The Changing Attitudes and Behaviors of University Students Toward Public Transportation: Final Report

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Disclaimer

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ABSTRACT

A three-wave longitudinal survey of a cohort of North Dakota State University (NDSU) students who matriculated in the fall of 2005 was conducted to investigate changing attitudes and travel behaviors. The longitudinal framework allowed for investigation of individual as opposed to group changes in behavior. The third wave of the survey found that most fourth-year NDSU students live off campus and nearly all of those who do have access to automobiles. One-third of off-campus students use transit to commute to campus occasionally while two-thirds have used the bus to travel between their residence and campus at least once. Students identified cost savings, convenience, reducing traffic congestion and parking demand as the primary benefits of transit. In the future, two-thirds of students stated that they will ride transit occasionally or regularly. Among those surveyed, 64% of students stated that they would at the least consider voting for increased funding for transit. A mixed multinomial logit model was used to investigate the role of individual and alternative attributes on mode choice. The analysis found that students prefer walking or biking to travel by automobile or transit. The study finds that increased fuel prices result in modest increases in transit ridership and pedestrian travel. The analysis indicates that continued redevelopment of near-campus areas, resulting in shifts in the location of residence of off-campus students, will result in higher transit and pedestrian traffic. The analysis also shows that express bus service between campus and off-campus areas with high student populations could attract a significant number of transit riders. However, the cost of providing the necessary service may be outweighed by the benefits or limited resources may be better used to provide other services.

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1. INTRODUCTION

This study investigates the changing attitudes and travel behaviors of a group of North Dakota State University (NDSU) students who matriculated in the fall of 2005. A longitudinal survey conducted in three waves collected a core set of information as well as that on contemporaneous issues to assist in guiding policy development, planning, and decision making. Interim findings resulting from analysis of the first two waves of the study are available in Ripplinger, Hough, and Easterday (2008). In this paper, descriptive statistics from the third and final wave are presented, and a mixed multinomial logit model is fit to investigate the impact of certain factors on the transportation mode choice of university students. A longitudinal survey, where the same sample is surveyed at regular intervals, provides many benefits to cross-sectional methods, where a new sample is drawn each time. The ability to identify changes in individual behaviors and attitudes is especially valuable for the campus transit survey as most students at NDSU have limited experience with and knowledge of public transportation. To be able to track these changes at a time when complex attitudes about personal mobility are forming provides additional, important information.

1.1 Background

The Small Urban & Rural Transit Center (SURTC) has regularly conducted surveys of university students in the Fargo-Moorhead metropolitan area since 2003. Initial surveys invited all university students to participate by email, with about 5% of students electing to do so. During the first two years of the survey, this convenience sampling method did not appear to affect the responses. However, during the third year, the relative response rate by gender differed significantly from that in the respective student bodies. Combined with previous findings that ridership varied slightly by gender, this led to a reevaluation of the survey design that resulted in a decision to pursue the development of the longitudinal survey.

A longitudinal survey provides a number of benefits relative to a cross-sectional survey. Most importantly, it allows one to track individual changes as opposed to changes in group behavior. Also, longitudinal surveys reduce recall bias as participants are asked to report events from more recent periods. Longitudinal surveys also reduce sampling variability, allowing one to have smaller sample sizes to draw inferences. They also help reduce the time required to collect the same personal information each year, which may reduce the level of participation.

At the same time, there are concerns and challenges to conducting longitudinal surveys, including the high cost of repeated surveying and the loss of respondents due to attrition. The cost issue is not particularly relevant in the case of the campus transit survey as its cross-sectional form was expected to be continued. Attrition is of larger concern in the case of campus transportation as many students leave the university before completing their undergraduate degree. Also, some types of analyses are not possible during the early stages of longitudinal study as the required information has not yet been collected.

A cross-sectional survey sent to a random sample of students was also considered. This option would result in an increase in the cost of conducting the survey, but eliminate the problem of self-selection. By construction, a cross-sectional survey would not allow for tracking individual changes in attitude and behavior.

1.2 Objective

The objective of the study is to (1) identify current attitudes toward public transportation and travel behavior of university students, (2) construct a model to estimate the relative mode share of university students, and (3) apply the model to provide guidance and a framework to assist in planning.

1.3 Population of Interest

The study surveys and analyzes the attitudes and travel behavior of NDSU students who matriculated the fall of 2005. This cohort of first year students is then surveyed at regular intervals throughout their undergraduate study. To ensure statistical validity of the results, considerable effort was used to determine the minimum sample sizes needed and to accommodate attrition that was likely to occur as students left the university or were unwilling or unable to participate (see Ripplinger, Hough, and Easterday 2008). Students in the cohort would have just begun their fourth year of study during the third and final wave of the survey.

