Literature overview of intermodal rail-sea terminal operations

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Abstract

This work presents a literature overview on intermodal rail-sea terminals, focusing on the rail operations performed in the rail shunting yard and in the maritime terminal for managing trains. In particular, this paper aims at describing the arising optimization problems together with solution approaches and at surveying the related literature. Higher efficiency in these operations should lead an increment in the usage of rail transport modality, the most environmental friendly one.

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1. Introduction

In a railway freight network several terminals having different functions are generally operative. They might be: i) rail yards, i.e. regular rail terminals where inbound trains/cars are disassembled/reassembled (Boysen et al. (2012)); ii) intermodal terminals, which could be either rail-sea yards (Kr"amer (2019)) or rail-road yards, generally simply called inland terminals (Dotoli et al. (2017)).

This paper aims at describing the optimization problems arising in the rail process of intermodal rail-sea yards (where the switch between rail and sea transportation modes happens) together with solution approaches and at surveying the related literature. Note that, this work cites some representative works on intermodal rail-sea terminals, focusing on the rail operations performed in the rail shunting yard and in the maritime terminal, the two zones generally composing the port area. The whole literature, to the authors knowledge, will be included in the short paper.

2. Intermodal rail-sea yard operations

A typical railway process in a rail-sea exchange node can be explained as follows. Firstly, trains travelling on the railway network arrive in the port area. After that, there is the transport with shunting locomotives of either whole
trains, train sections or wagons to the terminals. When trains or sections arrive at the assigned maritime terminal, the operators have to conduct additional checks on both the train and the cargo before starting the unloading process. A comparable opposite process is related to the departure of trains from the port area. After the completion of train loading operations in the terminal, specific checks and load controls must be performed before the train departure.

The rail activities can be divided into port rail shunting operations and rail maritime terminals operations, depending on the zone where they mainly happen. As far as port rail shunting operations are considered, we can note that arriving and departing trains can either transport goods belonging to different maritime terminals, or having a single destination/origin terminal. Therefore, in the first case, trains arriving at the port have to be split into cars depending on the terminal of destination, while the departing trains have to be composed by cars from different terminals. Among the few papers dealing with these problems in port area, we cite Rusca et al. (2019) that focus on simulation models for describing the process and evaluating the port shunting yards capacity. In the second case, the whole train arriving at the port area have to be transferred to the terminal of destination (and vice versa for departing trains). In Ambrosino and Asta (2019) possible approaches for scheduling the activities to perform on trains are discussed. In Caballini et al. (2016) the focus is a discrete-time model in order for planning port shunting operations.

More papers deal with the optimization of operations in maritime terminals, instead of the shunting zone, and in particular with the train load planning problem (Xiea and Song (2018)). When the train (a set of wagons) arrives at the maritime terminal it must be unloaded. More attention is required for the management of import containers, in order to efficiently perform their loading on trains. The loading of the trains is strongly affected by the storage strategies used in the (rail) yards. A review of the models proposed for defining the train load planning problem is presented in Heggen et al. (2016).

A deep analysis on storage yard operational strategies in container terminals is proposed in Carlo et al. (2014).

3. Conclusions

This paper provides an overview on the port rail shunting optimization problems, solution approaches and related literature. The few papers related to rail port shunting in rail-sea yards address the rail shunting operations related to the management of cars/wagons by simulation models (while these problems are well studied for inland terminals). When the shunting operations concern the whole train, the scheduling (and re-scheduling) of the shunting operations is described and some solution approaches are discussed.

The rail operations in maritime terminals are much more studied than rail shunting operations; in particular, the train load planning problem is the most studied one.

Optimization models for improving the efficiency of the whole rail process are necessary.

The whole literature will be deeper analysed and presented during the conference.

References


