

A Sustainability-Centric Methodology for the Wagon Assignment Problem

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Abstract. Tracks operations, such as shunting operations, require specialized machinery often equipped with large-volume compression-ignition internal combustion engines with high power outputs. This involves significant fuel consumption and emission of harmful pollutants in the exhaust gases which often do not meet any emission standards and generate high maintenance costs. Given the impossibility to use electric locomotives for such types of heavy operations, the optimization of the wagons assignment affecting the shunting activity can be achieved only through the development of innovative hybrid locomotives or clever effective policies. This study aims to examine the effect of applying four different wagon assignment policies (WAPs) to freight trains, considering demand and maintenance constraints, and analyze key performance indicators to check the long-term impact on rail operations in terms of service level, overheads, and emissions.

Several simulations are carried out for validation of policies' usefulness, exploiting a real schedule from 2020 up to 2040 used by the Luxembourg National Railway Company with a particular focus on the Bettembourg Eurohub Sud Terminal which connects various EU countries. The results show a substantial contraction in fuel consumption with the respect to the terminal state-of-art, and therefore both in costs and emissions generated, keeping an acceptable service level.

Keywords: Freight trains operation; Mileage-based maintenance; Shunting operations; Rolling stock problem; Wagon maintenance; shunting emissions;