HOW THE BUILT ENVIRONMENT AFFECTS ELDERLY TRAVEL BEHAVIOR: AN ACTIVITY-BASED APPROACH FOR SOUTHEAST FLORIDA

By

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A THESIS PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS IN URBAN AND REGIONAL PLANNING

UNIVERSITY OF FLORIDA

2014

To my family

ACKNOWLEDGMENTS

I am deeply grateful to my committee chair, Dr. Ruth Steiner, for her guidance during my research. She provided me with her insights in transportation and land use interaction, and guide me through confusions and doubts. I would also like to appreciate my co-chair, Dr. Siva Srinivasan, for his guidance and help in my modelling techniques. He provided me with a lots of valuable informations and experiences in activity-based model. Additionally I want to thank Dr. Zhong-Ren Peng for his advices during my research.

I give my special appreciation to Roosbeh Nowrousian, a PhD student in civil engineering, who provides tremendous help to me through my research. I would also thank my friends and colleagues from both the Department of Urban and Regional Planning and Department of Civil and Coastal Engineering. It is great to live, learn and cooperate with other Gators.

This research is sponsored by the Eisenhower Transportation Fellowship provided by the Federal Highway Administration (FHWA) from the United States Department of Transportation. Here I thank them for their financial support in the last two years.

Last but not least, I would like to thank my parents, who have always been my most ardent supporters. They give me strength and willingness to continue studying in transportation planning.

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May 2014

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Major: Urban and Regional Planning

Elderly travel behavior can potentially be shaped by changes in the built environment. However the debate over the connection of transportation and land use has not yet reached a consensus. In order to better understand the relationship between the built environment and elderly travel behavior, this analysis adopts an integrated activity-based type approach to study the impact of the built environment represented by disaggregate land use characteristics on different levels of elderly travel decisions (activity generation, tour generation and tour-based mode choice). Using data from National Household Travel Survey (NHTS) 2009 Florida Add-on and GIS data from the Florida Geographic Data Library (FGDL), a case study is presented on the Southeast Florida Region. The results show that different levels of travel decisions are affected by different built environment factors. Employment density can encourage elderly travel. Better street connectivity increases the likelihood of travelers engaging in a simple tour, while living in a neighborhood with an office area may result in less time constrained tour. Street connectivity, regional accessibility and transit accessibility are found to be correlated with elderly mode choice. This study provided a more

comprehensive interpretation of the travel patterns, and subsequent travel behavior and needs of the elderly.

CHAPTER 1
INTRODUCTION

The rapid growth of population over 65 years old, usually referred to as elderly, is increasingly evident throughout the world. According to U.S. Department of Health and Human Services, the American elderly population is expected to reach 72.1 million in 2030, almost twice as large as in 2000 (Wan et al. 2005). Such growth can potentially bring about greater challenges to the transportation system, since elderly in the near future are likely to expect the same level of mobility as younger generation, which is higher than the expectation of current elderly (Buehler and Nobis 2010; Van den Berg, Arentze, and Timmermans 2011; Karimi et al. 2012). Previous research suggested that elderly will try to keep their auto-ownership in order to retain their mobility (Rosenbloom 2001). Compounding this issue are consistent safety concerns that elderly are more likely to be involved in crashes as drivers, despite their self-regulation of the amount of driving (Giuliano, Hu, and Lee 2003; Hilderbrand 2003; Burkhardt 1999). As a result, a shift from an auto-dependent travel pattern is essential for the elderly drivers to maintain their mobility level. However research also found that elderly are less likely to rely on public transit, and are more likely to suffer serious or fatal injury in pedestrian crashes due to higher exposure rates (Giuliano, Hu, and Lee 2003). Therefore as individuals became older, physical conditions and the lack of alternatives to automobile travel may hinder them from sustaining their expected level of mobility. Without proper mobility, elderly may suffer from isolation and depression, thus compromise their general quality of life.

Land use planning is increasingly used as a strategy to improve the viability of the alternatives to automobile (Handy 2005). Such policies are to utilize the interaction between transportation and land use which assumes that travel demand can be shaped by urban development pattern. Since the elderly are more sensitive to local accessibility, it is expected that promoting more transit-friendly, mixed-use communities will be effective in improving elderly mobility (Giuliano, Hu, and Lee 2003). However previous findings raised more questions than answers about this issue. Some research suggested that higher density development can significantly increase elderly mobility level, and reduce the use of automobile by increasing the probability of walking and cycling (Kim and Ulfarsson 2004; Mercado and Paez 2009; Van den Berg, Arentze, and Timmermans 2011; Sikder and Pinjari 2012). On the contrary, Oaks et al. (2007) concluded that the effects of density and block size on total walking and physical activity are modest to non-existent, if not contra-positive to hypotheses. In general, previous literature does not reach a consensus on how and why the built environment affects elderly travel behavior.

Traditionally two approaches have been taken to study the traffic impact of land use: to analyze trip generation, usually in terms of number of trips or the distance of travel; and to use discrete choice model to study mode choice or time of day choice at trip level. However the accuracy of these methods has been questioned for the fact that travel pattern has become much more complicated since the introduction of these models. The availability of activity-based model provides us with new opportunities to perform detailed analysis on how land use interacts with elderly travel behavior, particularly at a level involving activity engagement. Travel related choices, in activity-based models, become part of the activity pattern and scheduling process. Such model will capture the demand for activity rather than demand for trips. This provides us with a sound and viable approach to forecast travel demand since activity-based model enables explicit interpretation of traveler's activities and their consequent sub-tours (Bhat and Koppelman 1999). The aim of this research is to analyze the effects of the built environment characteristics on different levels of travel decision making process using a simplified activity-based type model system. Although this model framework is descriptive in nature, it has two advantages compared to traditional methodologies.

First, the decision of travel in this analysis is layered based on a certain hierarchy: willingness to travel (activity generation), tour purpose split (tour generation), and mode choice at tour level. This model considers travel as a whole, starting from the activity generation, to tour generation and then to the travel decision at tour level. The impact of land use is tested in each level of the travel decision, thus making it clear how the built environment interacts with elderly travel behavior.

Second, a tour level mode choice set was created based on the assumption of “main” modes at the trip level. This setting implies the availability of different modes when making travel decision. For example, the tour mode is auto means that a car is available in all trips in the same tour. This method takes into account the interaction between trips in the same tour and avoids duplication of the same subjects traveling on a sequence of trips in the same tour using the same mode, thus providing us with an accurate interpretation of travel behavior.

The State of Florida has the highest percentage (17.3%) of elderly people among all states in the United States (Himes 2002). The analysis will use southeast Florida as a case study, and combine various data source from National Household Travel Survey (NHTS) 2009 Florida Add-on for household and trip related data, and GIS data by county from Florida Geographic Data Library (FGDL). By using this data sources we intended to construct a statistically efficient model to find out how much the built environment affect elderly travel behavior.

