port routing and scheduling therefore become of great importance, as reducing the time spent in ports can directly increase the profitability of the tankers and bring improvements to the total performance of the shipping company. This research considers a tanker arriving at a particular port with commitments of both picking up and delivering various cargoes at their corresponding terminals within the port, and aims to find an optimized plan with shortest time spent in port that comprises sequencing decision for visiting terminals and the corresponding departure plan. We also take into account stochastic travel times between the terminals within the port. The primary source of such uncertainties is waiting for the terminals to be ready to receive the tanker. Two stochastic models are proposed for the in-port routing problem, both addressing the stochasticity in travel times, but with different objectives representing different optimization focuses of the shipping company. The models are tested on real data collected from a chemical shipping company based in Norway. The computational results show that the solutions produced by the two models provide valuable decision supports in the company's port call operations.

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