1.4 Research Hypotheses

To guide the survey and analysis, four research hypotheses are posited:

- Travelers prefer fast travel.
- Previous users of transit will be more likely to ride in the future.
- Travelers prefer travel by automobile to transit and walking or biking.
- Travelers are responsive to changes in fuel prices.

1.5 Summary

This report presents the survey methods of the third phase and final findings of the study. Chapter 2 presents a review of literature in the areas of mode choice and university community transportation. Chapter 3 presents descriptive statistics from the final wave of the survey. Chapter 4 presents the results from applying the mixed multinomial logit model to the study's data. The final chapter presents a summary of findings and next steps.

2. UNIVERSITY STUDENT TRAVEL BEHAVIOR

In this chapter, the fields of transportation mode choice and university community transportation are reviewed. The intent is to provide the requisite background to the reader and demonstrate an understanding of the methods, theory, and findings in each area that are necessary to ensure that the analysis is properly conducted and interpreted. We'll begin the chapter by reviewing discrete choice modeling and its application to a traveler's decision of transportation mode and then move on to review some of the pertinent work in university community transportation and university student travel behavior.

2.1 Transportation Mode Choice

Individual decisions of transportation mode are usually modeled as a discrete choice following variations on the seminal work by McFadden (1974). Discrete choice is based on a random utility framework where the utility, U_{ij}, individual i receives from selecting alternative, j is a function of the attributes of the individual, Z_i, and the alternatives, X_{ij}, and an unobserved stochastic element, ε_{ij}:

$$U_{ij} = \beta' X_{ij} + \alpha' Z_i + \varepsilon_{ij} \qquad (1)$$

In many cases, data are available for either the attributes of individuals or alternatives, but not both. In the first case, $\beta' X_{ij}$ would be dropped from equation 1. In the latter case, $\alpha' Z_i$ would be removed. Models where choice is based only the attributes of alternatives are called conditional logit models. Discrete choice models may be binary, where there are two, often 'yes' or 'no' alternatives, or multinomial, where there are three or more alternatives. Equation 1 is fit using generalized linear modeling (GLM) techniques that involve a link function. Two link functions, probit, based on normal distribution, and logit, based on logistic regression, are commonly used. Many studies analyze transportation mode choice using multinomial logit models.

Multinomial logit models require agreement with the Independence from Irrelevant Alternatives (IIA) condition, that is, the ratio of probabilities of two choices is unaffected by the remaining probabilities. Nested logit models have traditionally been applied, including in transportation mode choice modeling, to address IIA. However, the mixed multinomial logit model introduced by Hensher and Greene readily allows for the error terms of alternatives to be correlated and consequently remove the need for IIA (2003).

While the results of modeling transportation mode choice using multinomial logit modeling can be valuable as a relatively independent effort, it is of greater value when employed as part of a thorough transportation planning process. Mode choice is the third step of the four part transportation planning process presented and refined by Manheim and Florian et al. (1979, 1988).

2.1 University Community Transportation

Transportation in university communities has received increasing attention in recent years and forms a unique case of transportation planning due the centralized control of land use, transportation, and other activities (Miller 2001). This in turn allows for the promotion of transit and pedestrian travel. Many large university communities have developed transportation demand programs (Krueger and Murray 2008) or organized efforts to more efficiently use transportation resources (VTPI 2009). Examples of university community travel demand programs include UPASS, which provides free rides for students and, in some cases, faculty and staff, ride-matching, vanpooling, and guaranteed rides home. Poinsatte and Toor addressed many of the tools of transportation demand management programs and companion case studies in the context of university communities (1999).

Half of the organizations responding to a survey conducted by Krueger and Murray reported that campus building projects required consideration of transit, while one-third reported that local government (exclusive of transportation providers) was involved in campus transit planning (2008). Daggett and Gutkowski (2003) conducted a survey of transit agencies of university communities, and reported that 30% of local governments had rules regarding the developments that impacted trip generation. Bourne and Shauer present a case study on university community transportation and land-use planning for CyRide and Iowa State University (1990). Although Iowa State University's master plan did not encourage the use of transit to replace automobile travel and consequently parking, a strong working relationship between the university, its students, and the City of Ames has had the same result. As a result of parking policies and zoning, transit has become the preferred mode of travel for many community members.

