Evaluation of methods for construction of robust supply vessel schedules with discrete-event simulation

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Abstract

Supply vessel planning problem arises in offshore oil and gas logistics, where a fleet of vessels provides cargo deliveries to offshore installations on a periodic basis from an onshore supply base. The objective is to define an optimal fleet composition and a least-cost weekly sailing plan of scheduled vessels' voyages. The problem is defined as a fleet-sizing and periodic routing problem with multiple time windows at installations and voyage duration constraints. Weather conditions change dynamically and may significantly influence vessels' sailing and service times, resulting in sailing plan infeasibility. The planners need vessel plans with sufficient robustness to offset the impact of weather conditions and avoid use of additional vessels. Known approaches for construction of robust vessel schedules consist of generation of shortest duration voyages and solution of a set covering model. In some approaches, voyage slacks are incorporated during voyage generation phase based on planners' experience. In other approaches, shortest generated voyages are simulated over multiple replications of wave height evolution to compute voyage robustness measure or to assign voyage duration. In this study, we evaluate robustness of vessel schedules constructed by different robustness approaches with the developed discrete-event simulation model. It simulates weekly sailing schedules repetitively over seasonal horizon over multiple replications of weather scenarios. Multi-site multivariate seasonal sea state modeling is based on nonparametric numerical resampling and intra-day hind-cast metocean data. Experiments are conducted on real-based instances from an oil and gas company. We examine the impact of various instance characteristics on robustness of weekly sailing schedules.

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