



Multimodal travel groups and attitudes: A latent class cluster analysis of Dutch travelers [☆]



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ABSTRACT

For developing sustainable travel policies, it may be helpful to identify multimodal travelers, that is, travelers who make use of more than one mode of transport within a given period of time. Of special interest is identifying car drivers who also use public transport and/or bicycle, as this group is more likely to respond to policies that stimulate the use of those modes. It is suggested in the literature that this group may have less biased perceptions and different attitudes towards those modes. This supposition is examined in this paper by conducting a latent class cluster analysis, which identifies (multi)modal travel groups based on the self-reported frequency of mode use. Simultaneously, a membership function is estimated to predict the probability of belonging to each of the five identified (multi)modal travel groups, as a function of attitudinal variables in addition to structural variables. The results indicate that the (near) solo car drivers indeed have more negative attitudes towards public transport and bicycle, while frequent car drivers who also use public transport have less negative public transport attitudes. Although the results suggest that in four of the five identified travel groups, attitudes are congruent with travel mode use, this is not the case for the group who uses public transport most often. This group has relatively favorable car attitudes, and given that many young, low-income travelers belong to this group, it may be expected that at least part of this group will start using car more often once they can afford it. Based on the results, challenges for sustainable policies are formulated for each of the identified (multi)modal travel groups.

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1. Introduction

One of the central aims of studying travel behavior is helping policy makers and other stakeholders to develop policies that make travel behavior more sustainable (Banister, 2008; Van Wee et al., 2013). Among other things, this involves reducing car travel and reinforcing travel by public transport and bicycle. To develop those policies it is important to understand the behavioral patterns of travelers. While traditionally research focused on explaining differences in behavior between

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individuals, there is now a growing interest in analyzing the variability of behavior within individuals (e.g., Heinen and Chatterjee, 2015; Jones and Clarke, 1988; Kitamura et al., 2006; Lavery et al., 2013; Schlich and Axhausen, 2003). Of particular interest is answering the question of whether travelers always use the same mode or whether they use different modes, i.e., the extent to which travelers are multimodal. Multimodality in itself can be regarded as a reflection of the deliberate choice process of a traveler who chooses a mode depending on context, as opposed to a habitual traveler who exclusively uses a single mode irrespective of context (e.g. Aarts et al., 1998). From a policy perspective, it is important to understand the nature of the multimodal group in order to help facilitate more of such behavior. Kroesen (2014) found evidence that multi-mode users are indeed more likely than single-mode users to switch over time from one behavioral profile to another.

Multimodality has historically been neglected in studies of travel behavior, in part because of the difficulties in obtaining the requisite data and building more complex models (Clifton and Muhs, 2012). Lately, however, a small but growing body of literature is investigating traits that are associated with multimodal travel behavior. For example, Nobis (2007) finds that multimodality is disproportionately high among adolescents, older people, and residents of population centers. Blumenberg and Pierce (2014) find that lower-income Americans are less multimodal than those with higher incomes. Kuhnimhof et al. (2012) find that an observed increase in multimodality among Germans between ages 18 and 29 is accompanied by a declining use of cars within the same group, which helps explain the flattening trend of car use overall. In contrast to most studies that are mainly descriptive in nature, Vij et al. (2013) take a modeling perspective and estimate latent class choice models. They find that different multimodal travel styles are related to long-term travel decisions and travel time sensitivity. In addition, various researchers have stated that travelers who always use the same mode may have incorrect knowledge of other modes. For example, it is often found that people who solely use car overestimate travel times by public transport. In this respect, Van Exel and Rietveld (2009) found that, on average, car travelers' perceptions of public transport travel time exceeded objective values by 46%. In contrast, travelers who also use other modes gain experience with those modes and may to a lesser extent over- or underestimate their performance. In particular, it is suggested that strong car users who also travel by public transport (PT) may develop different attitudes towards PT than strong car users who solely use car (Diana and Mokhtarian, 2009a, 2009b).

However, the mode perceptions and attitudes of multimodal travelers have received little empirical attention so far. Diana and Mokhtarian (2009a) examined the nature of various multimodal clusters, but limited the analysis to a few socioeconomic characteristics. Diana (2010) included a latent variable capturing the multimodality orientation for a given trip, as an explanatory variable for the decision to switch modes for a hypothetical future trip of the same kind. The model incorporated mode-specific cognitive and affective attitudes as other explanatory variables, but did not directly relate the attitudinal variables to the multimodality orientation. The aim of this paper is to address this gap in the literature, in particular by examining the relations between mode-related perceptions and attitudes and belonging to a particular mono- or multimodal travel behavior group in addition to socio-demographic and other structural variables.

Multimodality is defined as the (flexible) use of various modes of transport within a certain time period, whereas intermodality is the use of multiple modes in the course of a single trip (Nobis, 2007). Hence, classifying a traveler as multimodal depends on the time period considered. Blumenberg and Pierce (2014) use a one-day diary for this purpose, Nobis (2007), Buehler and Hamre (2015), and Kuhnimhof et al. (2012) rely on one-week travel diary data, and Vij et al. (2013) use six-week travel diary data. Although six weeks may be considered as a relatively long period for collecting diary data, it cannot be ruled out that car drivers who use public transport less frequently may be misclassified as solo car drivers even with six-week data and especially with shorter-duration data, while as argued above, it is of particular interest to identify this group. Diana and Mokhtarian (2009a, 2009b) consider a longer time period by relying on self-reported frequency of use of various modes over the course of a year, as measured on five-point ordinal scales. Although these kinds of standard survey data are less detailed than diary data, these have the advantage that much longer time periods can be taken into account. In addition, multiple-week travel diary data typically have rather small samples (Buehler and Hamre, 2015), whereas it is easier to realize larger samples with standard survey methods. Following this approach, this paper bases the identification of multimodal travelers on self-reported frequency of driving a car, bicycling, using train and using BTM (bus, tram, metro) measured on an ordinal scale running from 'every day' to 'less than once a year'. Data are collected from a sample of 2548 travelers in the Netherlands.

The approach to distinguish the different travel groups is related to the work of Diana and Mokhtarian (2009a, 2009b), who applied cluster analysis to identify multimodal travel groups. A disadvantage of conventional cluster analysis is, however, that it deterministically assigns travelers to a single cluster, ignoring the possibility of misclassification into the wrong cluster. To overcome this shortcoming, latent class cluster analysis (LCCA) is applied in this paper (e.g. Kroesen, 2014). LCCA is a model-based approach that probabilistically assigns individuals to clusters and thus takes measurement error into account. This analysis technique involves estimation of two models simultaneously. First is a measurement model, which identifies internally homogeneous latent clusters based on simple indicators, which in this study are the frequency of use of various transport modes. Second is a membership model, which predicts the probability of belonging to each of the identified clusters by personal characteristics such as socio-demographic, work-related, and attitudinal variables.

To summarize, the contribution of this paper to the literature is two-fold. First, it is the first paper that identifies (multi)modal travel groups by applying LCCA in which the indicators are simple self-reported mode use frequencies considering a long period of time. Second, the insight into who belongs to multimodal travel groups is extended from relying entirely on structural variables, like socio-demographics, towards including relations with attitudinal variables.

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