To provide necessary information for the North Carolina State University travel demand model, Eom, Stone, and Ghosh collected data on the activity patterns of the university's students (forthcoming). The study was unique in that it focused on students whose daily activity differs significantly from other households and individuals. Information was collected from undergraduate and graduate students using a daily activity pattern survey. The survey found that undergraduate and on-campus students were significantly more active than their graduate and off-campus counterparts. This information is valuable as other studies (e.g., Ripplinger 2008) have not segregated daily activity by class.

3. FOURTH YEAR SURVEY RESULTS

The third and final wave of the study's survey collected data from 75 fourth-year students at NDSU during October 2008. The survey sample consisted of the same cohort of students that matriculated in Fall 2005 and that had previously participated in the first and second waves of the survey. The use of a longitudinal framework was intended to accommodate the investigation of changes in attitudes and behavior over time, to reduce recall error on the part of participants, and improve the statistical efficiency of the statistical analyses (Ripplinger, Hough, and Easterday 2008).

The survey questionnaire consisted of the same core set of questions asked in the previous waves. These questions relate to students' use of and perceptions of public transportation and related issues, such as travel demand, vehicle access, parking, and Metro Area Transit (MAT) service and service quality. For the third wave, two additional lines of questions were added. The first series of questions investigated the role of increased gas prices on travel behavior. The second inquired about future transit ridership and potential financial support of transit following graduation.

The third wave of the survey was collected during October 2008. Prior to collection, the email addresses of members of the cohort were reviewed for accuracy. An email was sent to prior participants inviting them to complete the survey by following a link to the online location of the survey. For those who didn't complete the survey within two weeks, a second email was sent and followed up by a phone call that informed past participants about the new survey and to inform them that alternative forms of the survey could be completed. As in prior waves, no students accepted the offer of a written or oral survey.
The 75 students who completed the survey represent 2.5% of the NDSU senior class during the fall 2008 academic semester. Of the respondents, 57% identified themselves as male, which aligns closely with the male-female ratio of NDSU seniors of 56.5%-42.5%. Most survey participants, 80%, stated that they were 21 years old and 19% stated that they were 22 years old. The remaining 1% were 23 years old.

3.1 Life Events

Participants were asked if they had experienced any of 14 life events in the six months prior to the survey. The results are presented in Figure 3.1. The most frequently reported life event was a change in work hours, followed by a new job or change in residence within the same city. A number of students reported having changed jobs or majors, or moved to a different city.

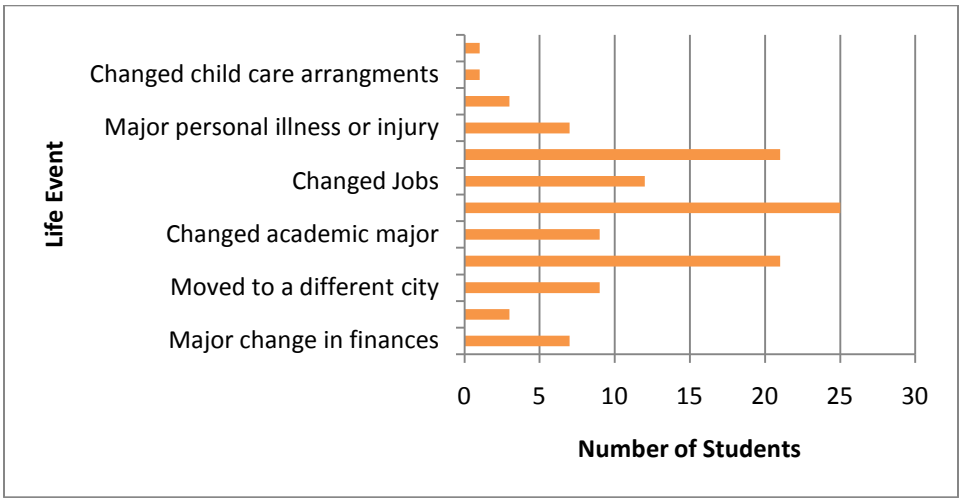

Figure 3.1 Life Events Within the Past Six Months

3.2 Motor Vehicle Access

Participants were asked if they have access to a motor vehicle for transportation. Nearly all students, 96%, responded 'yes.' This is an increase from the 77% and 89% who stated they had access to motor vehicles in the first and second phases of the survey.

3.3 Residence

Only 10% of survey respondents reported living on campus. This is a significant decrease from the 80% of first year students who reported living on campus, and 42% of third-year students who did.
The distance of off-campus residents to NDSU as reported by survey participants is presented in Figure 3.2. Just over 30% of students stated that they live within 1/4 mile of campus with another 13% living between 1/4 and 1/2 mile away. Relatively few students live between 1/2 and 2 miles from campus, while nearly 40% live between 2 and 5 miles from NDSU.