CHAPTER 2
LITERATURE REVIEW

Much of the research on urban form and elderly travel behavior has been focused on whether mixed-used, higher density community can increase physical activity and the use of transit by elderly (Giuliano, Hu, and Lee 2003; Kim and Ulfarsson 2004; Mercado and Paez 2009; Van den Berg, Arentze, and Timmermans 2011; Sikder and Pinjari 2012). The majority of the research has adopted a traditional method of evaluating trip generation and trip level travel decision. These methodologies are generally in consistent with studies that analyze land use and general travel behavior. Similar to the findings of elderly travel behavior research, the results of these studies that address the coordination of transportation and land use bring about more questions. Many researchers suggested that higher density development can significantly affect travel behavior (Cervero and Seskin 1995; Cevero and Kockelman 1997; Kitamuram Mokhtarian and Laidet 1997, Steiner et al., 2008). Other studies, which adopted similar methodologies as those mentioned above, showed that the built environment does not have a significant impact on travel demand and travel behavior (Giuliano 1995; Crane and Crepeau 1998; Boarnet and Sarmineto 1998). In general, we can conclude that previous literature does not reach a consensus on how and why the built environment affects travel demand and travel behavior.

Recent improvements in the research of elderly travel behavior have included studying mobility level and preference of elderly (Siren and Blomqvist 2009; Sikder and Pinjari 2012), and using multiple correspondence analysis to study nonlinear and non-monotonic relationships between socioeconomic characteristics and elderly travel behavior at a trip chain level (Golob and Hensher 2007). There has been little research on how the built environment impacts elderly travel behavior, particularly the travel behavior involving activity generation. It is clear that further research on this topic is required to better understand the connection between elderly travel behavior and the built environment.

Travel demand modeling has made significant advances in the past 35 years. Discrete choice modeling techniques were first developed in order to study the choice of travelers on a trip based scenario (McFadden and Talvitie 1977; Ben-Akiva and Lerman 1985). This methodology was further developed into tour based models that capture the interrelated decision making in a trip chain (Daly, van Zwam, and van der Valk 1983; Gunn 1994). Later on, activity-based modeling concepts were developed in order to report the constraints of activity schedule and important activity-based demand responses (Ben-Akiva, Bowman, and Gopinath 1996; Bowman and Ben-Akiva 2000). Activity-based model can capture the subtle impact of explanatory variables to the travel decisions on different layers. Such characteristics give us opportunities to implement this methodology into the analysis of land use policies (Shiftan 2008).

The analysis presented in this paper incorporates an activity-based approach into the study of land use and elderly travel behavior interaction. It is different from previous study in the following ways. First, it takes into account that travel decision is not made solely based on a specific trip, instead people consider travel as a whole including willingness, purpose and mode choice together. Second, tour generation is represented by a binary model studying what aspects of land use can encourage time unconstrained tours, given that the increase in the proportion of unconstrained tours implies better elderly mobility level. Third, this approach considers mode choice at a tour level instead of trip level, considering that mode choice for a chain of trips within the same tour usually interrelates with each other. As such, the incorporation of activity-based type model can potentially lead us into further understanding of how the built environment affects elderly travel behavior, thus bring new insights into the pool of current literature.

CHAPTER 3
MODEL FRAMEWORK

The model framework in this study is an activity-based type model system consists of a series of disaggregate logit models. Travel decisions are classified into three levels based on a hierarchy of decision making process: activity generation (willingness to travel), tour generation (purpose and complexity of tour), and tour level mode choice. Lower level choices are conditional on the decision of higher level. 错误！未找到引用源。 shows the diagram of the model framework. The underlying basis for such a model framework is that travel decisions on activity generation level are driven by the need of the travelers. Therefore activity generation is considered to be the highest level of the analysis hierarchy. For tour level decision such as mode choice, they tend to be driven by convenience, travel conditions, and short term temporal constraints. Therefore they are positioned at a lower level of the hierarchy.

For each level of travel decision, a discrete choice analysis is conducted to estimate the effects of land use on travel decision. At activity generation level, a binary logit model is fit in order to find what affects elderly willingness to travel.

At tour generation level, we choose a binary logit model that reports what factors would encourage the elderly to make more time-unconstrained travel over a regression model for studying how many trips or tours elderly person produced. The underlying logic is that higher proportion of unconstrained tours in the travel schedule of the elderly person indicates mobility level, since tours with time constraints, such as work, school or medical, are always necessary regardless of the built environment. Higher proportion of complex tours means elderly is likely to plan their travel before hand as a compromise to their constraints. After controlling socioeconomic factors, the models are intended to explore the degree of association between multiple dimensions of land use and elderly travel behavior.

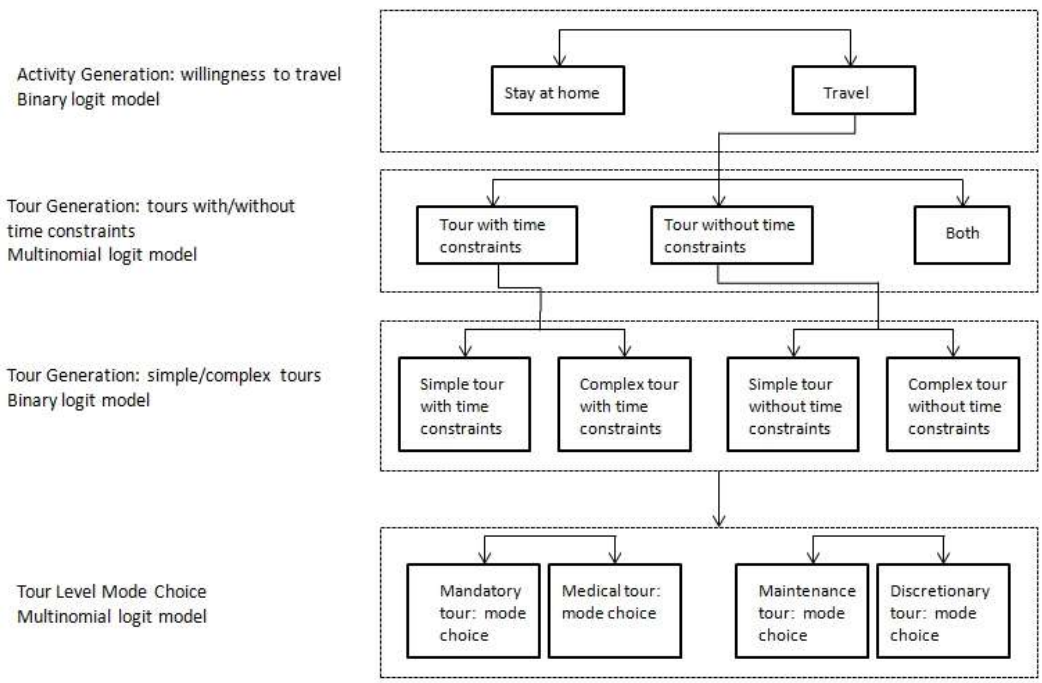

Figure 3-1. Activity-based Model Framework

For tour based mode choice, a multinomial logit model is fit for medical, maintenance and discretionary tour purpose. Mandatory purpose is not estimated here since travel decisions on mandatory tours are generally inelastic, and elderly are less likely to conduct mandatory travel compared to younger generation.

