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Effect of residential proximity on university student trip frequency by mode

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1. Introduction

Existing literature in transportation does not provide a comprehensive understanding of student travel patterns at state-supported universities, including the University of North Carolina system, where the only significant survey was performed over a decade ago (City of Bloomington, 1998a) . However, with 16 campuses spread across the entire state, the system can serve as a diverse test bed to develop models of student travel behavior. For example, it can be expected that an urban campus such as the University of North Carolina Charlotte (student enrollment is less than 2% of the surrounding population within a 50 min driving distance) will have a very different impact on the transportation network of Charlotte than Appalachian State University (student enrollment is approximately 13% of the surrounding population within the 50 min driving distance) will have on the town of Boone where it is located.

In order to gain a deeper insight into student travel behavior, the North Carolina Department of Transportation (NCDOT) authorized a multi-year research project with the intention of collecting data from a wide and representative sample of universities in North Carolina and using the data to develop a realistic and reliable model of student travel behavior. The two principal objectives of this research were to allow transportation modelers to:

- investigate and resolve on- and off-campus transportation problems more systematically to improve campus transportation planning and operations and,
- facilitate transportation system modeling practices, such as university transportation models, MPO models, and even to improve the North Carolina Statewide Model and better traffic analysis studies of transportation related projects within or near universities.

The project was completed over a period of two years. Over 3700 surveys were collected at six campuses in the University of North Carolina (UNC) system, making it the largest survey to date on the transportation behaviors of university students. Each survey consisted of a detailed travel log provided by a given student over a twenty-four hour period of time. Survey data were validated to remove errors and the cleaned data was used to estimate the parameters for model development and inform inferences.

This paper presents the results of one component of the project, namely, a regression analysis of the relationship between student trip frequency by mode and distance to campus. The principal rationale for developing this model is as follows. While extant literature has focused on using university student travel survey data to generate travel demand models, an alternative to full-scale travel demand models that provides an efficient means to estimate university student trips and their impact has not been widely explored. As a first step in addressing this literature gap, this paper provides a methodology for collecting university student travel survey data and provides a quick impact assessment tool for modeling and estimating trip frequency as a function of travel mode and distance from students' residence to campus. While limited in its scope since access distance is the primary determinant variable in our model, it nonetheless provides a basis for future enhancements that include other characteristics that affect student travel behavior. In addition to an assessment of daily vehicle miles traveled (VMTs) and transit ridership, this tool may prove useful for generating a high-level estimation of total trips by mode based on the proximity of campus resources to university students' residences. Thus, the regression models developed may provide an efficient means for generating big picture estimates in the absence of sufficient resources for creating a full-scale travel demand model.

The next section provides a review of university student travel surveys that have been conducted in the United States and internationally. The review provided important insights to the research team related to survey administration and the results were used to set expected participation rates and trip rates.

2. Literature review

A university student travel survey is similar to a household travel survey in that both collect socioeconomic characteristics, demographic characteristics, and travel behaviors (usually through travel logs). The instruments used in many university student travel surveys are

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Table 1
Summary of university student travel surveys in the United States.

University	Time	Campus context	Sample size	Response rate	Distribution of instrument	Note
Indiana University – Bloomington (IU-B)	1998	Suburban	583	11.7%	Web	Only record inter-zonal trips
North Carolina State University (NCSU)	2001	Urban	843	10.5%	Mail	
Arizona State University (ASU)	2007	Urban	2036	3.4%	Web (SNAP)	Only record trips to or from ASU
Old Dominion University (ODU)	2009	Urban	708	14.1%	Web (SNAP)	First round of VDOT surveys.
Virginia Commonwealth University (VCU)	2009	Urban	652	13.0%	Web (SNAP)	First round of VDOT surveys
University of Virginia (UVA)	2009	Suburban	780	15.6%	Web (SNAP)	First round of VDOT surveys
Virginia Tech (VT)	2009	Suburban	643	12.9%	Web (SNAP)	First round of VDOT surveys
Old Dominion University (ODU)	2010	Urban	1468	29.4%	Web (SNAP)	Second round of VDOT surveys
Virginia Tech (VT)	2010	Suburban	1128	22.6%	Web (SNAP)	Second round of VDOT surveys

modified versions of household travel surveys. However, a household travel survey typically uses households as samples, whereas a university student travel survey uses students. Compared to household travel surveys, university student travel surveys usually cover a much smaller area, use different survey techniques, and need to focus on problems that are important to University trips, such as parking constraints.