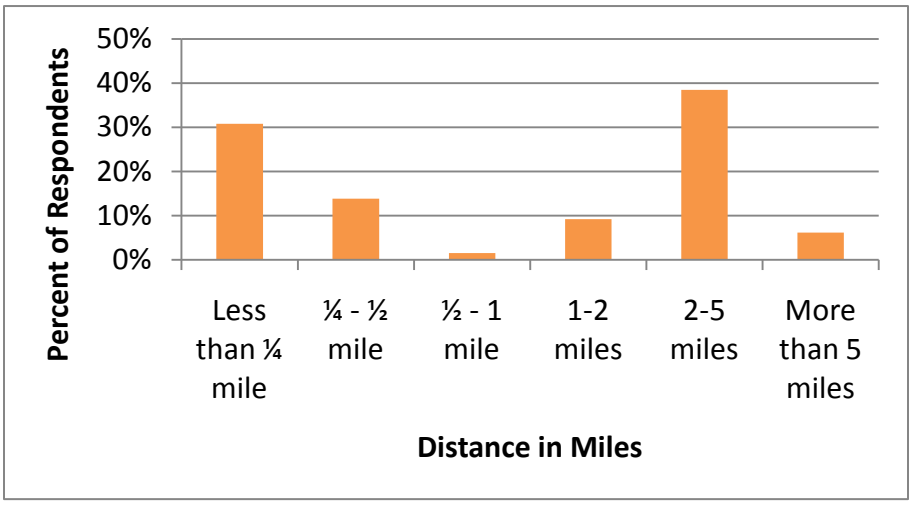

Figure 3.2 One-Way Distance Between Residence and Campus

3.4 One-way Trips

The number of one-way trips between their residence and campus reported by off-campus students is reported in Figure 3.3. Most students, 63%, living off-campus, made two one-way trips. The second most frequently reported number of trips was four with 18% of participants reporting that value.

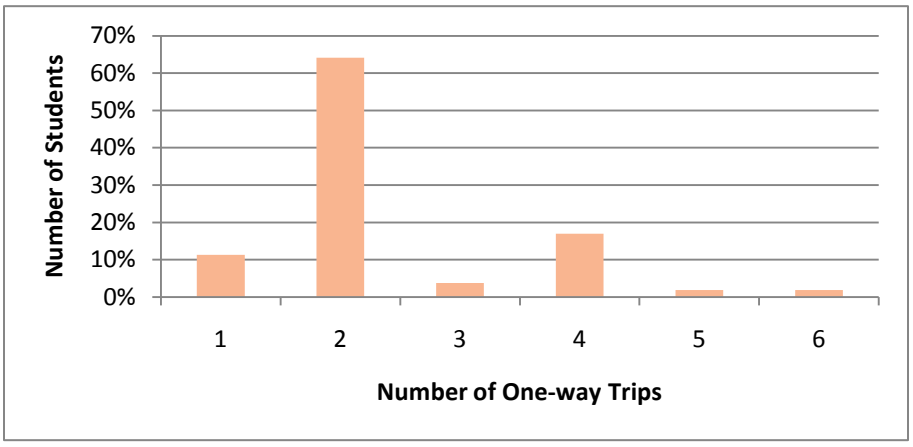

Figure 3.3 One-Way Trips Between Residence and Campus

3.5 Most Common Transportation Mode

The most common transportation mode taken when traveling between residence and campus by off-campus students is presented in Figure 3.4. Personal automobile was the most reported mode of transportation with 53% of students driving to campus. Pedestrian modes of walking and bicycling were next with 20% and 12% of students reporting those modes. Public transportation was reported as the most common mode of transportation by 7% of participants.