CHAPTER 4
DATA

This analysis will be conducted by using primary data from National Household Travel Survey (NHTS) 2009 Florida Add-on. The case study area includes three counties from Southeast Florida which are Palm Beach, Broward and Miami-Dade. The other component of the dataset is the parcel data from FGDL. In total 2557 households, 2747 persons are in the data sample.

The NHTS 2009 dataset is collected on daily trips taken in a 24-hour period. The purpose of NHTS 2009 is for researcher to have a better understanding of travel behavior. The design of NHTS 2009 data is a random digital dialing telephone interview survey conducted over an entire year (FHWA 2011). The dataset includes socio-economic and trip related information at a household and person level, and information of transportation mode and vehicle ownership, trip chain, and also respondent's perception of the transportation system. In the add-on samples such as Florida Add-on data, O-D information for all trips are included and it allows us to geocode the location of the respondents and study the relations between travel behavior and the built environment.

The Florida Geography Data Library (FGDL) provides a rich pool of GIS-based data of the land use and built environment information in Florida. We utilize the parcel data from 2010, roadway data, and transit data for the analysis. The primary reason for picking south Florida as the case study is that south Florida is a very urbanized area and it has a rich variety of land use patterns and different activity patterns. This can provide us with a significant diversity in the sample for the analysis.

The Tour Setting

Tours constitute a fundamental unit of analysis in activity-based and tour-based travel demand modeling systems (Nowrouzian and Srinivasan 2012). In this analysis, a tour is a sequence of trips that begin from home and return to home after one or more intermediate stops with none of them being home, therefore all tours studied here are home-based tours. In the NHTS 2009 Florida Add-on, trips are categorized into 36 different purposes, and then we combine each trips into tours based on their specific travel information. The following trips were excluded from the process of tour creation:

- Traveler did not start and/or end the survey day at home
- Traveler made one tour with no intermediate stops (i.e., a trip that starts and ends at home)
- At least one person made at least one tour with more than six intermediate trips

Based on the above criteria, we have 2099 out of 2747 elderly persons who generate at least one tour. Table 4-1 shows that our selection method doesn’t skew the data. These 2099 persons produced 3130 observations of tours. Note that for activity generation, we still conduct our analysis with the complete sample.

Table 4-1. Comparison between All Sample and Elderly Who Made Tours

Age group	All Sample (Including Stay at Home)		Elderly Who Made One or More Tours	
	Frequency	Percentage	Frequency	Percentage
65-69	669	24.4	567	27.0
70-74	591	21.5	476	22.7
75-79	566	20.6	451	21.5
80-84	520	18.9	374	17.8
85+	401	14.6	231	11.0
Total	2747	100.0	2099	100.0

The 2099 elderly generated 3130 tours in total. Tour generation and tour level mode choice are conducted based on these 3130 tours. Tour mode is defined based on the most important activity of the tour, i.e., the purpose of a tour is the highest priority activity taking place in the tour. The most important activity is determined based on pre-defined hierarchy considering flexibility in frequency, location, and scheduling of the activities. The lesser the flexibility of an activity in frequency, location, scheduling, the higher is its priority in hierarchy. The activity purposes are ranked in order as: mandatory (work, school or school related, pick up or drop off), medical, maintenance (shopping, eating out, etc.) and discretionary (social/recreational, exercise, etc.). Mandatory and medical tours are considered to be time constrained, while maintenance and discretionary tours are considered to be unconstrained. Table 4-2 shows the frequency and percentage of each trip purpose.

The complexity of tours are defined by the number of stops in each tour. If a tour contains two stops, the tour is defined as simple tour. If the tour contains at least three stops, it is defined as complex tours. Table 4-3 shows the distribution of tour type.

Table 4-2. Tour Purpose Distribution

Tour generation	Tour purpose	Definition	Frequency	Percent
Time constrained tour	mandatory	Work, School, escort, etc	215	6.9
	medical	go to doctor, dentist, etc	354	11.3
Time unconstrained tour	maintenance	Shopping, eating out, etc.	1331	42.5
	discretionary	social/recreational, exercise, etc.	1230	39.3
Total			3130	100.0

Table 4-3. Tour Type Distribution

Tour Type	Frequency	Percent
Simple tour with time constraints	285	9.1
Simple tour without time constraints	1717	54.9
Complex tour with time constraints	284	9.1
Complex tour without time constraints	844	27.0
Total	3130	100.0

The travel mode of the entire tour is determined to be one of the following based on the modes of the individual trips in the tour and the vehicle occupancy levels: Drive Alone, Shared Ride 2, Shared Ride 3+, Non-motorized, and Walk-Transit. If all trips within the tour are made by Auto, the tour mode is first broadly classified as auto. The tour-level auto-occupancy is then determined based on the maximum number of participants on the trip that occur within the tour. Based on the tour-level auto occupancy, auto tours are further classified into Drive Alone, Shared Ride2, and Shared Ride 3+. If the mode for all trips in a tour is Walk or Bike, the tour mode is respectively defined as Non-motorized. To complete a tour, if both Transit and Auto are used, tour mode is classified as Drive-Transit. If Transit is the only mode to make a tour, tour mode is defines a Walk-Transit. We do not have any drive-transit in our sample. 错误！未找到引用源。 shows distribution of tour mode

Table 4-4. Distribution of Tour Mode

Tour mode	All		Mandatory		Medical		Maintenance		Discretionary	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Drive alone	1374	43.9	177	82.3	151	42.7	686	51.5	360	29.3
Share ride 2	999	31.9	24	11.2	144	40.7	401	30.1	430	35.0
Share ride 3+	317	10.1	14	6.5	22	6.2	96	7.2	189	15.4
Non-motorized	370	11.8	-	-	-	-	121	9.1	249	20.4
Walk transit	70	2.2			37	10.5	27	2.0	-	-
Total	3130	100.0	215	100	354	100	1331	100	1230	100

Literature expected the trip chaining behavior to increase in general as a population ages, due to the increasingly ageing society which a large portion of the population being 65 years or older, who are less constrained when undertaking single-purpose commuting activity (Golob and Hensher 2007). The literature also suggested the growth in more active lifestyles of seniors and their ability through trip chaining to meet multiple objectives in one tour (Banister and Bowling 2004).

Control Variables

Socioeconomic characteristics and some travel information are used as control variables in this analysis. 错误！未找到引用源。 presents the descriptive analysis of all control variables. Since medical conditions are an important aspect of elderly travel, we include two physical condition variables here: driving impaired, and mobility impaired. Driving impaired means a person has a medical condition that makes driving hard, and mobility impaired means a person has medical condition that makes travel in general difficult.

