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Empirical study of variable neighbourhood search applied to the optimization of the internal delivery vehicles at maritime container terminals

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Abstract

This work addresses the problem of operational management of the internal delivery vehicles on the yard of a maritime container terminal using a Variable Neighbourhood Search algorithm. An empirical analysis is performed to find the Variable Neighbourhood Search variant that provides the best result for the proposed problem. This analysis tests 144 different variants on a wide range of realistic scenarios.

Keywords: Maritime Container Terminal, Internal Delivery Vehicle Synchronization Problem, Variable Neighbourhood Search, Empirical Study

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1 Introduction

The Variable Neighbourhood Search [3], in short VNS, is a metaheuristic based on the idea of a systematic change of neighbourhood during two phases, both within a descent phase to find a local optimum and on a perturbation phase to get out of the corresponding valley. This algorithm has been already successfully used when solving a huge range of combinatorial and global optimization problems. The VNS varies its behaviour depending of some changes related to its configuration, such as the set of available neighbourhoods, how these change on the descent phase, which solutions are selected or how the initial solutions are created.

The main goal of this work is to determine the variant of VNS that has the best performance on the optimization of the usage of the internal delivery vehicles that move containers around a maritime container terminal. This optimization is done in terms of working time in scenarios where synchronization is required.

2 Internal Delivery Vehicle Synchronization Problem

The Internal Delivery Vehicle Synchronization Problem addressed in this work seeks to manage the available fleet of vehicles in a maritime container terminal. It assumes there is a set composed of jobs that move a certain container from a determined source position towards a target position, both known in advance. This set of jobs are performed by a fleet of internal delivery vehicles, which departs from an initial position on the yard. To perform a job, a vehicle has to move towards the source position, pick up the container, move towards the target position and deliver the container.

Several jobs can share positions as source or target. On cases that some vehicles have to perform several jobs that share a position and they have to access to the same position simultaneously, they are queued in such a way that only one of them can perform its assigned job, using a priority assigned to each vehicle.

The feasible solutions for this optimization problem are composed by the set of routes to be followed by each internal delivery vehicle when performing all the existing jobs. The route followed by a vehicle starts on its initial position on the yard and visits consecutively the source and target positions of the subset of jobs assigned to it on a specific order. The combination of all the routes on a feasible solution must perform the entire set of given jobs. The optimization objective is to minimize the time required by the vehicles