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Effect of perception and attitudinal variables on mode choice behavior: A case study of Indian city, Agartala

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ABSTRACT

Attitudes and perceptions play a significant role in the individual's selection of a travel mode. In the developing cities of India, socioeconomic characteristics vary significantly among the trip makers and subsequently the perception towards various travel modes. In this study, variables such as the comfort and flexibility offered by different travel modes were used to estimate an Integrated Choice and Latent Variable (ICLV) model for understanding the effect of latent variables on mode choice behavior. With a model estimated using 561 work trip data collected from Agartala city, located in the North East part of India, we found that the comfort and flexibility influence the individual's choice of mode. The results obtained from the ICLV model support the hypothesis that the effect of attitude and perception is important in mode choice behavior and useful for transportation planners and policy makers.

1. Introduction

Cities in India are growing rapidly, and this growth has a significant impact on the travel patterns. In most of the smaller Indian cities, with a population less than five hundred thousand, there has been a significant change in the mode choice behavior of the individuals. According to a report from the Ministry of Urban Development (MoUD), Govt. of India (2008), in most of the small sized Indian cities there would be a significant increase in the modal share of private transport and motorized two-wheeler (MTW). Moreover, the share of public transport and the non-motorized mode is decreasing in many of these cities. At this juncture, it is important to know the mode choice behavior observed in these cities and the effect of different parameters affecting this behavior.

Mode choice decisions might not only depend on the quantifiable variables such as the travel time, travel cost, income, but also on the individual's preference for latent variables like flexibility, comfort, reliability, etc. For example, two identical individuals with a different requirement of flexibility or reliability may not choose the same mode. Integrated Choice and Latent Variable (ICLV) model represent a promising new class of models that combines the classic mode choice models with the structural equation approaches. Latent variables such as the attitude and perception are the important determinants of travel behavior recognized by the researchers for a considerable time. Though there has been significant interest in analyzing and modeling the effect of these variables, not many works were carried out in this area. The absence of the information regarding the trip maker's attitudes and preferences, in the data collected through the traditional household survey; and difficulties involved in forecasting these variables were the reasons for not incorporating the attitudes and perceptions in the mode choice models (Kuppam et al., 1999).

One significant advantage of the latent variable approach is that a large number of indicator variables can be aggregated together to visualize an underlying concept. A general approach to take this aspect into consideration is through the estimation of Multiple Indicator Multiple Cause (MIMIC) models (Bollen, 1989). Later, many studies have considered the latent variables in the choice models using various approaches, and a detailed review of some of the important studies is presented in the following section. The objective of the present study is to study the effect of attitudes and perceptions on the mode choice behavior.

Organization of the remainder of this paper is as follows. The following section reviews the literature, relevant for this study. Section 3 discusses the data collection and study area description. Section 4 describes the methodology, and section 5 presents the relevant results obtained from the model estimation. Section 6 concludes the paper by summarizing the main findings and discussing the policy implications.

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2. Literature review

There were a considerable number of studies in the recent years related to the application of Integrated Choice and Latent Variable model for travel behavior analysis (Morikawa and Sasaki, 1998; Kuppam et al., 1999; Sunkanapalli et al., 2000; Walker, 2001; Ben-Akiva et al., 2002; Morikawa et al., 2002; Yanez et al., 2010; Walker et al., 2010; Raveau et al., 2012; Bahamonde-Birke et al., 2015; Vij and Walker, 2015). Latent variable models became popular after the work of Walker (2001), who presented a general framework and methodology for incorporating the latent variables into the choice model. Morikawa and Sasaki (1998) and Morikawa et al. (2002) included modal comfort and convenience in their mode choice model. Golob (2001) used a set of models to explain how mode choice and attitudes regarding tolled high-occupancy vehicle lanes in San Diego differed over population. Kuppam et al. (1999) carried out a study from Puget Sound panel data to determine the role of attitudinal and preference variables in explaining commuter mode choice behavior. They concluded that the contribution of attitudinal factors is greater than that of the demographic variables. Sunkanapalli et al. (2000) carried out dynamic analysis of traveler's attitude, preference, and values from three waves of Puget Sound Transportation Panel survey. This study demonstrated the strong relationship between the travellers' attitudes and perceptions, and their mode choice behavior. They also advocated for the greater consideration of attitudinal dynamics in transportation planning and policy analysis.