Table 4-5. Descriptive Analysis of Control Variables

Variables	Definition	Activity Generation		Tour Generation and Mode Choice	
		Mean	Std. Dev.	Mean	Std. Dev.
weekend	Travel take place on weekend (dummy)	.29	.454	.27	.443
age	Age of subject	75.99	7.492	74.82	6.99
male	Subject is male (dummy)	.43	.495	.47	.499
employed	Subject is employed (dummy)	.15	.357	.18	.384
medium income	Medium income household (dummy)	.25	.436	.27	.445
high income	High income household (dummy)	.25	.434	.30	.457
no. of driver	Number of drivers in household	1.58	.768	1.64	.70
no. of vehicle	Number of vehicles in household	1.47	.871	1.55	.851
no. of adult	Number of adults in household	1.91	.788	1.87	.753
driving impaired	Medical condition which makes driving difficult (dummy)	.11	.312	.06	.230
mobility impaired	Medical condition which makes travel difficult (dummy)	.26	.436	.18	.383
driver license	Subject has a driver license (dummy)	.81	.393	.91	.292
live alone	Subject live alone (dummy)	.26	.441	.27	.445

Measures of the Built Environment

A variety of measures of the built environment are tested in this analysis. These variables are calculated using GIS technology which allows us to measure built environment variables with different scales. Densities are calculated based on census block and census tract, while other variables, such as connectivity and land use mix, are calculated by 0.25 miles buffer and 0.5 miles buffer around household locations. **错误！未找到引用源。** shows the descriptive analysis of all built environment variables.

Street Connectivity

In this analysis, street connectivity is represented in terms of number of intersections and number of cul-de-sacs in a certain buffer area. Additionally, connected node ratio (CNR) is used to represent the overall connectivity of local network. CNR is the number of street intersections divided by the number of intersections plus cul-de-sacs. The maximum value is 1.0.

Accessibility to Transit

Accessibility to transit is an important indicator of the viability of transit as an alternative to automobile. In this analysis, three measures of accessibility to transit are tested: network distance to nearest bus stop, number of bus stops in a certain buffer area and total length of bus route in a certain buffer area.

Regional Accessibility

In this analysis, the measure of regional accessibility determines the network distance of each neighborhood to each of four regional activity centers in southeast Florida (**错误！未找到引用源。**). The activity centers were defined as neighborhoods with the highest commercial square footage (Steiner et al. 2008). The distances were determined between the household locations to regional center along the roadway network.

Figure 4-1. Location of Regional Activity Center in Southeast Florida

Density

Density is a common measure of the built environment in the literature which explores the interaction between urban form and travel behavior. Higher density usually implies better accessibility, higher proportion of mixed-use area, and better transit services. In this analysis, net jobs density, net residential density and net population density are tested.

Diversity

Land use types are divided into the following six categories: residential, commercial, office, institutional, industrial, and other. The first set of the land use variables captures the fraction of a certain area by each land use type. These variables represent the diversity of land use pattern around residential location.

The next set of variables is the fraction of area that is developed, calculated as the ratio of the sum of the areas in the six land use categories (residential, commercial, office, institutional, industrial and other) to the total buffer area around the neighborhood. For neighborhood located near the coast line, the total buffer area is smaller.

Another set of variables is the entropy index around neighborhood. Entropy index is used to define the land use balance based on local or zonal characteristics (Kockelman, 1997). The equation for entropy is as follows.

$$\text{Entropy} = -\sum_j \frac{[P_j \times \ln(P_j)]}{\ln(J)} \qquad (4\text{-}1)$$

Where *Pj* is the proportion of developed land in the *j*th land use type; in this analysis, *J*=6.

The last set of variables is the mixed development index (MDI). It is a variable that characterizes the job-housing balance. The definition of MDI is as follows.

MDI=[(ED)*(RD)]/[ED+RD (4-2)

Where RD is Residential Density, and ED is Employment Density.

Descriptive Analysis of Land-Use Variables

Regional Context

The tables in this section only show the descriptive analysis on travel made by elderly. Younger travelers are excluded from the analysis.

As we can see from Table 4-7, the distance to activity center for non-motorized, and walk-transit are shorter than other modes. For distance to nearest residential center, walk transit has the lowest value.

From table 4-8 we can see a potential correlation between density and walk-transit. It is clear from this table that the higher the density, the more likely for elderly people to use transit.

Table 4-6. Descriptive Analysis of the Built Environment Variables

Category	Variables	Activity Generation		Tour Generation and Mode Choice	
		Mean	Std. Dev.	Mean	Std. Dev.
Street Connectivity	No. of intersections in .25 mile buffer	29.71	15.38	28.83	15.21
	No. of cul-de-sacs in .25 mile buffer	6.21	6.49	6.22	6.33
	No. of intersections in .5 mile buffer	115.3	48.71	112.44	47.40
	No. of cul-de-sacs in .5 mile buffer	24.32	18.92	24.57	18.72
	No. of intersections in 1 mile buffer	433.3	160.47	423.15	154.08
	No. of cul-de-sacs in 1 mile buffer	88.29	51.55	88.99	50.73
	CNR .25 mile buffer	0.82	0.15	0.81	0.15
	CNR .5 mile buffer	0.82	0.11	0.81	0.11
	CNR 1 mile buffer	0.82	0.09	0.82	0.08
Transit Accessibility	number of bus station in 1 mile buffer	38.91	44.97	36.08	42.28
	number of bus station in 0.5 mile buffer	10.35	13.32	9.40	12.53
	Distance to nearest bus stop (1000 meters)	1.24	2.03	1.25	1.91
	Total length of bus route in 0.5 mile buffer (1000 meter)	11.46	15.74	10.41	14.62
Regional Accessibility	Distance to Regional Activity center (miles)	10.74	4.86	10.73	4.60
Density	net job density blk (1000/sq mile)	2.69	3.19	2.53	3.04
	net house density block level (1000/sq mile)	3.23	4.56	3.20	4.63
	net population density block level (1000/sq mile)	6.45	7.74	6.16	7.53
	net population density tract level (1000/sq mile)	6.23	4.87	5.96	4.76
	net job density tract level (1000/sq mile)	2.28	1.75	2.15	1.69
	net house density tract level (1000/sq mile)	3.27	3.57	3.24	3.70
	net job density block group level (1000/sq mile)	2.42	2.19	2.24	2.06

Table 4-6. Continued

Category	Variables	Activity Generation		Tour Generation and Mode Choice	
		Mean	Std. Dev.	Mean	Std. Dev.
Diversity	Mixed Development Index block level (1000)	1.21	1.43	1.17	1.41
	Mixed Development Index tract level (1000)	1.25	1.04	1.20	1.03
	Fraction of .25 buffer area that is developed	0.46	0.22	0.46	0.21
	Fraction of .25 buffer area that is residential	0.59	0.30	0.59	0.30
	Fraction of .25 buffer area that is commercial	0.06	0.12	0.06	0.13
	Fraction of .25 buffer area that is office	0.03	0.07	0.03	0.07
	Fraction of .25 buffer area that is institutional	0.15	0.20	0.14	0.20
	Fraction of .25 buffer area that is industrial	0.02	0.09	0.03	0.10
	Entropy Index in .25 mile buffer	0.39	0.24	0.38	0.24
	Fraction of .5 buffer area that is developed	0.41	0.20	0.41	0.21
	Fraction of .5 buffer area that is residential	0.39	0.22	0.39	0.22
	Fraction of .5 buffer area that is commercial	0.10	0.11	0.10	0.11
	Fraction of .5 buffer area that is office	0.04	0.06	0.04	0.06
	Fraction of .5 buffer area that is institutional	0.23	0.19	0.22	0.19
	Fraction of .5 buffer area that is industrial	0.03	0.07	0.03	0.08
	Entropy Index in .5 mile buffer	0.41	0.24	0.40	0.25

