A short turning strategy for an urban rail transit line with multiple depots

Miao Zhang Yihui Wang * Yimeng Luo Shuai Su Jing Xun Tao Tang
State Key Laboratory of Traffic Control and Safety
Beijing Jiao Tong University, Beijing 100044
{16120277, yihui.wang, 16125107, shuaisu, jxun, ttang}@bjtu.edu.cn

With the rapid development of urban rail transit systems, the ridership of urban rail transit lines has reached a large number. The busiest subway system-Beijing subway, carries more than 10 million people per day with the total number 3.66 billion in 2016. Under such huge pressure, train schedules play an important role in satisfying the passenger demand and reducing their waiting time. There are several methods to solve the problem, the most common of which is increasing the service frequency. As stated in [1], service frequency is usually determined by the heaviest load route segment, whereas the full length train services may cause the inefficient operation since the passenger demand at other segments are not heavy. Actually, the stochastic passenger flow is not evenly distributed at all stations, but shows a tendency such as a curve that drops gradually from the maximal volume point to the end of the line, especially for the CBD areas during peak hours. To ease the imbalanced load problem, a strategy with short turning train services could be applied [2]. Schedule coordination mode is proposed by Furth [3], which is defined as the ratio between the number of short turning train services and full length train services.

This paper proposed a mixed interger linear programming(MILP) model to obtain a train schedule with a short turning strategy based on the predefined headway obtained by the passenger demand analysis. In addition, the train circulation is also included in the model formulation.

In this MILP model, we assume that there are three depots in the urban rail transit line and the train services in the up direction and down direction are identified with different indexes. We also introduce servaral 0-1 binary variables to indicate the different choices for train operations, such as whether a train service is a short turning one or a full length one, whether the train service comes out from the depot or not, and whether the train service goes back to the depot or not. The decision variables are the binary variables mentioned above and the departure/arrival times. The objective function includes two parts. One is to minimize the deviation of the headway in the train schedule and the predefined headway obtained by the demand analysis. The other is to minimize the rolling stocks required. Finally, a case study is carried out based on the data of Beijing Subway line 6 to assess the performance of the train schedule with short turning strategy and the proposed approach.

References

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