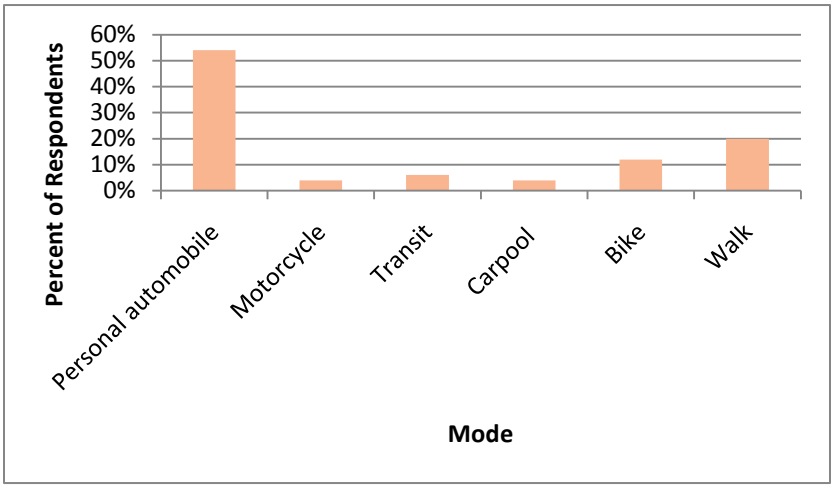

Figure 3.4 Most Common Transportation Mode Between Residence and Campus

3.6 All Transportation Modes

Participants were also asked to identify any modes of transportation they had taken when traveling from residence to campus in the past six months. Again, personal automobile was the most common response. Walking came in second, followed by bicycling and carpooling; and 36% of students reported riding the bus occasionally.

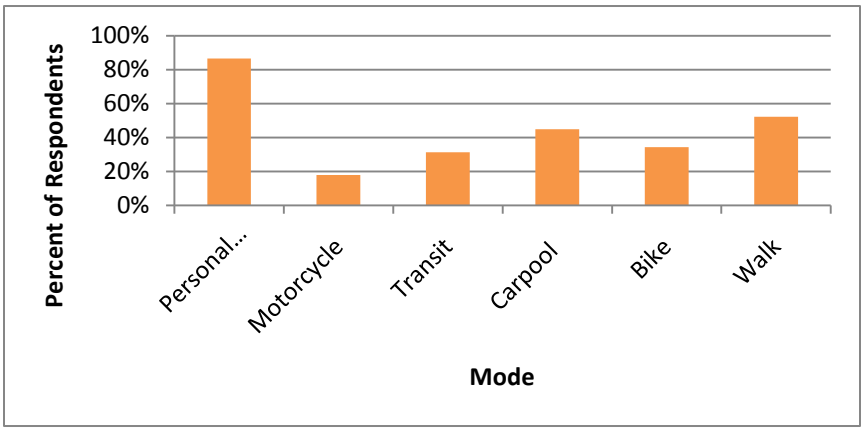

Figure 3.5 Transportation Mode Between Residence and Campus

3.7 Travel Time to Campus

Participants were asked how long, in minutes, it takes to travel from their residence to campus. Most students, 43% of those reporting, were able to make the trip in less than 9 minutes. This was followed closely by trips from 10 to 19 minutes duration reported by 42% of students. No students reported commutes of 30 minutes or longer.

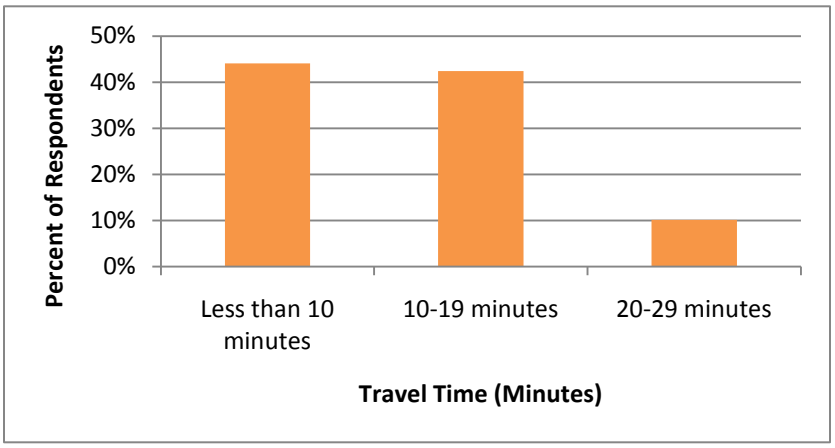

Figure 3.6 Automobile Travel Time from Residence to Campus

3.8 Acceptable Travel Time by Bus

All off-campus residents, including transit riders and non-riders, were asked what would be an acceptable travel time from their residence to campus by bus. Thirty-seven percent responded that trips of less than 10 minutes are acceptable followed by 28% who would accept trips from 10 to 19 minutes. Surprisingly, a larger percentage, 22%, stated they would accept a trip from 30-39 minutes, than those who would accept a trip from 20-29 minutes, which was reported by 9% of students.

