Trip chaining impact on within-day mode choice dynamics: Evidences from a multi-day travel survey

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Abstract

Mode choice is influenced by a large variety of factors, as for example users’ socio-economic attributes or level of service for the different alternatives. In order to understand better what leads to temporal and spatial variations of modal split, we propose in this paper an analysis of a multi-day travel survey, with a series of descriptive statistics as well as inferential analysis on the correlation between mode choice and tour-specific attributes at both spatial and temporal levels. Identified patterns show the importance of modelling dynamic mode choice with trip chaining and time of the day. Furthermore, the definition of activity spaces by principal mode choice and home-work locations introduces the calibration of probabilistic aggregate Gaussian fit to visited points.

Keywords: Mode choice dynamics; Multimodality; Trip chaining; Travel survey; Activity space

1. Introduction

Recent developments in terms of mobility and transport systems create major challenges for the future planning of networks. While in the past travel demand was mostly captured by single modes users, the development of new systems such as Mobility as a Service, as well as policies aiming to reduce car use and ownership, enhance the multimodal behaviour of travellers. In order to more reliably assess future planning and management of networks we believe it is necessary to estimate and predict temporal and spatial distributions of travel demand. Activity-based models already ensure consistency of successive trips which are triggered for undertaking activities (Ben-Akiva and Bowman, 1998). In this work, we aim to evaluate to what extent we can observe this possible relationship at an aggregate level and apply it for modelling accurately dynamic modal splits. (De Witte et al., 2013) undertook a comprehensive review of the many determinants of mode choice and highlighted that departure time and even more so, trip chaining are too often ignored. The complexity of trip chaining and its impact on mode choice has also been linked to the concept of activity space (AS). For example, the notion of time-space prism, refined by (Lenntorp, 1976), has been widely used notably in the activity-based approach to travel demand modelling. To reflect better AS and analyse differences with respect to used modes, (Perchoux et al., 2014) qualify individual space-time patterns through a set of indicators. In this work we propose a new definition of AS and propose to link it with mode choice through common factors for groups of users. The “Behaviour and Mobility within the week” (BMW) database used in this work is a multiday travel survey collected in Ghent in 2008 (Castaigne, 2009). The “Mobidrive” study (Axhausen et al., 2002) constitutes an excellent reference in such analysis as it was used for analysing both activity scheduling and mode choice of complex tours. The BMW share of multimodal trips is an opportunity to study in detail the correlations and interconnection between successive mode choices, time of the day and activity characteristics.

2. Methodology

In order to test the following hypotheses, we analyse a travel diary collected for 707 individuals. The goal here is to observe emerging behaviours from these respondents in order to detect quantitative characteristics to be applied in future aggregated dynamic mode choice models. We focus on the HW trip chain of workers from a spatial and temporal dimension and the tested hypotheses are the following:

- Modal split changes over the day and is statistically correlated with activity choice dynamics

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• The mode chosen for a trip strongly depends on the mode chosen at an earlier time of the day
• AS varies with the most frequently mode used and can be described by knowing home and work locations

In order to observe how they combine and how usage differs by time of day, we calculated the usage profiles for those modes and compared these patterns. The results are matched to individual observations through the transition probabilities. To show the link between temporal and spatial dynamics, the dispersion of each user’s AS has been estimated using the method of 95% confidence ellipse. To apply the observations to groups of users and to use soft constraints, a gaussian fitting has been chosen to make ellipses probabilistic. The multivariate gaussian describes plausible visited areas given home and work regions. It is again parametrized by the centre of mass of the visited points and the model is estimated by the maximum likelihood, using the expectation-maximization algorithm.

3. Results

Starting hypotheses have been supported by a sample of Ghent population. The modal split varies throughout the day and successive mode choices are strongly correlated to each other. This stands in particular for owned vehicles (bicycle or car), as there is a constraint of carrying the resource around. The usage profile of modes and the transition matrix show complementarity of modes, in particular walking considered as a mainstay of many multimodal trip chains.

![Image](image)

Figure 1 (a) Modes transition matrix (b) Modal split by hour of the day (c) Study area and HW of 11 users (d) Gaussian fit for these users

Activities which are most frequent are usually located within a shorter distance from home or work, while longer distances are travelled for infrequent activities for which the destination cannot be substituted. Parameters defining AS can be estimated by knowing the home and work locations of an individual which gives a good approximation of its centre, orientation and one of the axes of the ellipse. Aspect ratio and area are governed instead by the commuting mode choice. For applying to aggregated groups and using AS as a soft constraint for choice modelling, we fit, instead of a single ellipse, a bivariate normal distribution for groups of users. These findings can be used as the basis for more accurate travel demand modelling for estimating mode specific travel demand by time of day and regions.

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References

Castaigne, M., 2009. Behaviour and Mobility during the week “BMW.”