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The potential of e-ticketing for public transport planning:
the Piedmont region case study

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Abstract

In the Piedmont region (Italy) the electronic ticketing system called BIP, is currently active across much of its territory, and the data collected in the Province of Cuneo since the full activation of the system (2014) provide today a sound source of information. Two different travel documents are available, travel passes and pay-per-use, with different validation rules: check-in only for travel passes and check-in and check-out for pay-per-use. Data produced by this electronic ticketing system employing smart cards allow to perform a detailed analysis of each user's behaviour, and calculate time and space distributions of each passenger trip. In detail, data originating from smart card transactions allow to trace back the trip chains, establish journey origins and destinations, and produce a "travel diary" for each passenger. Based on this data, performance indicators (i.e. load factor) as well as user mobility patterns and origin-destination matrices can be calculated in an automated and reliable way. This article presents a methodology for assessing the quality of the data collected when information about boarding and alighting stops is available from the (on board) validation system. It also presents an algorithm to assign a destination for each trip where only the boarding information is available. In the case study of the Province of Cuneo, it was found that 91% of the pay-per-use journey data are reliable and can be used for further analysis, whereas with the use of the proposed algorithm it was possible to estimate the destinations for 82% of the travel pass trips.

Keywords: public transport, electronic ticketing, transport planning, OD matrices

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1. Background and objectives

The rural public transport service in the Province of Cuneo (Italy) is made up by more than 100 bus lines and a total of 2,500 daily services on a standard winter working day (data referring to 2015). The service is carried out by the Grandabus consortium, which includes 14 local transport companies. Grandabus offers an electronic ticketing system that allows the use of different buses of any of its 14 operators with a single ticket. All tickets have to be loaded on the BIP smart card or alternatively single tickets can be purchased on board and are also recorded by the system. The BIP smart card can hold travel passes (e.g. weekly, monthly, annual) or pay-per-use credit. These two travel documents have different validation rules: travel pass holders only have to check-in whereas holders of pay-per-use credit have to both check-in and check-out in order to enable the system to identify the trip carried out and deduct the corresponding fare from the smart card. In 2014 more than 200,000 travel passes were sold and more than 100,000 smart cards with pay-per-use credit were issued. 12,000,000 ticket validations were carried out (90% travel passes and 10% pay-per-use credit) along the public transport lines operated by the Grandabus consortium.

The aim of the present research was to explore the potential of the BIP system for the planning, programming and management of public transport in the Piedmont region (Italy) building on the rural transport data available for the province of Cuneo. In particular, the research had two main objectives:

1. Check the quality of the data regarding the pay-per-use credit (where both check-in and check-out are required) and estimate the percentage that is free of errors, shortcomings and/or inconsistencies and therefore can be directly used.
2. Develop, test and evaluate the reliability of a methodology for estimating the check-out for travel passes (for which only the check-in is required) in order to identify the alighting bus stop and thus recreate the entire trip carried out by public transport.

In the case of pay-per-use credit it was possible to reconstruct 91% of the trip stages (sequence of check-in and check-out). In particular, 71% of the data did not require any elaboration whereas 20% showed errors that were corrected with algorithms developed ad hoc. Only 9% of the trip stages could not be reconstructed.

In the following sections the paper will focus on the second objective and the case of travel passes, detailing the methodology developed and the results obtained, as it presents a more complex and challenging case.

2. Literature review

The problem of estimating the alighting bus stop of transit passengers using smart cards, who are only required to carry out check-in, has already been addressed in the existing literature and similar methods have been applied at international level in different contexts (urban, rural), for different network types (surface transport, underground, railway) and for different quantities of recorded data (from metropolitan areas to small-medium towns).

Trépanier et al. (2007) proposed a model to estimate the destination location for each individual boarding a bus with a smart card; experiments were carried out on the mid-size public transport system of Gatineau, Quebec, and showed a success of 66% for destination estimation, reaching around 80% at peak hours. Cui (2006) presented the development of an algorithm to estimate a bus passenger Trip Origin-Destination (OD) Matrix based on automatic data collection system archived data including Automated Fare Collection data, Automatic Passenger Count data, and Automatic Vehicle Location data. The data used in the case study pertained to the morning peak time period (6-9 am) of 6 routes managed by the Chicago Transit Authority for five weekdays. Munizaga et al. (2011) estimated an OD public transport matrix from smart card and GPS data for Santiago, Chile, where the contactless smart card bip! is the only available payment system on buses and by far the most important in the Metro (99%). The method was applied to 36 million observations corresponding to one week of operation of the large scale multimodal public transport system of the city and it allowed to obtain 79.9% success in the estimation of trip stage alighting points. Li et al. (2011) presented an algorithm to estimate, within a satisfying computational time, passenger trajectories with various transfer distances, using pre-processed smart card data in Jinan city, China. In Jinan the number of daily bus passengers