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Departure and travel time model for the temporal distribution of morning rush-hour traffic congestion

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The chronic traffic congestion undermines the level of satisfaction within a society. This study proposes a departure time model for estimating the temporal distribution of morning rush-hour traffic congestion over urban road networks. The departure time model is developed based on the point queue model that is used for estimating travel time. First, we prove the effectiveness of the travel time model (i.e. point queue), showing that it gives the same travel time estimation as the kinematic wave model does for a road with successive bottlenecks. Then, a variant of the bottleneck model is developed accordingly, aiming to capture travelers' departure time choice for commute trips. The proposed departure time model relaxes a traditional assumption that the last commuter experiences the free flow travel time and considers travelers' unwillingness of late arrivals for work. Numerical experiments show that the morning rush-hour generally starts at 7:29 am and ends at 8:46 am with a traffic congestion delay index (TCDI) of 2.164 for Beijing, China. Furthermore, the estimation of rush-hour start and end time is insensitive to most model parameters including the proportion of travelers who tend to arrive at work earlier than their schedules.

Keywords: Departure and travel time; point queue model; bottleneck model; temporal distribution; traffic congestion.

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1. Introduction

The transportation sector makes an increasingly significant difference to intercity and intracity mobility. The so-called "mobility as a service" has been widely adopted in the transportation network company (TNC) such as Uber, Lyft and Didichuxing which make e-hailing popular among citizens. Apart from e-hailing, car-sharing programs are on the horizon. Zipcar and TOGO offer car-sharing services in the