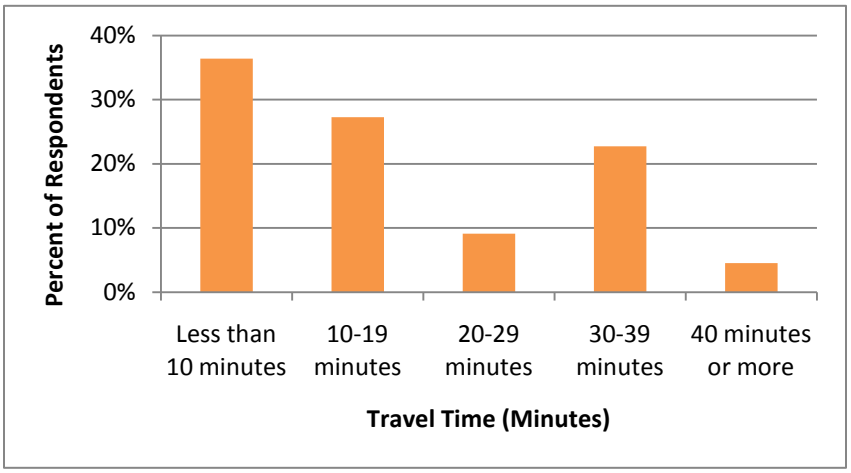

Figure 3.7 Acceptable Travel Time From Residence to Campus by Bus

3.9 Actual Travel Time by Bus

For off-campus residents who did report riding the bus, 36% said the actual travel time was less than 10 minutes, 27% said it was less than 20 minutes, and 27% stated it takes more than 30 minutes.

3.10 Parking Permit Use

Only 42% of students reported having parking permits for campus parking. This is a drop of more than a third from the 67% of students who stated they had parking permits the year before.

3.11 Previous Transit Use

Among the respondents, 67% stated that they had ridden the bus in the past. This compared with 33% of first year participants, and 45% of third year participants. Thirty-four percent of respondents stated that they had ridden the bus in the past three months.

Among survey participants, 48% stated that they had ridden a circulator at least once before, a 50% increase over the third year response of 33%; and 27% stated that they had ridden a campus circulator in the past three months.

3.12 Tri-College Enrollment, NDSU Downtown Campus, and Transit Use

Only 4% of students stated that they were currently enrolled in any Tri-College courses, which allows students at NDSU, Minnesota State University-Moorhead, and Concordia College to enroll in select courses at partner institutions. This is a decrease from the 9% who reported taking Tri-College courses the previous year. Of those, 1/3 took transit travel to other campuses. Only two students reported taking classes at NDSU's downtown campus, but both reported regularly riding the bus to that location.

3.13 Benefits of Public Transportation

Participants were asked if they agreed with certain benefits of public transportation. Among those, 73% agreed that riding the bus was a way to save money. Seventy-one percent agreed that it would reduce traffic congestion, the same percentage of respondents who thought it would reduce parking demand. Sixty-eight percent thought convenience was a main benefit of transit. Only 40% of respondents stated that the primary benefits of riding mass transit include helping the environment; while 32% thought that riding transit was a way to save time, and 30% thought of it as a safer transportation alternative.

3.14 Fuel Costs Impacts on Travel Behavior

Given relatively large increases in gas prices in the summer of 2008, just prior to the survey, two additional questions were added to investigate the impact of the change in price on travel behavior. Among respondents, 53% stated that increased gas prices had resulted in them taking fewer trips, and 33% stated that it has caused them to shift modes, with most shifting to either walking (22%), biking (14%), or riding the bus (8%).

3.15 Future ridership and support for transit

As the last wave of the study, with participants in their fourth and traditionally final year of undergraduate study, two questions were added to the core survey to inquire about students' expectations regarding future ridership and support for transit. Among respondents, 4% stated that they would regularly ride the bus in the future, and 66% said they would occasionally.

A general question regarding future financial and political support for public transportation was added to the survey. In response, 14% stated that they would support local funding initiatives for transit, while 52% stated that it was a possibility. This is interpreted by the authors as demonstrating relatively strong support for transit given the absence of specifics on the finance initiative.

4. MODELING TRANSPORTATION MODE SHARE BY UNIVERSITY STUDENTS

While descriptive statistics provide a valuable snapshot understanding of travel behavior and attitudes, econometric modeling is necessary to more fully investigate the role that individual and transportation alternative attributes have on mode choice. In this chapter we present the methods and results from the employment of the mixed multinomial logit model presented in Chapter 2.

4.1 Mode Choice Model

We posit that the utility a student receives by selecting a mode of transportation for the commute between their residence and NDSU's main campus is defined by

$$U_{ij} = \beta_{TT} Travel\ Time + \beta_{AC} Automobile\ Cost + \beta_A Automobile + \beta_T Transit + \beta_{PU} Previous\ Use + \varepsilon_{ij}$$

where U_{ij}, the utility of the ith individual from choosing alternative j, is a function of travel time, which varies by distance and mode; the cost of travel by automobile; dummy variables for automobile and transit modes and a dummy variable for previous use of transit.

