How does considering bus drivers with different driving behaviors impact the performance of interval control tools?

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Abstract

The fleet control operation tools for high frequency bus service seek to maintain regularity between bus headways. Almost always, these tools suggest a series of control actions that must be executed by drivers that are assumed to be identical in their driving behavior. However, not all bus drivers drive in the same way and their behavior can be affected by different factors related to the environment in which they carry out their work.

This work focuses on determining the impact on headway regularity of considering homogeneous drivers in the control tools, when they are actually not. Since the goal is to understand the effectiveness of the control tools, we will characterize this behavioral difference by the velocity at which a particular driver may drive through a given context of the route. To this end, we modify the headway control model developed by Delgado et al., (2012), to include a driver-specific desirable speed as a proxy of their behavior.

Keywords: Public transport · Bus driver · Regularity · Bus Driver Behavior
1 Introduction

In high frequency bus services, a key aspect to offer a reliable level of service is the headway regularity between successive buses (Delgado et al., 2012; Ibarra – Rojas et al., 2015). A series of measures designed to evaluate the regularity of a service have been proposed by various authors. Most of these measures take into account the headway distribution and their relationship with the expected interval (Cats et al., 2011). Other authors have estimated functions that connect average travel time with a frequency metric, usually the standard deviation of travel time (Mazloumi et al., 2009; Moghaddam et al., 2011).

Other studies identify various factors that influence headway regularity and reliability of the service, among them are: length of the route (Sterman & Schofer, 1976), presence of signalized intersections (Abkowitz & Engelstein, 1983, 1984, Strathman et al., 1999), volume of vehicular traffic (Sterman & Schofer, 1976), passenger boarding and disembarking (Abkowitz & Engelstein, 1983, 1984; Strathman & Hopper, 1993), direction of travel (Strathman et al., 1999) and time of the day (Strathman et al., 1999).

Phillips et al. (2015) analyze the impact that the driver has on the performance of a real-time headway control tool. To do this, using the model developed by Delgado et al., (2012), they analyze the effect it has in the performance of the control tool that a driver or group of drivers does not execute bus holding instructions suggested by the control center. In this study, it is also assumed that all drivers are identical and that they drive at the same speed. The results show that it is enough that 7% of buses do not receive instructions (or do not obey) to reduce benefits by almost 15%.

Although the literature identifies many elements that impact headway regularity, until now there is no clarity about what are the benefits of having a control model that explicitly consider the heterogeneity of drivers’ behavior and its influence in the planning of an operation with regular headways. It is logical to assume then that the heterogeneity of the behavior of the driver can vary from one bus to another which should affect headway regularity and thus the perception of the system by the users.

2 Problem Description

The problem consists in estimating the impact on headway regularity between buses when explicitly considering in the control strategies, an attribute of heterogeneity of the behavior of the drivers. The attribute to be included will be the average travel speed associated with each category of driver.

To do this, we modify the model developed by Delgado et al., (2012) by including in the mathematical formulation different driving speed to each driver according to groups previously identified (eg, fast drivers and slow drivers). In addition, the effect of headway regularity will be analyzed based on the assignment of drivers similar in their driving versus a completely random assignment, or a systematic assignment based on driving categories to a given service.

The results of the model are compared with the ones from Delgado et al., (2012) which assumes that all drivers have the same driving behavior. In both cases, the models are
embedded into a simulated context in which drivers are indeed heterogeneous. To compare the different proposed scenarios, we use a simulation tool based on discrete, dynamic and stochastic events. It is expected that the quality of the solution measured in terms of headway regularity and waiting times will be superior to the case that does not differentiate behavior among drivers.

As a second step in this paper we will study the impact of different driver allocation strategies to routes in the system’s performance. For example, in the case of operating two routes, we will compare a completely random allocation to one where the assignment is decided based on driving behavior; i.e. the slowest work in one route, while the fastest in the other. If properly managed through a headway control tool we expect to observe important productivity gains in terms of frequency, especially if drivers are very different in their performance.

The main performance indicator that we will use to evaluate each strategy are the average waiting times experienced by passengers from they arrive at the stop to arrival at their destinations. Other indicators considered are the variability of the objective function as a measure of how reliable it is to operate the system through a given control strategy and driver assignment; The trajectories of the buses on a space-time diagram, which makes it possible to distinguish the duration of the holdings and the presence of bus bunching in the corridor; Distribution of cycle times, as a measure of regularity and reliability from the point of view of the operator and finally load of passengers in the different buses at the different stops along the route, as an indicator of the level of service offered to users.

The expected results are focused on quantifying the savings in total waiting times, as well as possible improvements in the level of service to users by producing more balanced passenger loads between buses and by assigning specific categories of drivers.

References


