An Optimal Analytical Approach to Design a Transit Exclusive Lane Network

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Abstract

Urban traffic congestion is a major challenge in almost all cities. Transit vehicles, with higher passenger capacities than personal cars, are capable of increasing the passenger throughput of roads. This higher capacity justifies the introduction of transit exclusive lanes. This study is aimed at presenting an analytical approach to design the network of transit exclusive lanes. The presented approach would identify the optimal combination of transit exclusive lanes, considering the benefits of all network users. The presented method involves the effects of shift in modal split, private car route choice, and transit route choice. The problem is formulated in form of a bi-level optimization with integer variables. A solution algorithm based on a decomposition method is proposed. The presented approach is applied to an example network and results are discussed.

Keywords: road space allocation, exclusive lane, transit network.

1.   Introduction

Transport networks are developed in response to the travel demand. With the ever increasing travel demand, traffic congestion is a challenge for many cities around the globe. Transport authorities have two approaches for development of the transport network: 1) expansion of the infrastructure and 2) reallocation of the existing infrastructure. While construction of new roads, interchanges, and mass transit lines may not always be a viable option, management of the existing network can emerge as a solution. The first approach also depends upon availability of often substantial sources and time whereas; the second approach is less costly and can be implemented in a short term. This paper focuses on the second approach to manage the existing transport network. Since transit vehicles move higher number of passengers than private cars, the efficiency of a road can be increased if the road-space is shared appropriately. This is the concept of exclusive bus lane which can be used as a powerful mean in network management [1].

The introduction of exclusive bus lanes is a form of transit priority which deals with reallocation of the road-space between road users [2]. A range of studies have focused on a link or a corridor. Black et al. [3] presented a model to evaluate several alternative road space allocations for a corridor. The total travel cost of users in the corridor was considered as the performance measure. In another attempt, Jepson and Ferreira [4] assessed different road space priority treatments such as a bus lane and set-backs based on delays in two consecutive links. Using the concept of intermittent bus lanes [5], Eichler and Daganzo [6] suggested an analysis method which is based on kinematic wave theory. This method can be applied to a long arterial.

The above researchers have focussed on examining bus lane problems on an individual link level basis. Only a few researchers have considered the problem from a network wide, multi link viewpoint. Waterson et al. [7] represented a macro-simulation approach which evaluates a given priority scenario in the network of Southampton city. This approach considered rerouting, retiming, modal change, and trip suppression. A similar evaluation approach is carried out using a micro-simulation by Liu et al. [8]. Stirzaker and Dia [9] applied another micro-simulation approach to evaluate a major bus lane project in Brisbane.

Although the reviewed studies have different focuses in terms of the spread of the proposed exclusive lanes, all researches evaluate some given alternatives. Despite the great level of details in some