Table 4-7. Distance to Regional Center for Each Tour Based on Different Tour Mode

	distance to activity center miles		distance to residential center miles	
	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	10.81	0.12	9.13	0.14
Shared Ride2	10.81	0.15	8.79	0.17
Shared Ride3	11.22	0.27	9.10	0.30
Non-motorized	10.28	0.24	9.19	0.26
walk-transit	8.96	0.55	6.69	0.52

Table 4-8. Block Level Density around Household for Each Tour Based on Different Tour Mode

	net job density at blk level per square mile		net house density at blk level per square mile		net pop density at blk level per square mile	
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	2521.56	90.42	3454.65	137.57	6660.94	229.85
Shared Ride2	2406.57	91.64	3309.21	150.08	6277.71	237.97
Shared Ride3	2677.43	199.97	3566.39	343.21	6793.63	468.26
Non-motorized	2558.05	185.57	3269.37	234.86	6880.10	475.61
walk-transit	3999.11	540.99	5899.66	1123.57	9317.43	1280.47

Table 4-9. Tract Level Density around Household for Each Tour Based on Different Tour Mode

	net job density at trct level per square mile		net pop density at trct level per square mile		net house density at trct level per square mile	
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	2163.23	44.36	5969.09	125.60	3212.33	95.71
Shared Ride2	2001.10	49.56	5527.84	137.34	2968.93	102.85
Shared Ride3	2350.95	113.47	6525.16	311.41	3575.70	236.76
Non-motorized	2181.75	89.02	6089.20	267.57	3250.85	208.30
walk-transit	3099.59	266.24	8839.78	654.87	6198.09	757.70

Similarly to density at the block level, walk-transit has the potential correlation with density at tract level.

Connectivity and Transit Accessibility

The second set of land-use variables is the street connectivity and transit accessibility.

Table 4-10. Transit Accessibility around Household for Each Tour Based on Different Tour Mode

	number of bus station in 1 mile buffer		dist to nearest bus stop meter		NUMBER OF BUS STOP IN HALF A MILE		total bus route length in half mile buffer	
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	33.08	1.10	1328.70	53.92	8.59	0.33	9672.32	386.80
Shared Ride2	34.76	1.28	1208.04	58.99	9.20	0.39	9558.33	404.54
Shared Ride3	38.59	2.42	1353.53	118.37	9.57	0.69	10825.74	832.58
Non-motorized	42.14	2.39	1049.26	81.80	10.85	0.68	12044.87	797.34
walk-transit	70.21	6.34	742.25	150.40	19.74	1.82	26676.95	3095.40

We can see a smooth variation from auto (drive alone, carpool) to non-motorized and finally to transit. This is a strong indication that transit accessibility is highly correlated with mode choice.

Table 4-11. No. of Intersections around Household for Each Tour Based on Different Tour Mode

no. of intersections	Buffer 0.25 miles		Buffer 0.5 miles		Buffer 1 mile	
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	28.84	.414	112.37	1.263	422.61	4.033
Shared Ride2	28.08	.466	110.20	1.458	416.25	4.811
Shared Ride3	29.19	.823	114.66	2.755	434.25	9.069
Non-motorized	30.22	.804	115.31	2.447	431.08	8.243
walk-transit	36.61	1.855	141.54	6.039	500.86	20.182

From Table 4-11 we can see the correlation between model choice and number of intersections around household location.

Table 4-12. No. of Cul-de-sacs around Household for Each Tour Based on Different Tour Mode

no. of culdesac	0.25 miles		0.5 miles		1 mile	
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	6.35	.165	24.87	.481	88.72	1.305
Shared Ride2	6.20	.197	24.56	.575	91.54	1.604
Shared Ride3	6.34	.362	25.68	1.086	92.53	3.109
Non-motorized	5.92	.352	23.11	.983	84.54	2.596
walk-transit	6.24	1.124	26.00	4.127	80.03	8.715

The number of cul-de-sacs around residential location, on the other hand, has a totally opposite effect compared to the number of intersections. Travelers tend to choose automobile more as the number of Cul-de-sacs increases.

Table 4-13. Connected Node Ratio around Household for Each Tour Based on Different Tour Mode

connected Node ratio	0.25 miles		0.5 miles		1 mile	
	Statistic	Std. Error	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	.8038	.00412	.8117	.00281	.8203	.00219
Shared Ride2	.8063	.00482	.8107	.00349	.8130	.00271
Shared Ride3	.8161	.00678	.8095	.00570	.8162	.00496
Non-motorized	.8237	.00825	.8281	.00544	.8276	.00455
walk-transit	.8706	.01389	.8592	.01305	.8662	.01091

Not surprisingly, the trend found in this table coincides with the finding in the number of intersections. People leaning towards non-motorized mode and transit as the increase of connected road ratio.

Mixed-use

The next set of land-use variables are the mixed-use variables.

Table 4-14. Mixed Development Index around Household for Each Tour Based on Different Tour Mode

mixed development index	tract level		block level	
	Statistic	Std. Error	Statistic	Std. Error
Drive Alone	1199.30	26.65	1149.46	37.24
Shared Ride2	1118.22	29.54	1147.13	47.63
Shared Ride3	1312.85	71.09	1207.92	87.21
Non-motorized	1210.92	55.39	1137.84	73.82
walk-transit	1890.84	179.47	1735.34	288.64

Mixed use always considered to be correlated with choice over non-motorized mode and transit. Form Table 4-14 and Table 4-15 we can clearly see the trend.

Table 4-15. Entropy Index around Household for Each Tour Based on Different Tour Mode Motorized Mode and Transit.

Similarly to mixed development index, entropy increases with the choice of non-

	entropy index 0.25	
	Statistic	Std. Error
Drive Alone	.380	.006
Shared Ride2	.369	.007
Shared Ride3	.376	.013
Non-motorized	.407	.013
walk-transit	.470	.028

CHAPTER 5
MODEL RESULTS

Activity Generation

Table 5-1 reports the binary logit model that estimates activity generation. The dependant variable is whether elderly travel (1) or stay at home (0) at travel day. Controlling for other correlates, the results show that higher net job density and higher MDI is associated with a higher likelihood of travel, which indicates that higher density and mixed use is likely to encourage elderly to conduct activity outdoors.

