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Using hierarchical tree-based regression model to examine university student travel frequency and mode choice patterns in China

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ABSTRACT

This paper applies a nonparametric statistical method, hierarchical tree-based regression (HTBR) model, to explore university student travel frequency and mode choice patterns in China, using the data collected by a web-based travel survey. In this study, HTBR models were constructed to predict student travel frequency and classify student mode choice. It was found that student grade, school location city, public transit station coverage ratio (PTSCR) and family income have impacts on student travel frequency, and travel distance, bicycle ownership, school location city, PTSCR and student gender are significantly correlated to student mode choice. The study results reveal travel characteristics of university students in China at a disaggregate level and provide information to better understand their travel behaviors.

1. Introduction

Higher education in China is continuously growing, changing and developing. In 2012, there were over 2000 universities and colleges, with more than 25.6 million full-time undergraduate and graduate students in total, which nearly accounted for 2% of the Chinese total population, according to the statistics of Ministry of Education of the People's Republic of China, 2012 (http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s7567/index.html).. However, the spatial distribution of Chinese higher education resources is seriously imbalanced (Xue and Xue, 2002). Specifically, a large number of universities and colleges concentrate in big cities, typically such as Beijing, Shanghai and Nanjing, called as 'Three Major Education Centers of China'. These cities have booming economy, high population density, and good transportation services, all of which have been proved critical for higher education (Taylor, 2009; McCray and Brais, 2007; Kenyon, 2011). It is widely accepted that the big cities provide better education resources and job opportunities in China, which encourages more and more students pouring into these cities to seek better education and career opportunities. Concentration of institutions of higher education also happens within these mega-cities. This part of the city is usually called 'Higher Education Region'. Examples of these regions include Haidian District in Beijing, Yangpu District in Shanghai, and Gulou District in Nanjing. In these areas, university campuses play an important role in urban land use and transportation development.

In Chinese high education regions, university campus is a special community that tends to have unique traffic demands. Generally, university or college campuses are very distinct communities where students of different backgrounds, household incomes, lifestyles and attitudes mix together to live, study, and recreate (Balsas, 2003). The class schedules of university students are intermittent, which allows students to enjoy various activities for almost the entire day (Limanond et al., 2011). In China, most of university students have no income and rely on their parents to pay the education fees and living costs. In order to reduce Chinese university students' accommodation expenses and facilitate the campus management, the universities provide dormitories and canteens for all students to live inside of campuses, subsidized by government to lower the students' living costs. Thus, most of student's routine activities for study and living take place within the campuses. The situation results in that Chinese universities have a high student density. Specifically, the high density and centralized living environments do not allow Chinese university students to use private cars through strict management and control, which is quite different with the situation in some countries and regions, such as USA and Europe, etc., who paid more attention to the students' parking issues (Poinsatte and Toor, 2001; Jessup et al., 1990).

Exploring and understanding of traffic development situation

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and travel demand are the basic support for making transportation development strategies, policies and planning. Generally, the country-wide or the city-wide travel surveys are commonly introduced in many cities (Auckland, London, Sydney, Washington, etc.) or counties (Denmark, Germany, UK, USA, etc.) to measure the travel behavior of the general population. Specifically in China, some mega-cities have conducted city-wide travel surveys, such as the Fourth Comprehensive Travel Surveys in Shanghai (2009) and Beijing (2010), to investigate the travel behavior of general population and improve the urban traffic models. However, these surveys, as a type of household travel survey, significantly underrepresent Chinese university students. First, as mentioned above, student's daily activities, including learning, eating and living, are mainly carried out within the campus environment, which is definitely different from the general household activities, such as working and shopping. Second, universities represent environments that are more livable, are friendly to alternative travel modes, have a higher density than other environments, and offer mixed travel modes (Khattak et al., 2011). Thus, exploration of university students' travel behavior can reveal fundamental and valuable information about the relationship between campus environment and student's travel demand, which is quite important to calibrate the regional travel demand models and to develop transportation policies. In recent years, many Chinese universities are building, or are planning to build new campus to accommodate the increasing number of students. These campuses become huge traffic generation/attraction centers in the neighborhood. Better planning and coordination are urgently needed to mitigate its impact on local road network, and to address related safety issues. Given the lack of literature dedicated to this area, empirical studies focusing on campus travel behavior are urgently needed to provide better guidance on future practice. To fill this gap in the literature, we conducted web-based travel surveys among Chinese university students. It is worth noting that the surveys conducted in this study focus on the students' travel patterns in the trips from inside of campuses to outside if campuses, rather than the activities of students on campus (e.g. going to class, canteen or dormitory) or university commuting travel behaviors. The former has significant impact on regional traffic network, and should be carefully considered in regional transportation planning.

