Chapter 10

Modelling Urban Public Transit Users’ Route Choice Behaviour: A Review and Outlook

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ABSTRACT

Public transport is one of the key promoters of sustainable urban transport. To encourage and increase public transport patronage it is important to investigate the route choice behaviours of urban public transit users. This chapter reviews the main developments of modelling urban public transit users’ route choice behaviours in a historical perspective, from the 1960s to the present time. The approaches reviewed for this study include the early heuristic studies on finding the least-cost transit route and all-or-nothing transit assignment, the bus common lines problem, the disaggregate discrete choice models, the deterministic and stochastic user equilibrium transit assignment models, and the recent dynamic transit assignment models. This chapter also provides an outlook for the future directions of modelling transit users’ route choice behaviours. Through the comparison with the development of models for motorists’ route choice and traffic assignment problems, this chapter advocates that transit route choice research should draw inspiration from the research outcomes from the road area, and that the modelling practice of transit users’ route choice should further explore the behavioural complexities.

INTRODUCTION

Developing urban public transit systems has become the focus for most transport experts and urban planners, who want to solve the problems with urban passenger transport in an effective and sustainable way. Demand modelling is an indispensable and essential part of transit planning, and modelling transit users’ route choice behaviour is one of the cornerstones. This modelling work is not only significant but also challenging as many...
complexities from different sources—such as the human decision-making process, and the transit system’s operation—are involved. More sophisticated models have been proposed to simulate transit users’ route choice in the last half century, and this progress will keep its momentum because developing and studying public transit systems are gaining increasing attention all over the world. This chapter aims to review the main development of modelling transit users’ route choice behaviour, and looks into future possible research directions in this area.

The review part of the chapter is given under the next eight subtitles: shortest path algorithm, bus common lines problem and solutions, volume dependent route attributes, deterministic user equilibrium models, random utility maximisation based discrete choice models, stochastic user equilibrium models, frequency and schedule based network formulations, and within-day and day-to-day dynamics. These can be further classified into four groups according to the four key theoretical issues of transit route choice modelling; namely, route search, crowding effects, uncertainties, and dynamics. The representative modelling approaches are briefly introduced here. Within the limited space of this chapter, the primary purpose of this review is to provide a panorama of development and its underlying motivations, rather than a detailed reference.

Following the review, the existing approaches to modelling transit users’ route choices are rethought. This section first makes a chronological comparison between urban transit and urban road studies of the development of users’ route choice modelling. As expected, the two related areas are concerned with similar theoretical issues; however, the development of the transit area seems to have lagged behind at each development stage such that further progress is needed. Next, some deficiencies of existing approaches are pointed out. Finally, the authors explore possible further research directions, with an emphasis on exploring the complexities of transit users’ route choice behaviour.

### Shortest Path Algorithm

The earliest studies on urban public transit route choice problems can be found in the late 1960s. In these early stages, only heuristic algorithms were proposed to solve the transit assignment problem, with many of them representing simple treatments of road network assignment procedures such as the all-or-nothing assignment. The early methods for finding users’ routes/paths in transit networks—such as those proposed by Dial (1967), Fearnside and Draper (1971), Le Clerq (1972) and Rapp et al. (1976)—belong to the least-cost route finding algorithm. This type of algorithm is designed to find the shortest transit route, with the simple assumptions on the fixed in-vehicle travel cost and expected travel time. It became the backbone of the later studies.

### Bus Common Lines Problem and Solutions

As stated by Nguyen and Pallottino (1988), a major obstacle in developing a passenger routing model for transit networks stems from the difficulty in modelling the passenger route choice behaviour at a transit stop shared by several competitive transit lines. Since there may be more than one line passing through a transit link, passengers can choose between boarding the arriving vehicle and waiting for the vehicle of another express line to minimize their total travel time. Thus, the waiting time for boarding a line is probabilistic, and there may be more than one minimum cost path for each origin/destination pair. This is known as the ‘bus common lines problem’.

Chriqui and Robillard (1975) may be the first to define explicitly the attractive set between two consecutive points as a subset of transit lines which minimise the rider’s expected travel time; that is, the sum of the mean waiting and in-vehicle times.
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