Travel Preferences and Choices of University Students and the Role of Active Travel

Travel Preferences and Choices of University Students and the Role of Active Travel

By

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A Thesis

Submitted to the School of Graduate Studies

in Partial Fulfillment of the Requirements

for the Degree

Master of Art

MASTER OF ARTS (2011)
(School of Geography and Earth Sciences)

McMaster University
Hamilton, Ontario, Canada

TITLE	Travel Preferences and Choices of University Students and the Role of Active Travel
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NUMBER OF PAGES	iii, 85

ABSTRACT

The increased focus on the importance of active travel within a community to improved social, economic and environmental sustainability has facilitated discussion and questions about how to best encourage those who take a personal automobile to switch to an active mode of travel. In attempting to answer this question, it is first important to understand that there are a variety of factors that impact an individual's decision to take a certain mode of transportation. This study attempts to determine which factors have the largest impact on students' decisions to take an active mode of transportation within a university setting.

Through investigation of socio-demographic and attitudinal variables of university students, a comparison of ideal versus actual commute time was modeled. Regression analysis was applied to test the relationship between the ratio of ideal to actual commute time and the individual's socio-demographic variables and attitudinal scores. Research using discrete choice analysis further provided more detailed evidence of specific factors affecting student's decision to choose an active mode of travel based on the level of utility they obtained by each mode as a function of attitudes, the built environment and socio-demographic variables.

The results obtained from this study contribute insight and support for initiatives aimed to increasing active modes of travel by students in university settings.

Recommendations are provided that can be adopted at the institutional and municipal level of both policy and planning to increase uptake of active modes of travel.

ACKNOWLEDGEMENTS

I would like to acknowledge those who contributed to this Masters thesis:

Thank you to Dr. Antonio Paez for all of your support and guidance throughout the duration of my studies at McMaster. It has been both a pleasure and honour to have worked with you and learned from you.

To all of the researchers who contributed to this thesis by collaborative research efforts to create the second and third chapters of this study, I am sincerely appreciative.

Thank you to all of the authors of the works sourced within this paper who jointly contributed to constructing the basis of knowledge on the topic of sustainable transportation, which has enable other researchers, such as myself, to build upon and make further contributes to the discipline.

Thank you to the students who took the time and effort to respond to the survey which enabled this research to be conducted using all four modes of travel, including public transit, personal automobile and especially those modes of walking and cycling. The significance of these results is what sets this research apart from previous studies of students and employees at McMaster that were only able to focus on the personal automobile and public transit.

Support and assistance from McMaster's Office of the Registrar and Ethics Department was integral for effective survey distribution. Funding and support from McMaster's Security & Parking Services and their previous All-modes Commuting and Transportation (ACT) Office, as well as the Social Sciences and Humanities Research Council of Canada contributed to the response success through enabling the provision of an incentive-based survey.

To two of my most valued mentors, Terry Sullivan and Rob Cooper, who have supported and encouraged me throughout my studies and guided me in my career not only by being great bosses and by encouraging me to keep learning and growing, both personally and professionally, but by leading by example; I am truly grateful.

Last, but certainly not least, I wish to express my deepest thanks to my family. Thank you to my father, Ray, for the wonderful advice and guidance that, no matter how chaotic and ugly I presented the problem to be, always provided me with the simplest and most logical solution. To my mother, Sue, for never setting down her pompoms and for cheering me on around every corner and up every hill. Blake, thank you for your constant understanding when work and school took priority over eating and sleeping, when "working late" meant a nine-hour day at the office and then another nine hours in the lab, and when sleep deprivation and hunger helped me take crankiness to a whole new level – I couldn't have gotten through those times without you, or your wonderful coffee.

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STATEMENT OF CONTRIBUTIONS

It is important to highlight that a collaborative effort by various researchers was an essential part of the success of this study.

The initial survey, which was adopted from a similar survey designed by Prof. Patricia L. Mokhtarian and colleagues, was modified and extended by Dr. Antonio Páez in 2008. The survey was tested by graduate students at McMaster University, and Prof. Catherine Morency provided valuable advice regarding this version of the survey.

The main chapters of the thesis have been prepared in the form of co-authored journal manuscripts to recognize the contributions of various individuals.

In Chapter 2 a combined effort by Dr. Antonio Paez and myself was put forth to conduct a multivariate analysis to test the relationship between the ratio of ideal versus actual commute and altitudinal variables of survey respondents by mode. I was responsible for organizing the data, conducting the analysis, and interpreting the results, and preparing the initial manuscript.

The work presented in Chapter 3 evolved after discussions with Prof. Juan A. Carrasco. Mr. Felipe A. Sanhueza prepared the database used in the analysis. I conducted the analysis of the data and the analysis of the results. I was also the lead author of the initial and final versions of the manuscript.