The objective of this study is to examine Chinese university students' demand characteristics of traveling out of campus based on a web-based traffic survey in eight universities in the three typical higher education cities in China. The students' travel frequencies can represent the campus traffic generation intensity to a large extent, which is critical for planners to accurately forecast traffic generation at universities. Three alternative travel modes, walking, cycling and public transit, were provided for Chinese university students to choose their dominating mode choice under the given conditions. Since Chinese university students traditionally rely on green transportation modes (non-private vehicles), it may be important to enhance level of service of public transportation in the campus areas to retain and promote sustainable transportation development. Specifically, using the method of Hierarchical Tree-based Regression (HTBR), the study characterizes the differences in travel frequency and mode choice patterns between different student groups based on their grade, gender, family income, and whether they own a bicycle or not. Given the above, this study aims to provide a better understanding of travel behaviors of Chinese university students from inside to outside of campuses, and make preliminary recommendations for university transportation planning and management to improve the transportation services for Chinese university students.

2. Literature review

2.1. University student travel behavior investigate literature review

The travel behavior and socio-demographics of university students are different from those of the general population (Khattak et al., 2011). And some related research has been conducted to explore the relationship between university student's travel behavior and campus environment. In many communities, university campuses are very often the largest traffic generators of region, and have impact on neighboring communities in many ways, such as parking, traffic, service access (Balsas, 2003). The situation of increasing traffic demand aggravates the traffic congestion and lacking of land for parking, which motivates some researchers focus on much more attention on the encouragement of sustainable transportation efforts for university environments (Balsas, 2003; Cole and Wright, 2003; Toor and Havlick, 2004; Shannon et al., 2006). Although sustainable transportation campaigns implemented in university environments only affect a small area and a small group of students, they may result in significant impacts on the community in a sustainable manner (Limanond et al., 2011). Specifically in China, university campuses are relative enclosed social activity environments where campuses boundaries (enclosing wall) usually cut the connectivity of local transportation network system (Sun et al., 2011). Whereas the high student density generates a huge traffic volume, and there are only three or four gated entrances allow social vehicles to get in and out of the campuses, which result in heavy traffic pressure on the adjacent roadways surrounding the campuses, and influence the local traffic operation and management. Thus, the relationships between travel behaviors and campus characteristics/traffic conditions are an important aspect to learn about Chinese university student traffic demand.

In recent years, the transportation situation of university students has been paid increasing attention. There are several researchers from different countries investigated different aspects of the travel patterns of university students. In a special setting of rural Thailand, Limanond et al. (2011) confirmed vehicle ownership as the largest factor associated with student mode choice decisions. Based on a sample of 205 Australian university students, Collins and Chambers (2005) suggested public policy strategies should focus on individuals' transport-related environmental beliefs and situations to achieve a transport-mode shift to public transport. While in another article concerning Australia university student commuting patterns, Shannon et al. (2006) concluded that travel time is the most important barrier for students to shift the travel mode from cars to cycling or walking modes. On the basis of an online survey among students of the Ruhr-University Bochum, Klöckner and Friedrichsmeier (2011) proved that students mode choice decisions were jointly determined by situational factors (availability of infrastructure, transit accessibility, trip characteristics and cost) and psychological factors (individuals' intentions, belief, norms and attributes). From a America perspective, Rodríguez and Joo (2004) found that local topography and sidewalk availability were significantly associated with the attractiveness of non-motorized modes, using data from a University of North Carolina-Chapel Hill commuter survey of student and staff; while the findings of Delmelle and Delmelle (2012) indicated that the availability of lower-cost parking permits was an enabler of shorter distance car commutes, especially in the winter season. At Virginia, Wang et al. (2012) researched the travel behavior of university students and aimed to improve regional travel demand models, using the a web-based survey of students at Old Dominion University, their results showed that students living on or near campus were significantly more likely to walk and bicycle and less likely to drive automobiles, besides, in another similar article, they