The most prominent university student travel surveys conducted in the United States in the past two decades are summarized in Table 1. All but one of the surveys were web-based. Surveys were conducted at three suburban campuses (Indiana University-Bloomington (City of Bloomington, 1998a,b), University of Virginia (Khattak, 2011, 2012), Virginia Tech (Khattak, 2011, 2012) and four urban campuses (Virginia Commonwealth University (Khattak, 2011, 2012), Old Dominion State University (Khattak, 2011, 2012, 2011), North Carolina State University (Eom et al., 2009; Wilbur Smith Associates, 2001), Arizona State University (Pendyala, 2007). None of the campuses were located in rural regions and most sample sizes were less than one thousand per survey year. Response rates ranged from 3% to 29%. Across the studies, there were limitations to the survey instruments employed. For example, the Indiana University Student Travel Demand Survey at Indiana University-Bloomington only examined trips to and from the campus (City of Bloomington, 1998a,b). Surveys conducted by the Virginia Department of Transportation (VDOT) used a modified version of the National Household Travel Survey (Khattak, 2011, 2012, 2011).

Limited literature exists on university student travel surveys conducted outside of the United States. One recent study conducted at a rural university in northeastern Thailand focused on students who study and live on campus and resulted in a total sample of 130 students. The survey instrument was a seven-day travel diary that provided information on the travel patterns of participants (Limanond et al., 2011). Another recent study conducted at an urban university in southwestern Nigeria utilized a self-administered paper questionnaire that was provided to undergraduate students that were registered in a particular course on campus. A total of 1638 students completed the survey, and the data was analyzed to determine modal choice of undergraduates – walking was the most common choice for students living on-campus and commercial bus was the most common choice for students living off-campus (Olawole and Olapoju, 2016). For a study of student commuting patterns in Kyoto, Japan, online travel diary survey data was used in conjunction with geospatial datasets to examine the relationship between commute mode choice and the distance from students' residence to campus based on student commuting routes. The study found that students living further from campus tend to commute by bus or train while those that live closer tend to commute by bicycle or foot (Hanaoka et al., 2014).

While some of the reviewed studies examined the relationship between students' residence location and commute mode choice, none explored an alternative approach to full-scale travel demand models that could serve as an efficient tool to estimate university student trips and assess their impact. In addition, each study was conducted at a single campus, rather than encompassing an entire university system.

3. Study design

A fundamental objective of the study presented in this paper was to conduct a larger survey of student travel behavior than had previously been accomplished by focusing on an entire university system rather than a single campus. With this goal in mind, over 3700 students were sampled from six different campuses of the University of North Carolina system. In addition to sampling campuses in suburban and urban areas, a campus located in a rural region was also included in the study (Appalachian State University).

During the first year, two campuses were surveyed: North Carolina State University (NCSU) and UNC Greensboro (UNCG). These campuses were chosen because of their representativeness (NCSU is one of the largest campuses in the UNC system and located in a large metropolitan area and UNCG is a mid-tier sized university in the system that is located in a smaller urban area that draws upon students from surrounding rural counties). A total of 922 students from NCSU started the survey and 415 completed it. The corresponding numbers for UNCG were 841 surveys started and 442 surveys completed. Based on this experience, four more campuses were selected to be surveyed in the second year of the project: Appalachian State University (Mountain Region), UNC Charlotte (Piedmont Region), Fayetteville State University (Coastal Plains Region), and UNC Wilmington (Coastal Region). Campuses were selected for inclusion in the project based their influence (the size of the campus in relation to the population within a fifty minute drive time), commuter or professional student population, and geographic dispersion. These criteria were used in order to capture the diversity of student demographics and the geographic distribution of university locations in North Carolina.

For Appalachian State University, a total of 633 students started the survey and 266 completed it; for UNC Charlotte, a total of 2860 students started the survey and 1492 completed it; for Fayetteville State University, a total of 539 students started the survey and 266 completed it; and for UNC Wilmington, a total of 1612 students started the survey and 917 completed it. In summary, a total of 7408 students across the six campuses started the survey and 3857 students completed the survey.

3.1. Survey instrument

In developing a survey to obtain planning data for collegiate student travel behaviors, key survey dimensions and associated data were determined based on studies undertaken for universities in other states as well as utilizing existing data made available by University Planning and Analysis (UPA) at NCSU. Through reviewing the literature and discussing technical issues, a survey was initially drafted in early January of 2013.

Several criteria were used for designing the questionnaire. It was expected that the fully voluntary nature of the self-administered survey would require a simple short questionnaire requiring little time to complete. It was also anticipated that it would be easier for respondents to pin locations on a map than to type address text. These two overall