Other variables tested in this model have the expected signs. Proximity to regional activity center will increase the probability of travel, potentially due to the increased number of opportunity near the activity center. Age, travel day (weekend or not), driver license, auto-ownership all have impacts on the decision to travel. It is worth noticing that mobility impaired elderly are much less likely to travel according to the significance and magnitude of the estimation results. We can conclude that medical conditions of elderly are one of the most important determinants of travel.

Tour Generation

Table 5-2 presents the second stage of the model that focused on tour generation. This model uses a binary logit model to estimate elderly travel decision over time constrained tour or unconstrained tour. Those respondents in the survey who did not report making a tour are eliminated from this analysis. Constrained tours are usually for things that have to be done, including mandatory tours (work, school, and escort) and medical tours; while unconstrained tours include maintenance tour (shopping, eating out) and discretionary tours (socio-recreational, exercise).

Table 5-1. Activity Generation Estimation Results (Binary Logit Model)

Base case: stay at home	Base Model		Final Model	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Constant	3.202**	.596	3.517**	.633
employed	.939**	.214	.933**	.214
age	-.029**	.007	-.032**	.007
weekend	-.383**	.105	-.376**	.106
Mobility Impaired	-.503**	.111	-.511**	.112
Driver License	1.044**	.128	.961**	.130
no. of car	.190**	.077	.233**	.081
no. of adult	-.318**	.078	-.323**	.079
Distance to Activity Center	-	-	-.028**	.013
net Job Density tract level (1000/mile^2)	-	-	.455**	.103
MDI tract level (1000unit)	-	-	.746**	.182
Pseudo-R^2	0.127		0.133	
Log-likelihood	-1585.150		-2526.969	
Sample size	2747			

*:significant at 90% confidence level; **: significant at 95% confidence level

Better transit accessibility around residence increases the likelihood of engaging in a time unconstrained tour, while living in a neighborhood with much diversity in land use area may also result in more time unconstrained tour. This finding may partly be attributed to the fact that elderly people who lived in a business area are likely to find more opportunities in the neighborhood. Thus, the number of unconstrained tours produced by these elderly people is higher. The results show here are good indicators that mixed uses with better accessibility can potentially encourage elderly people to travel, since the more simple tour and unconstrained tours are related to a more relaxed life style.

Tour Mode Choice

For each tour purpose, namely medical, maintenance and discretionary, a multinomial logit model is estimated for tour mode choice (Table 5-3 toTable 5-5). All four models have a significant increase in Pseudo-R^2 compared to their base model, indicating that the inclusion of built environment factors strengthens the models, substantially reduced the unexplained variation in different dependent variables. Drive alone is used for base case in all four models in order to test the viability of alternatives to drive alone. The availability of modes varies according to different tour purposes. In maintenance tours, both non-motorized mode and transit are properly represented in the sample, however elderly only choose transit as an alternatives to driving for medical tours, and non-motorized travel is the only options other than automobile in discretionary tours.

Street Connectivity

Street connectivity is found to be highly correlated with the choice for non-motorized and transit. Connected node ratio (CNR), in particular, affects tour level mode choice in both significance and magnitude. Better street connectivity would increase the likelihood of choosing non-motorized and transit for medical, maintenance, and discretionary tours. This finding is consistent with previous literature that walking is found to be most strongly related to measures of intersection density (Ewing et al. 2010).

One interesting finding is that street connectivity seems to affect walking and biking more than transit. In Table 5-3, Table 5-4 and Table 5-5 we can see that the parameters of connected node ratio (CNR) for non-motorized in both 0.5 miles buffer and 1 mile buffer area appears to be significant, and much greater than the parameters for walk-transit, implying that the choice of non-motorized mode is much susceptible to street connectivity.

Transit Accessibility

Not surprisingly, we found that better transit accessibility is likely to increase transit use, however among all the transit accessibility variables we estimate for this analysis, the number of bus stops within a certain buffer area of residence turns out to be the most significant indicator, in some cases it is the only significant transit related variable. Although the estimation results show the expected sign of transit parameter, the magnitude is small compared to other sets of variables such as street connectivity. Other variables, such as total bus route length, are not significant, implying that the convenience to reach a station is more important than the availability of different bus routes around neighborhood.

Regional Accessibility

The distance to a regional activity center is correlated with elderly mode choice when conducting maintenance tours. Longer distances to activity centers would decrease the utility of travel by non-motorized mode and transit. Residential areas that are farther away from an activity center are usually suburban communities with single land use. Therefore distance to activity center implies the land use type of the residential neighborhood, thus affects the decision of mode choice. Longer distance to activity center would also increase the probability of carpooling for the same reason.

Density

The modeling results show that density has a relatively small effect on elderly mode choice, as previous literature suggests (Ewing et al. 2010). Both significance level and the magnitude of the parameters of density are moderate to marginal compared to other variables. The weak relationship between density and mode choice indicates that density has an intermediate connection between travel behavior and other built environment variables such as accessibility and connectivity.

Although the impact of density on travel behavior is small, we cannot ignore the existence of this influence. The model results show that for tours without time constraints (maintenance and discretionary), density variables seems to have a greater impact on mode choice compared to medical tours. For maintenance tour, five density variables turned out to be significant, including job density, house density and population density etc. This facts may have a profound implication suggesting that elderly are more likely to consider the effect of the built environment when conducting unconstrained travel.

Diversity

Diversity can shape elderly mode choice in a larger scale, in terms of significance level and magnitude, compared to density. For medical, maintenance and discretionary tours, higher entropy or higher percentage of commercial and office area tends to promote non-motorized mode and transit. The entropy index calculated for smaller buffer areas (0.25 miles) seems to be more relevant than the entropy of larger buffer areas (0.5 miles), therefore we can conclude that the diversity of land use matters to mode choice only in a smaller spatial area. Job-housing balance (represented by MDI), however, does not increase the viability of non-motorized mode and transit, even given the relatively larger sample size in maintenance tours and discretionary tours.

CHAPTER 6
CONCLUSIONS

Based on the results of the models, we can conclude that the built environment has greater impact on the tour level travel decision than on activity generation and tour generation. The demand for activity is still largely driven by the socioeconomic characteristics, while the travel behavior at lower level of activity engagement, such as tour level mode choice, is heavily affected by the built environment. However, the effect of built environment on activity generation and tour generation cannot be underestimated. Although density is found to be moderately correlates with mode choice as previous research suggested (Ewing et al. 2010), it impacts activity generation in a greater significance level. According to 错误！未找到引用源。, the parameter estimated for job density in activity generation implicates that the increase of 1000 employees per square mile will increases the utility of elderly travel in a magnitude that larger than most of the socioeconomic variables. This finding suggests that density is significantly related to travel not by affecting trip length or mode choice, but by shaping the decision of elderly on whether to travel or not.

The diversity of land use around residential neighborhood area can increase the proportion of tours without time constraints. Larger business area can potentially bring new opportunities and conveniences for elderly, thus increase their unconstrained travel. This conclusion is based on the assumption that constrained travels are for mandatory or medical purpose, therefore the increase in the proportion of unconstrained travel means the increase in the total number of travel in general.

