Analyzing the Effect of Mandatory Smart-Card Use and Priority Lanes on Public Transport Reliability

Nir Ron
e-mail: nir.ron@biu.ac.il
Department of management,
Max ve-Anna Webb street, Bar-Ilan University, Ramat Gan 5290002, Israel

Yuval Hadas
e-mail: yuval.hadas@biu.ac.il
Department of management,
Max ve-Anna Webb street, Bar-Ilan University, Ramat Gan 5290002, Israel

Public Transport (PT) plays a major role in passenger mobility and contributes for sustainable transportation, by way of traffic congestion and air pollution reduction. PT systems must provide a continuous accessibility and connectivity for passengers, otherwise these advantages cannot be achieved. Furthermore, as service reliability is a major attribute for modal shift from car to PT (Redman, Friman et al. 2013), an unreliable and unconnected PT system discourages modal shift. Similarly, reliability is considered as a major property of PT, affecting users' perceptions and levels of use of the different modes (Bates, Polak et al. 2001).

Reliability can be associated with the two major components of the travel time: ride time and dwell time. Hence reliability mitigation can address each of these components. For the first, priority lanes schemes are one of the well-known options, while smart-cards can address the latter.

PT priority schemes are used to "reduce or eliminate certain types of general traffic interference that can slow down transit service, make it less reliable, or reduce its capacity" (Kittelson & Associates., Transit Cooperative Research Program. et al. 2003). Reducing the boarding time as well as decreasing boarding time variability can be achieved with the use of smart-cards, as they negate the interaction with the driver (shorter boarding time) and the need for money exchange (reduced boarding variability) (Tirachini 2013).

To analyze urban bus service reliability, specific PT reliability measures can be computed for different components of the system, such as stops, routes, and the overall network (Chen, Yu et al. 2009). These measures can be based on various information technologies used for PT planning and operations. The main systems being used are: a) Automatic Vehicle Location (AVL) systems b) Automatic Passenger counting (APC) systems, and c) AFC (Automatic Fare Collection) systems

(Acumen Bulding Enterprise Inc., Booz Allen Hamilton Inc. et al. 2006, Furth, Hemily et al. 2006, Strathman, Kimpel et al. 2008). Each of those Automatic Data Collection systems (ADC) has a specific contribution: AVL systems provide tracking of buses, APC systems provide passenger loads, and AFC systems assist with ticketing and monetary transactions.

Assessing the effect of payment methods and priority lanes can be investigated using AVL and AFC data sources. However, in order to do so it is required that only these factors will be changed over a short period of time in order to keep all other factors unchanged. Luckily, two events related to the Israeli PT system permit us to do so. 1) starting January 2019, all boarding at buses in Tel-Aviv metropolitan area are with “Rav-Kav”, the Israeli PT smart-card. whereas before it was possible to use both the smart-card and to pay cash (no exact amount is required). 2) starting April 2019, several priority lanes will be opened in Tel-Aviv. The relative short time between these events will enable the analysis of the effect of payment method and the combined effect of payment method and priority lanes on the PT system's reliability and performance.

This work aims to use data mining techniques, such as machine learning and clustering to analyze the factors affecting reliability and performance (such as travel time, schedule adherence, bunching), related to the above mentioned 3 data periods for routes in the Tel-Aviv metropolitan area. Moreover, the contribution of each data source (AVL, AFC) will be investigated as well, as the former is an open and free data source, while the latter is not. Figure 1 provides initial insights related to the average speeds of the week before the change and the week after the change.

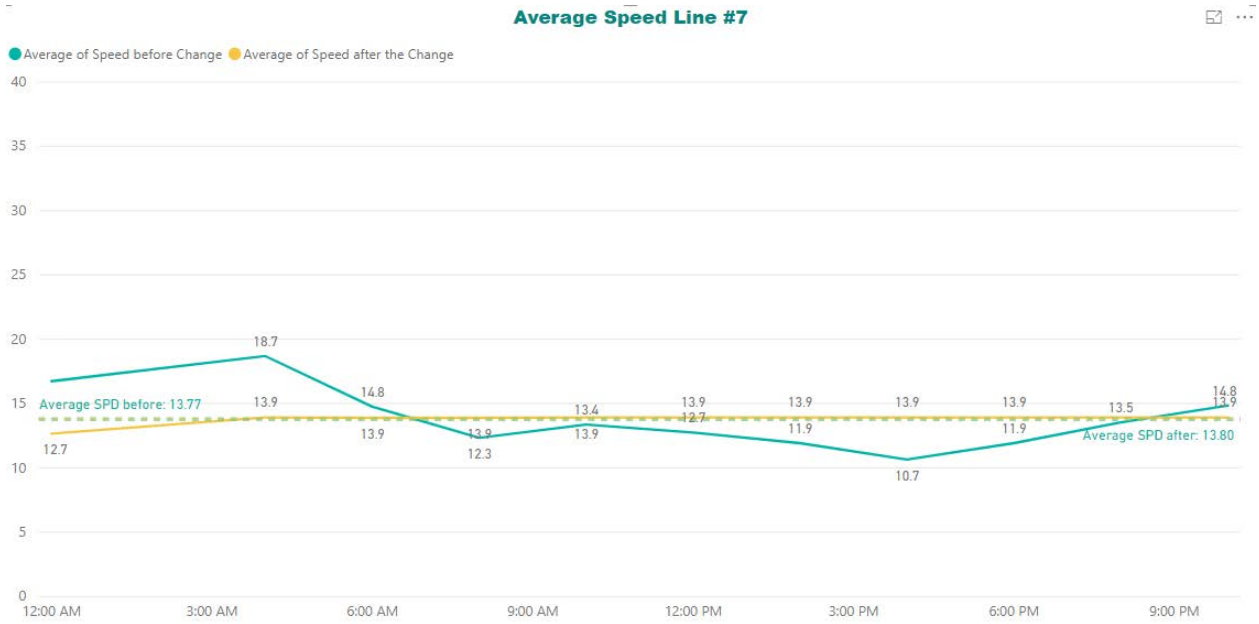

Figure 1 – Average speed for Line 7, before and after the mandatory smart-card use

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