Johansson et al. (2006) studied the effect of attitude and personality traits on mode choice. They used a sequential Integrated Choice and Latent Variable modeling approach and concluded that the attitude towards flexibility, comfort, pro-environment friendly, influence the individual's mode choice. Ben-Akiva et al. (2002) found that the parameters estimated by the simultaneous approach to be more efficient. Temme et al. (2008) have shown the impact of abstract motivations such as the power and hedonism as well as attitudes such as the desire for flexibility on mode choice. Kitrinou et al. (2009) have used the Integrated Choice and Latent Variable (ICLV) approach for modeling the residential relocation decision. They found that the addition of latent variables significantly influence the model outcome and considerably improve the goodness-of-fit of the model. Yanez et al. (2010) reported that the mode choice models with latent variables performed better than the traditional mixed logit model without latent variables. They found that the latent variables such as comfort/safety and accessibility were significant in the final model. Paix et al. (2011) used a hybrid choice model to jointly estimate the choice and latent variable for finding the relationship between the urban environment and travel behavior. They concluded that the hybrid choice models show a major improvement in the goodness-of-fit of the model as compared to the classical discrete choice models. Paulssen et al. (2014) reported that the personal values denoting power, hedonism and security affect the individual's attitudes towards flexibility, comfort, convenience, and ownership, which in turn influence the mode choice behavior. Kamargianni et al. (2015) used a new probit kernel based ICLV model formulation (Bhat and Dubey, 2014) to analyze the children's travel mode choice to school. They found that the latent variables such as safety consciousness, green lifestyle, physical activity propensity, affects the mode choice of the individual. Bahamonde-Birke et al. (2015) showed that the perceptions affect the decision-making process, and can capture a significant portion of the variability that is captured through alternative specific constant, offering a significant improvement in the goodness of fit for the whole model. The literature review suggests that the subjective and attitudinal factors play a significant role in mode choice modeling and ICLV formulation results in better estimates of the corresponding coefficients.

3. Data collection and the study area description

In this study, Agartala, the capital of Tripura state, located in the north-eastern part of India, has been chosen as the study area. Agartala Municipality consists of 35 municipal wards, divided mostly for administrative purposes. This city is the second largest in the north-east India, after Guwahati, in terms of area (58.84 km^2). According to census data 2011, the population of Agartala city was 399,688 with a population density of 6793 persons per square kilometer.

Travel data were collected through a household survey conducted in the study area during March–September 2012. Sample size, in terms of households, is about 1% of the total number of households (1028 households) of the study area, taken randomly from different municipal wards. Through this survey, information related to the trips and the travel modes like origin, destination, the purpose, mode, and length of the trip have been collected. The data on socioeconomic characteristics, like age, gender, and years of education, household size, household income, vehicle ownership, and the license status of the trip makers, were also collected during the survey. A final dataset of 561 work trips, along with the attitude and perception data were used in the present study. The sample was found to be representing the overall travel pattern of Agartala residents. In the collected sample, 37.2% of the trips were non-motorized and more or less a similar figure was reported in a report (2008) of Ministry of Urban Development, Government of India. Table 1 shows the statistics of the sample data.

Network database was used to collect the mode related data. The link attributes such as the speed, travel time and distance

Table 1
Descriptive statistics of the sample.

Socioeconomic characteristic	Value in percentage
Gender	
Male	73.38
Female	26.62
% of individual in the age category	
Up to 20	3.95
20–30	17.69
30–40	18.53
40–50	24.08
50–60	22.77
>60	12.98
% of household having driving License	
Having	49.5
Not Having	50.5
% of individuals (Years of education)	
0	0.19
1–5	4.05
5–8	9.13
8–10	20.51
11–12	15.62
13–15	33.02
16–18	17.31
19–21	0.00
More	0.19
Car Ownership	13.83
MTW ownership	44.21
Monthly household income (in Indian rupees)	
0–2000	0.28
2001–10,000	33.96
10,000–20,000	30.48
20,000–50,000	24.46
>50,000	10.82

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