Passenger Focused Shuttle Bus Planning

Evelien van der Hurk∗†
Email: evdh@transport.dtu.dk
Paul Bouman†, Leo Kroon†, Gabor Maroti†,
Otto Anker Nielsen∗, Peter Vervest†
∗Technological University of Denmark
†Erasmus University Rotterdam

April 2016

1 Introduction

Passengers experience significant inconvenience from track closures required for planned maintenance and infrastructure updates of rail networks. Generally, operators restore connectivity with shuttle busses replacing the closed link in the network. This however introduces additional transfers, while the speed of travel on busses for the replaced links is generally lower than the speed of the previous rail service. Therefore, a passenger-demand based design of shuttle services that takes into account the true origin and destination of passengers, the change in speed on the bussed-links, and possible alternative routes for busses, may improve passenger service without increasing operating cost.

This presentation will cover two topics. On the one hand, it will give a short overview of some of the work done by the authors on deducing passenger behavior from smart card data in the Netherlands. This includes the deduction of route choices and travel patterns of passengers. Furthermore, the presentation will discuss in more detail the continuous work on shuttle planning using detailed information on passenger behavior. The remainder of this abstract will focus on the later.

2 Background

The shuttle planning problem is a restricted form of a line planning problem or network design problem. Schöbel (2011) presents an overview of methods and models in operations research for line planning. Recently, Parbo (2016) proposed a tabu search framework for line planning with a strong focus on state-of-the art passenger route choice models. The shuttle planning problem was as one of the first studied by Kepaptsoglou and Karlaftis (2009). Jin et al. propose an optimization based approach for both the generation and selection of shuttle lines. Van der Hurk et al. present an alternative method specifically focussed on the ability to include a large number of passenger groups, and realistic passenger route choice, in the optimization framework. However, this approach is still simplistic in comparison to the state-of-the-art modeling of passenger route choice, e.g. as
proposed in Nielsen (2000); Nielsen and Frederiksen (2006). This study aims to bridge the gap between advanced optimization models for the design of the shuttle plan and state-of-the-art route choice models. Moreover, new is that the shuttle planning problem is considered in a wider context including both regular rail and regular bus services.

3 Solution Method

The solution process in Figure 1 contains two modules: (1) a passenger route choice model based on Nielsen (2000) where the transport costs or inconvenience of individual passengers depend on the route choice of other passengers in addition to the in-vehicle time, number of transfers, and waiting time of the route. For example, a crowded vehicle will have a higher inconvenience cost, especially for the passengers standing. Module (2) is a combinatorial optimization model that selects the lines and frequencies for the shuttle busses, based on Van der Hurk et al.. Module (1) defines the passenger groups, the costs of their paths to (2), and is used to define attractive candidate geolines for (2): Module (2) defines the transportation network. The solution value is calculated in (1) based the selected lines and frequencies in (2). The two modules are iteratively solved until convergence, or until a maximum number of iterations has been reached.

4 Acknowledgements

This research is part of the larger research project RobustRails supported by both the IFD\(^1\), and a consortium of Danish public transport operators such as train operator DSB and bus transport company Movia. We also thank the Complexity Project of the Netherlands Organization for Scientific Research for their support.

References


\(^1\)Innovation Fund Denmark