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Chapter 1 Introduction

1.1 Sustainability and Transportation

The most widely accepted definition of sustainability, following the Brundtland Report of 1987, encompasses not only the environmental, but the social and economic impacts of our decisions. The importance of sustainability to not only the local, but global environments, populations and economies is becoming ever more important as our dependence on non-renewable resources increases; health impacts associated with sedentary lifestyle, poor air and water quality worsen; and as economic constraints related to competing priorities of where to allocate government funds continues. To ensure sustainable development, there is a requirement that policy makers, planners, organizations, and individuals take a holistic view when evaluating the impacts of their decisions on our communities and countries, with respect to the environment, society and the economy.

One of the main topics of discussion at all levels of government, and an issue that is faced by every individual, is that of transportation. In North America, transportation is one of the highest contributing sources of greenhouse gas emissions (Marsden and Rye, 2010; Schmidt and Meyer, 2009; Unger et al., 2010); has societal impacts on individual health, family spending, and personal wellbeing (Frank et al., 2004; Heart and Stroke Foundation, 2010; DeLeire and Kalil, 2005; Anable and Gatersleben, 2005); and has a substantial proportion of government and institutional spending allotted to the maintenance and expansion of its infrastructure (May et al., 2000; May and Crass, 2007;

Metrolinx, 2010; Walkinginfo.org, 2011; Ministry of Transportation of Ontario, 2010). A shift from an automobile-based society to one with increased use of active modes of transportation, such as walking and biking is growing in importance. As it is understood that this shift will benefit the local and global environments, societies and economies, we find that governments, institutions, groups, and organizations alike are investing time and money to encourage this shift to take place. Specific to this study, post secondary institutions are one key area worth investigating further (Khattak et al., 2011; Lovejoy and Handy, 2011).

1.2 Motivation of the Study

University settings present valuable research opportunities for several reasons.

First, universities are major trip attractors that have a great deal of infrastructure to support large volumes of commuters (Lovejoy and Handy, 2011), and promotion of transit and active travel aligns well with institutional sustainability goals[1], in addition to having an impact on the broader community. Campus transportation issues have in fact become a prominent object in the research agenda in various countries (e.g. Al-Rukaibi et al., 2006; Kamruzzaman et al., 2009; Rodriguez and Joo, 2004; Sanches and de Arruda, 2002; Shannon et al., 2006; Tolley, 1996). McMaster University is a major destination in Hamilton, and the campus is served by a terminal for regional transit as well as a network of bus stops for local transit. In addition, the City of Hamilton maintains bicycle lanes surrounding the university. McMaster has a well-developed system for bicycle parking, including public bicycle racks, a medium security bicycle storage facilities with a

[1] At McMaster, see http://www.mcmaster.ca/sustainability/

capacity of 48 bicycles, and twenty individual bicycle storage lockers. McMaster also has a pedestrian-priority main campus to support walking and pedestrian safety.

Secondly, individuals traveling to university facilities are part of a population segment of special interest. One key aspect of studying university populations within the general population are statistics that show higher usage rates of active forms of transportation among university students, to that of the general population which tends towards the use of a personal automobile (Khattak et al., 2011). Studying university populations is ideal for an exploration of attitudes to traveling by different modes, because of a good representation of the modes of interest. This allows the analysis to consider every mode without sacrificing less reported modes (Diana, 2008, p. 471; Rodriguez and Joo, 2004, p. 156). Lovejoy and Handy (2011), for instance, point out that campus settings, with their larger cycling populations, permit the study of a mode that would otherwise be difficult to capture. While this is not by any means representative of the modal shares of the general population in the host city, the dataset is suitable because it depicts a situation where no single mode completely dominates the picture (see Rodriguez and Joo, 2004, p. 156).

Thirdly, university towns are shown to support mixed land-use characteristics whereby amenities are located in close proximity to the main campus. For instance, Khattak et al. (2011) highlight that “university communities represent liveable environments that are alternative-mode friendly, higher density and mixed land use”, and that “exploration of students’ behavior can be instructively and reveal valuable information about associations with the built environment and the extent of differences in travel compared with the general population".

Last, but not least, universities have an immense potential to influence a large proportion of the future leaders, decision makers, planners, policy makers, and ultimately the society that will live, learn, work and play in our cities and communities.. Developing a better understanding of the travel behavior of students can help to generate valuable information about factors that sustain the habit of using active transportation. Developing a culture of sustainability within the university setting through both education and by providing programs and infrastructure to support sustainable behavior is integral to encourage sustainable decisions beyond graduation.

1.3 Context for Study and Materials

The case study for this research is McMaster University located in Hamilton, Canada. McMaster is a land-locked urban campus with a total undergraduate student population (at the time of the study) of approximately 23,000, facing increasing space pressures as parking space directly competes with other valuable uses of space for teaching, research, and administrative activities. Created in 2002 and tasked with the goal of reducing parking demand on campus, McMaster's All-modes Commuting and Transportation (ACT) Office became active in the promotion of walking, cycling, carpooling and public transit. In 2008, the ACT Office was folded into one of the seven areas of focus for a newly created Office of Sustainability. With the main objective of developing a culture of sustainability at McMaster University, the Office of Sustainability promotes the use of active and sustainable forms of transportation by providing a variety of transportation options and infrastructure to encourage sustainable commuting. Sustainability at McMaster considers not only environmental, but the social and economic impacts of our decisions. The data collected and analyzed in this study are intended to provide information for McMaster to effectively implement initiatives that will be sustainable in the most holistic sense of the definition.