Travel time is a function of the distance from the individual's off-campus residence to campus and mode. The automobile costs were taken from the American Automobile Association (2005, 2007, 2008). Average operating costs per mile include the price of gas, tires, oil, and maintenance. There is no cost variable for transit as the service is provided free to all NDSU students under MAT's UPASS program. Previous transit use data were collected by the recent and previous study surveys. The model was fit using SAS Statisical software version 9.2.

Before presenting the results of the model, the study's hypotheses should be reviewed. Travelers prefer faster travel, and in terms of our model this would require that the coefficient for travel time be negative. Travelers are responsive to changes in fuel prices, a condition that requires that the automobile cost coefficient will be negative. Travelers prefer automobiles to transit or pedestrian travel, which requires that the coefficient for the automobile mode dummy be positive and larger than the transit dummy coefficient. Finally, we hypothesize that previous users of transit will be more likely to ride in the future. That is, the coefficient for previous transit ridership is expected to be positive.

The results are presented in Table 4.1. All parameters have the expected sign. However, two coefficients, previous use of transit and automobile cost, are not statistically significant. That is, the model and data do not support that the true values of the coefficients are different than zero.

Table 4.1 Mixed Multinomial Logit Model Results

Parameter	Estimate	St. Error	T statistic
Travel Time*	-.196	.0906	-2.16
Automobile Cost	-.979	2.389	-.41
Automobile Dummy*	-1.01	.928	-2.62
Transit Dummy*	-2.42	.506	-2.01
Previous Use of Transit	.32	1.339	.23

Two of the four research hypotheses are supported by the analysis while two are not. Travelers do prefer faster trips and are responsive to changes in fuel price, although the latter finding is not statistically significant. However, pedestrian travel is preferred to other modes, and previous use of transit does not significantly positively correlate with current use for off-campus residence to campus commutes. The preference for pedestrian modes is not surprising. While students would prefer to walk or bike, with everything else held equal, pedestrian travel is slow. As a result, for trips over any but the anything shortest of distances, automobile and transit are more commonly chosen modes.

Students would rather drive than ride the bus (the transit dummy is smaller than the automobile dummy variable), depending on the price of gas and relative travel time. Since over longer distances, automobile travel is typically faster than transit, it becomes the dominant mode.

The statistical non-significance of the previous use of transit coefficient may result from residential choice and travel behavior. The first wave of the survey found that most first-year students live on or near campus and use the bus. However, by the time students have reached their fourth year of study they typically live off-campus, many at distances of 5 miles from campus or more. At these distances, transit is unable to compete with the automobile mode on the basis of travel time. Anecdotal evidence supports this as off-campus students often make the choice of where to live first and then decide upon travel mode, usually automobile. When the relative cost of travel by automobile rises, as has occurred over the past few years with the increased cost of fuel, residents realize that transit service is relatively inconvenient. Without a viable alternative, students continue to commute between their off-campus residence and campus by automobile.

4.2 Applying the Model Results

The model allows for the investigation of the impacts of a combination of changes in controllable and uncontrollable factors in transportation mode shares, and it allows one to answer many policy questions. What is the impact of increased cost of automobile travel? What level of ridership could be expected from increasing the level of transit service that results in decreased travel time for its users?

Figure 4.1shows the relative mode shares between automobile, transit, and pedestrians modes by distance from campus when the price of gas is $2.50 per gallon. Pedestrian travel is highest for students living within 1/2 mile of campus. Automobile travel is most common for trips beyond 1/2 mile from campus. Transit has a mode share between 10% and 15% at distances just more than 1/4 mile from campus and less than 2.5 miles from campus. At long distances, the choice of pedestrian modes approaches zero. The information is presented in tabular form in Table 4.2.