Job-housing balance (represented by MDI) is found to be significant in activity generation, implying that diversity of land use is also strongly related with elderly willingness of travel. However, this study doesn't support the previous notions that job-housing balance can significantly increase walk and transit use (Cervero et al. 2006). Entropy index, on the other hand, is found to be correlated with choosing non-motorized modes and transit, although this analysis also finds that only calculated in a smaller area can entropy become significant.

Street connectivity and regional accessibility are highly correlated with elderly tour level mode choice as previous research predicted (Ewing et al. 2010). Street connectivity has the largest effect on elderly tour level mode choice, and it has larger impact on non-motorized mode than on transit.

The findings on transit accessibility, suggest that access to transit stations, rather than the availability of multiple transit routes, is the primary reason which elderly choose transit. In another word, if elderly can get to a transit station easily, they are more likely to use transit regardless how many transit routes are available for them.

Another interesting finding is that we do not find any consistency in how the built environment affects carpool. Most indicators turned out to be insignificant, while those significant sometimes reports contradictory results. This may imply that the built environment doesn’t affect elderly carpooling behavior as the way it affects elderly use of transit. The choice of carpool is largely determined by the need of travel, the purpose of travel, and availability of companions.

CHAPTER 7
SUGGESTIONS FOR FUTURE RESEARCH

This analysis adopted an activity-based model system which allows us to examine the effects of land use on different layers of travel decision. One improvement of this model system is to incorporate a logsum term which makes the model more of a "nested" structure. Such characteristics can bring the connection between different layers of travel decision together, and choices at lower level are conditioned on choices at higher level, while choices at higher level also reflect the choices at lower level.

We can also improve the viability of the methodology by introducing a more specific classification on tour purpose. In this analysis, tour purposes are only divided into tours with time constraints and without time constraints. Using a more complete activity-based model system can increase the accuracy of the results, which are likely to report the effects of land use on conducting different purposes of travel.

This research shows that elderly travel behavior is correlated with several built environment factors. However, for elderly population, the lack of mobility is usually caused by their physical conditions. Potential longitudinal research can be conducted to study how the elderly travel behavior changes through time when they become increasing mobility impaired and how these may vary across different neighborhood type.

Another limitation of this study is that it does not control for self-selection. Tour-based analysis requires each tour to be started and ended at home, therefore making analysis based on destination location difficult. One possible solution is to use interaction terms which connect demographic variables with land use variables in order to examine who locates in mixed-use development area and why. This method can potentially give some insights for the self-selection issue.

Table 5-2. Tour Generation Estimation Results (Multinomial Logit Model).

Base case: tour with time constraint	Base Model		Final Model	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Constant	1.984**	.139	1.422**	.301
Weekend	1.874**	.164	1.814**	.166
Male	.258**	.105	.253**	.106
Employed	2.065**	.121	-2.078**	.123
High income	.350**	.116	.252**	.119
No. of adult	-.203**	.060	-.235**	.063
Mobility Impaired	-.665**	.129	-.661*	.131
No. of Bus stop in .5 mile buffer	-	-	.013**	.004
Fraction of .25 buffer area that is office	-	-	1.336*	.786
Fraction of .25 buffer area that is commercial	-	-	.696**	.252
Fraction of .5 buffer area that is institutional	-	-	1.059*	.612
Pseudo-R^2	0.154		0.167	
Log-likelihood	-305.914		-2049.807	
Sample size	2099			

*:significant at 90% confidence level; **: significant at 95% confidence level

Table 5-3. Tour Mode Choice for Medical Tours Estimation Results (Multinomial Logit Model)

For medical tour	Shareride 2				Shareride 3+				Walk-transit			
Base case is Drive alone	Base Model		Final Model		Base Model		Final Model		Base Model		Final Model	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	1.626	.664	2.693	3.485	-1.274	.913	.116	6.911	1.505	1.646	-34.720	13.251
No. of driver	-1.299**	.413	-1.777**	.489	-1.803**	.625	-4.349**	1.001	-1.710**	.552	-1.392*	.723
No. of vehicle	-.669**	.252	-.742**	.291	-.560	.466	.230	.572	-3.008**	.594	-3.955**	.833
No. of adult	.949**	.359	1.731**	.495	1.729**	.453	3.119**	.726	1.460**	.717	2.777**	.934
Mobility Impaired	1.139**	.313	1.262**	.353	.444	.564	-.064	.790	1.005*	.526	1.365**	.683
Live alone	-2.070**	.475	-1.560**	.569	-.971	.752	-.800	1.049	-1.427	1.048	-.376	1.234
Street Connectivity												
No. of intersection in .25 mile buffer	-	-	.008	.013	-	-	.064**	.031	-	-	.041	.026
No. of cul-de-sacs in .5 mile buffer	-	-	-.012	.017	-	-	-.088*	.046	-	-	-.110**	.055
CNR 1 mile buffer	-	-	.849	3.805	-	-	3.536	7.313	-	-	39.096**	13.769
Density												
Net population density tract level	-	-	-.443**	.143	-	-	-.805**	.364	-	-	.268	.260
Net house density tract level	-	-	-.268**	.131	-	-	-.585	.365	-	-	.323	.207
Net job density block group level	-	-	-.092	.142	-	-	-.584	.385	-	-	.466**	.220
Diversity												
MDI tract level (1000unit)	-	-	2.552**	.805	-	-	5.611**	2.150	-	-	1.201	1.603
Fraction of .25 buffer area that is developed	-	-	-.463	.851	-	-	2.304	1.834	-	-	5.907**	2.203
Fraction of .25 buffer area that is office	-	-	-5.748*	2.997	-	-	5.414	4.946	-	-	16.772**	7.160
Entropy Index .25 buffer	-	-	.081	.859	-	-	1.182	1.951	-	-	6.053**	2.144
Fraction of .5 buffer area that is residential	-	-	-.727	.878	-	-	5.957**	2.061	-	-	-2.360	1.773
Fraction of .5 buffer area that is commercial	-	-	-2.350**	1.571	-	-	9.344**	3.093	-	-	6.224	3.949
Pseudo-R^2	0.208		0.398									
Log-likelihood	-190.356		-452.196									
Sample size	354											

*:significant at 90% confidence level; **: significant at 95% confidence level

Table 5-4. Tour Mode Choice for Maintenance Tours Estimation Results (Multinomial Logit Model)

