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Indian Railways: Train Set Assignment Problem in Suburban Services

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Abstract

A 'train set' can be defined as a self-propelled electric (EMU) or diesel multiple unit (DMU) with permanently coupled passenger coaches. The efficient utilization of the train set is an essential objective for railway planning. The utilization efficiency can be increased by optimizing the number of train sets required to cover all designated services according to the timetable. The reduction in train sets requirements provides flexibility to the railway planners to increase the frequency of maintenance of the train set, increase the number of passenger services to cater to the increasing demand, and make smooth backup arrangements during emergencies. Hence, the safety, reliability and consistency of the railway system depend on the efficient assignment of the train sets. In railway parlance, a 'service' denotes a specific journey traversed by a particular train set from an originating station to the destination as per the timetable. Train sets are usually employed in the Indian Railways to provide suburban services in large metropolitan cities such as Mumbai, Kolkata. Railway planners must assign a particular train set to multiple interlinked services throughout a day, considering different spatial, temporal, and technical constraints. Based on experience and heuristics, manual processes are usually followed while assigning the train sets, resulting in sub-optimal utilization efficiency. In this paper, we develop a MILP (Mixed Integer Linear Programming) model to obtain an optimal assignment of the train sets. We apply the model to optimize the train set requirements in Sealdah Divison under Indian Railways, which offers 930 daily services to cater to the transportation need in the city of Kolkata and its suburbs. We run the model in a simulated environment using CPLEX optimization software and obtain the results within a finite time. Our results show significant improvements in utilization efficiency over the heuristic-based existing model followed in practice.

Keywords: Large Scale Optimization, Mathematical Programming, OR in the Public Sector, CPLEX Optimization Software.

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