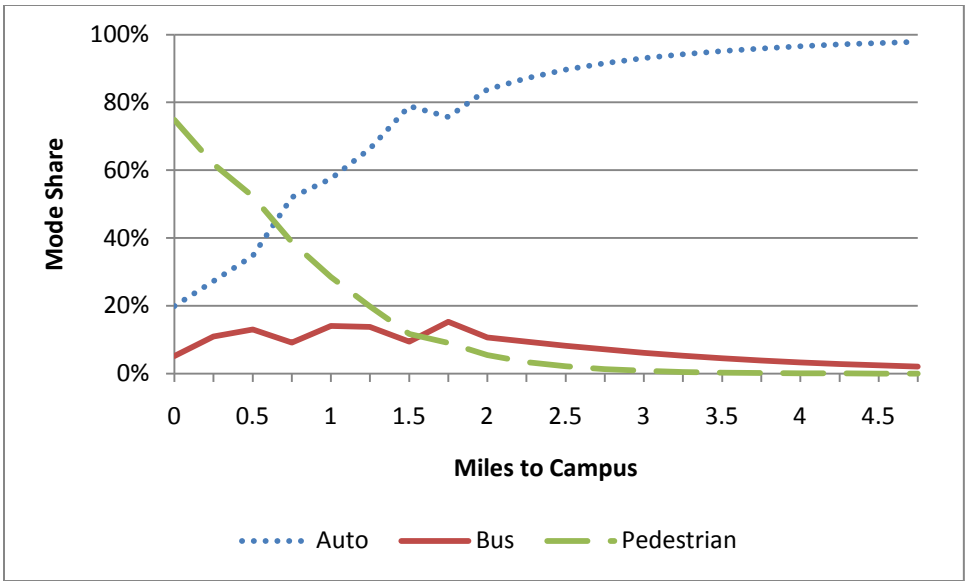

Figure 4.1 Relative Mode Share by Distance

Table 4.2 Relative Mode Share by Distance

Distance	Travel Time (minutes)			Mode Share		
(miles)	Auto	Transit	Pedestrian	Auto	Transit	Pedestrian
0.25	5	2	3.75	0.19	0.09	0.72
0.5	6	4	7.5	0.28	0.11	0.62
1	8	8	15	0.48	0.14	0.39
2	12	16	30	0.80	0.12	0.08
5	24	40	75	0.98	0.02	0.00

4.3 Implications for Public Transportation Planning

The model has implications for local and national public transportation planning. Two local issues are recognized. First, increased near-campus student residency would increase transit ridership. Second, transit can compete with automobile travel at long distances if it is provided at a high level of service. Nationally, there is growing interest in the implementation of fare-free transit service, of which UPASS is a special case.

Continued redevelopment of the near-campus, Roosevelt/NDSU neighborhood is expected to increase the area's student population. The analysis shows that an increase in the number of students living close to campus will result in more students walking, bicycling, and riding transit. With a mode share of .1, an increase in the number of near-campus student residents by 1,000, would be expected to result in an increase of 100 transit riders, or 200 one-way trips, per day.
If transit service is provided at no cost and a level of service competitive with automobile travel, the analysis supports a significant shift in mode shares. With gas at $2.50 per gallon and equivalent travel time on 5-mile trips, the auto-transit split would change to 70-30. To be competitive, students living far off campus would need to reside in the same general vicinity, and regular express bus service between campus and that area would likely be necessary. Given the high cost of service and other potential changes in service elsewhere in the area, this seems unlikely.

5. KEY AND FINDINGS AND CONCLUSIONS

In this study, the attitudes and behaviors of a cohort of North Dakota State University students were investigated. The study relied upon a three-wave survey of a cohort of students that matriculated in the Fall of 2005. Analysis of the survey included the compilation and presentation of descriptive statistics, a more rigorous econometric investigation of the factors that affect mode choice, and inquiry into the impacts of the analysis on planning. While the study does describe recent behavior and estimates the response of students to changes in service or market conditions, the greatest impact will be made if and when the information is used in policy development, planning, and decision making.

The study found that nearly all fourth-year NDSU students have access to automobiles. Most of these students live off campus, and those with access to automobiles use them to commute. There is variability in ridership with one-third of students using transit to commute to campus occasionally, while two-thirds have used the bus to travel between their residence and campus at least once. Students identified cost-savings, convenience, reducing traffic congestion, and parking demand as the primary benefits of transit. In the future, two-thirds of students stated that they will ride transit occasionally or regularly. Among these students, 64% stated that they would at the least consider voting for increased funding for transit. Transit currently has about 9% to 14% mode share for NDSU off-campus students commuting from near campus locations. The mode share drops slowly at longer distances where automobile transportation is preferred.

The mixed multinomial logit model demonstrated itself as a convenient tool to address the Independence of Irrelevant Alternatives condition. The study finds that increased fuel prices results in modest increases in transit ridership. This may be a sign of either strong preferences for automobile transportation or inflexibility for residents who live far from campus and would require relatively long trips as measured by travel time when commuting to campus.

The advanced analysis shows that continued redevelopment of near-campus areas will result in high transit and pedestrian traffic. At the same time, high levels of targeted express bus service would also attract additional riders. However, the cost of doing so may outweigh the benefits, or limited resources may be better used providing other services.

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