For maintenance tour	Shareride 2				Shareride 3+				Non-motorized				Walk-transit			
Base case is Drive alone	Base Model		Final Model		Base Model		Final Model		Base Model		Final Model		Base Model		Final Model	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	4.009	.821	1.125	1.991	1.868	.864	-.637	3.177	1.255	.894	1.107	3.192	1.971	1.566	-8.027	13.228
Male	-.091	.142	-.167	.163	-.540**	.251	-.721**	.305	.125	.210	.050	.250	-.884	.548	-2.590**	1.153
high income	-.376**	.166	-.408**	.198	-.145	.285	-.789**	.379	.349	.241	.421	.313	-20.169	0.001	-21.616	0.001
No. of driver	.656**	.209	.651**	.253	.372	.329	.553	.430	.776**	.331	.074	.417	.647	.648	.850	1.249
No. of vehicle	-.636**	.123	-.635**	.139	-.581**	.208	-.607**	.255	-.235	.166	-.056	.187	-3.215**	.539	-3.178**	.946
No. of adult	-.135	.198	-.129	.210	.383*	.224	.634**	.292	.016	.271	.244	.330	.491	.638	1.147*	.698
Drive Impaired	1.717**	.587	1.392**	.623	2.052**	.647	1.575**	.731	.228	.828	.091	.887	1.721**	.746	2.412*	1.285
Driver License	-4.039**	.762	-4.118**	.783	-4.064**	.819	-4.169**	.878	-4.480**	.827	-3.811**	.886	-3.271**	1.081	-3.104*	1.587
live alone	-1.768**	.262	-1.964**	.301	-.969**	.373	-.210	.450	.663**	.323	.425	.417	-.704	.839	1.007	1.157
Street Connectivity																
No. of cul-de-sacs in .25 mile buffer	-	-	-.031	.023	-	-	-.074	.046	-	-	-.037	.032			-.298**	.122
No. of cul-de-sacs in .5 mile buffer	-	-	.008	.014	-	-	-.006	.026	-	-	-.061**	.022			-.097	.074
No. of cul-de-sacs in 1 mile buffer	-	-	.005	.004	-	-	.009	.008	-	-	-.016**	.007			-.010	.033
CNR .5 mile buffer	-	-	3.289	2.039	-	-	-3.819	3.557	-	-	11.347**	3.751			1.163	15.262
CNR 1 mile buffer	-	-	-1.422	2.809	-	-	4.224	5.159	-	-	12.420**	4.542			2.504	23.241
Transit Accessibility																
No. of bus stops in 1 mile buffer	-	-	-.004	.003	-	-	.004	.004	-	-	.003	.004			.043**	.017
Regional Accessibility																
Distance to Activity Center	-	-	.021	.024	-	-	-.057	.044	-	-	-.031	.034			-.313**	.154
Density																
Net house density block level	-	-	-.031	.070	-	-	-.025	.106	-	-	.250**	.077			.323	.235
Net population density block level	-	-	-.017	.042	-	-	-.016	.071	-	-	.169**	.050			.270	.219
Diversity																
MDI tract level (1000unit)	-	-	1.474**	.656	-	-	-.532	1.103	-	-	1.962*	.837	-	-	1.664	2.330
Fraction of .25 buffer area that is residential	-	-	1.833**	.614	-	-	-1.826*	1.067	-	-	1.858*	1.093	-	-	6.359*	3.538
Fraction of .25 buffer area that is office	-	-	2.269	1.702	-	-	-6.599	4.314	-	-	5.783**	1.982	-	-	8.833	7.784
Fraction of .5 buffer area that is residential	-	-	-.643	.652	-	-	4.648**	1.204	-	-	-.864	.937	-	-	-7.037*	3.907
Pseudo-R^2	0.139		0.238													
Log-likelihood	-769.401		-1845.398													
Sample size	1331															

*:significant at 90% confidence level; **: significant at 95% confidence level

Table 5-5. Tour Mode Choice for Discretionary Tours Estimation Results (Multinomial Logit Model)

For discretionary tour	Shareride 2				Shareride 3+				Non-motorized			
Base case is Drive alone	Base Model		Final Model		Base Model		Final Model		Base Model		Final Model	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Constant	2.664	.759	6.003	1.492	1.349	.797	4.729	1.757	2.170	.809	4.927	1.692
weekend	.256*	.157	.298*	.165	.083	.195	.005	.208	-.507**	.196	-.589**	.210
Male	-.155	.155	-.210	.163	-.595**	.197	-.677**	.206	.229	.182	.195	.194
No. of driver	-.185	.300	-.374	.315	-.459	.352	-.471	.378	-.663**	.328	-.793**	.348
No. of vehicle	-.169	.118	-.164	.126	-.143	.149	-.085	.155	-.432**	.150	-.403**	.157
No. of adult	.069	.305	.245	.324	.669**	.336	.679*	.360	.722**	.328	.864**	.352
Mobility Impaired	.363	.229	.306	.249	.399	.264	.476*	.285	-.122	.268	-.173	.293
Driver License	-1.729**	.603	-1.826**	.675	-1.932	.633	-2.102**	.706	-2.057**	.616	-2.272**	.690
live alone	-1.825**	.322	-1.747**	.342	-.738**	.357	-.718*	.382	-.518	.353	-.353	.379
Street Connectivity												
No. of cul-de-sacs in .25 mile buffer	-	-	.046**	.021	-	-	.023	.026	-	-	-.047*	.026
No. of cul-de-sacs in .5 mile buffer	-	-	-.023**	.008	-	-	-.010	.010	-	-	-.025**	.010
CNR 1 mile buffer	-	-	-4.068**	1.533	-	-	-4.409**	1.900	-	-	3.283*	1.780
Transit Accessibility												
No. of bus stops in 1 mile buffer	-	-	.009**	.003	-	-	.006	.004	-	-	.008**	.003
Density												
Net house density block level	-	-	-.093	.061	-	-	-.086	.069	-	-	.238**	.088
Net population density block level	-	-	.062*	.036	-	-	.057	.041	-	-	.080*	.045
Net population density tract level	-	-	-.120	.095	-	-	-.235**	.115	-	-	.142	.110
Net job density tract level	-	-	.149	.180	-	-	.437**	.219	-	-	.077	.220
Net house density tract level	-	-	.125	.079	-	-	.151*	.089	-	-	.199**	.089
Diversity												
Fraction of .25 buffer area that is commercial	-	-	.804	.720	-	-	1.986**	1.013	-	-	.613	.841
Fraction of .5 buffer area that is commercial	-	-	.473	.904	-	-	2.495**	1.023	-	-	1.057	1.004
Fraction of .5 buffer area that is office	-	-	.362	1.741	-	-	2.295	1.986	-	-	4.683**	1.743
Pseudo-R^2	0.065		0.095									
Log-likelihood	-798.977		-2550.096									
Sample size	1230											

*:significant at 90% confidence level; **: significant at 95% confidence level

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BIOGRAPHICAL SKETCH

The author graduated from Tongji University in Shanghai with a bachelor degree in transportation engineering, and then attended the University of Florida as a graduate research assistant working with Dr. Ruth Steiner. He graduated with a Master of Science in civil engineering and a Master of Arts in urban and regional planning in the University of Florida in 2014 with a thesis “How the built environment interacts with elderly travel behavior: an activity-based approach from southeast Florida”, He has also worked with other research topics such as impact of land-use on VMT, travel behavior with High-occupancy/tolled lanes, pedestrian access range to transit station, etc.