Enhancing Mass Transit Passenger Safety during a Pandemic via In-vehicle Time Minimization

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Abstract

The risk of infection in a pandemic increases with duration of close contact with an infected person. For the COVID-19 pandemic, the World Health Organization defines unsafe contact as being within one meter of an infected person for more than 15 minutes. Since the application of social distancing in public transit vehicles is challenging, minimization of in-vehicle time can help to protect passengers from getting infected. Skip-stop operation is a viable strategy to reduce in-vehicle time as opposed to the conventional all-stop operation, and therefore can provide safer mobility for passengers. All-stop operation refers to service on a transit line in which each vehicle stops at every station. In skip-stop operations, vehicles provide accelerated service through the use of different stopping patterns on the same transit line. Skip-stop operations have been successfully implemented in many transit networks (e.g., New York, Chicago, Philadelphia, Santiago).

In this paper, a mixed integer linear programming model is formulated to minimize the in-vehicle time of passengers while operating an A/B stopping pattern (one of the most popular skip-stop strategies in the literature and in practice). In an A/B stopping pattern, three types of stations (denoted AB, A, B) and two types of vehicles (denoted A, B) are utilized. Type A vehicles stop at type A and type AB stations only. Similarly, type B vehicles stop at type B and type AB stations only. If a passenger travels from a type A station to a type B station (or vice versa), a transfer is necessary at a type AB station. Accordingly, each station on the line must be assigned to exactly one station type.

Since the number of direct trips is necessarily decreased when using skip-stop operation, this paper quantifies the tradeoff between the in-vehicle time of passengers as a pandemic-based safety measure and the number of direct trips as a measure of passenger satisfaction. In order to efficiently solve problems with a large number of transit stops, a multi-start genetic algorithm

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is developed. Rigorous numerical experiments indicate that the proposed approach can reduce in-vehicle time by up to 34%. Furthermore, Pareto optimal solutions are obtained to exhibit the tradeoff between in-vehicle time savings and percentage of direct trips.

Keywords: Transportation, COVID-19, Public transit, Passenger safety, In-vehicle time

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