Transfer attributes in route choice models for public transport passengers

Mette B. Dyrberg, Charlotte B. Christensen, Marie K. Anderson, Otto A. Nielsen, Carlo G. Prato
Department of Transport, Technical University of Denmark
Bygningstorvet 116B, 2800 Kgs. Lyngby, Denmark
Corresponding author: Marie K. Anderson, mka@transport.dtu.dk

Understanding route choice behaviour is crucial in order to explain travellers' preferences and to predict traffic flows under different scenarios. While a growing body of literature has concentrated on route choices by public transport users within a given public transport system, limited efforts have been posed towards multimodal public transport networks because of their inherent complexity and challenges (Hoogendoorn-Lanser, 2005). Compared to the more easily accessible information concerning travel and transfer times, detailed information about the attributes of public transport terminals is more difficult to collect, and the significance of these attributes in the route choices of public transport users is relatively unexplored in the literature.

This study deals with a route choice model for the multimodal public transport network of the Greater Copenhagen Area and in particular investigates the different factors related to the route choice with specific emphasis on the transfer experience. A variety of detailed attributes of the transfer terminals such as topological and service attributes were collected and their relation to the route choices of travellers in a multimodal network was estimated by the model. Knowledge about the preferences for transfer attributes is very useful for guiding relevant stakeholders and decision-makers in the process of terminal design. The study results suggest how to design terminals to minimize the transfer disutility experienced by the travellers and to encourage travellers to utilize the possibilities offered by the connectivity in the multimodal public transport network.

The study focuses on the revealed preferences of approximately 5,600 public transport users in the Greater Copenhagen Area. The data hold information on the use of lines, runs and stops in the multimodal networks consisting of public transport modes (intercity, regional and local trains, metro and regional and local buses) and private transport modes for access and egress transport to/from the public transport network (walking, bicycle, car). Anderson and Rasmussen (2010) matched the collected route choice observations to a dataset representing the Greater Copenhagen Area schedule-based public transport network containing addresses, train stations, bus stops, transfers, train lines, bus lines and a road network.

Anderson (2013) investigated the traveller preferences for time components and transfer components such as waiting and walking time and an aggregated measure for type of transfer (from/to bus/train). Additionally Anderson et al (2015) estimated mixed path-size logit models for describing route choices in the Copenhagen public transport network.

The study presented in the present paper significantly elaborates that model by taking on the challenge of formulating important attributes about the transfer terminals, collecting the information, and estimating route choice models for the passengers in the public transport network to capture the traveller's preferences for the transfer variables. Topological attributes such as the access of the platforms (ascending/descending transfer between two stops or station platforms), and service attributes such as information level and the coverage of the waiting area (possible to stand in shelter) are investigated.

Mixed path size logit models are estimated by use of observed routes and route choice sets. The models consider both taste variation (as in Nielsen, 2000) and overlapping routes (Anderson et al, 2015). The observed routes were collected within the Danish Transport Survey (TU) and data hence contain rich information on trip purpose and socio-economic background variables in addition to the observed route itself. This information is used to enrich the model estimation securing a high degree of fit of the estimated models. While path-overlap is fairly easy to describe in a "flat" network graph of a road network, it is more complicated to describe in a public transport network, since the overlap could consider lines/geography, terminals and type of services. There is thus a linkage between explanatory variables and overlap, which is elaborated in the model development section of the paper. The public transport route choice sets are generated using a doubly stochastic path generation technique which takes into account the variety in the travellers' perception of network attributes and the value of the attributes (Larsen et al, 2008). When generating choice sets by varying in 200 iterations the parameters for the error-term and for the parameters, choice sets with up to 190 unique routes for the OD pair of specific travellers are obtained.

The results from the study show that the attributes of the transfer terminals are indeed important for the public transport passengers. Considering the rates of substitution with regards to travel time it is evident that the design of a transfer influences the disutility of the traveller. A high number of level changes in a transfer entails a larger disutility compared to a transfer that can be done without level change. However, presence of escalators in transfers with level changes decreases the disutility obtained from the level change in a transfer. Furthermore having a shelter at the waiting area reduce the inconvenience of transfer waiting time, while the layout of the transfer stations and the information level provided are both important characteristics for the travellers transfer experience. Based on the results of the study it is possible to realise which aspects to pose special attention to when designing a transfer terminal.

The findings of the paper are important in order to officially focus investments in order to improve ridership in public transport. Investments in terminal improvements can be quite large, if they involve tunnels, bridges, escalators, buildings, etc. However, there are seldom carried out socio-economic cost-benefit analyses of such projects that include valid calculations of the passenger benefits, even though the investment sizes can be of the same order of magnitude as other transport infrastructure projects, where cost-benefit analyses are standard. Thus, a better ability of modelling terminals influence on passengers experiences, will greatly improve the decision basis for investments in terminal improvements.

Keywords: Route choice models, path generation, transfer terminals, estimation, mixed path size logit Public transportation

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