In order to assist with the examination of travel by individuals commuting to McMaster University, data were collected as part of a student travel behavior survey conducted in McMaster University between the months of February and March of 2008[2]. The data collection instrument was based on the survey designed by Moktharian and colleagues and employed in the studies in California (Mokhtarian and Salomon, 2001; Redmond and Mokhtarian, 2001; Mokhtarian et al., 2001; Ory and Mokhtarian, 2005; Choo et al., 2005; Cao and Mokhtarian, 2005; Ory and Mokhtarian, 2009). An important difference between Mokhtarian's survey and the survey used at McMaster is the mode of delivery. Whereas the original survey was a mail-in questionnaire, the survey used at McMaster was web-based only. This decision was made in order to keep the cost low[3] and to facilitate the processing of the data. Web-based surveys are occasionally criticized because bias could be introduced if certain segments of the population tend to be less computer-literate (e.g. seniors) or if they lack access to computers (e.g. low income households). In this case, the target population was the student body in an institution of

[2] The survey was not administered to faculty and staff because these segments of the university community were the target of a concurrent survey on telecommuting.

[3] The total budget available to conduct this research was $1,000…Canadian

higher education where all students are familiar with computer technology, have access to computing equipment in campus, and most own personal computers.

The original questionnaire provided by Prof. Mokhtarian was updated and adapted for use in a university setting. The questionnaire was pretested in the following ways (see Martin, 2005): 1) by means of expert appraisal and review (by A. Páez and C. Morency[4]); 2) the survey was tested by a group of nine graduate students who were debriefed to validate the interpretation of terminology and intent of questions; and 3) a pilot survey was distributed to 3,019 students in nine Geography and Earth Science courses in the Fall of 2007, to verify the usability of the data for modelling purposes.

Following pretesting, the data collection protocol for the final version of the survey was determined as follows: An e-mail address list was obtained from the university's Office of the Registrar, which included in addition to the address the first name of each student. No other information was requested from the university. The mailing list contained a total of 23,376 records. An invitation to participate in the survey was sent electronically by e-mail to all undergraduate students in the address database, or in other words, to all students registered for the academic term in 2008. The letter was automatically sent as a mass e-mail, but was "personalized" by addressing it to the name of the student which was drawn from the student database. Subsequently, two reminders were sent to students who had not yet at that point completed the survey. Prizes were offered to encourage participation: one electronic portable music player, and four gift

[4] Prof. Morency is assistant professor in École Polytechnique de Montréal and is directly in charge of the Montreal Metropolitan Area travel survey, one of the world's largest recurring travel surveys.

certificates, two for CAD 50 and two for CAD 25. The response rate for the McMaster survey was 22%, compared to 25% in Redmond and Mokhtarian (2001). Response rates in this range are very common in transportation research (Larson and Poist, 2004). After cleaning the database (e.g. by removing responses from students who lived in-campus, incomplete surveys, nonsensical responses), a total of 1,251 usable surveys were retained. This number of responses is very similar to that reported in Redmond and Mokhtarian (2001), is well within standards for sampling errors of less than 3%, and represents slightly better than a 5% sample of the student population in our case study.

The survey included questions designed to elicit information about the travel behavior of respondents. Respondents were asked about their chosen mode of transportation on the last day they went to school and the characteristics of the trip (e.g. number of transfers for bus users). To avoid bias towards the influence that daily weather characteristics would have on survey responses, the email invitations were sent on alternate dates to sections of the undergraduate population based on alphabetical listing by name. Based on the mode they chose, respondents were then asked to state which other modes would have also been a reasonable alternative on that day. Links for respondents to access web-based trip calculating tools were provided to assist respondents in answering questions relating to both their chosen mode and their available alternatives, such as the actual travel time from home to school by each available mode. In addition, the survey asked respondents about their basic socio-demographic information, including age and gender, program and level of studies, employment status, and, since many students work in campus, their place of work. With respect to living arrangements, students were asked if their place of residence during the academic term was with their family, in a university residence, or in other shared or solo accommodations outside campus. The postal code and/or nearest intersection were also asked in order to geo-reference the observations. The majority of respondents were determined to be local, but there were some commuters from the Greater Toronto Area and the Niagara region as well (see Figure 1.1). Respondents living with their families were additionally asked about the number of household members, the presence of children in the household, and whether they are the primary caregiver for children in the household. All participants were asked about the availability of certain modes of transportation, for example, or being able to walk to campus, having access to a car or to public transportation (i.e. buses). As well, respondents were asked about their visa status in order to identify domestic and international students.

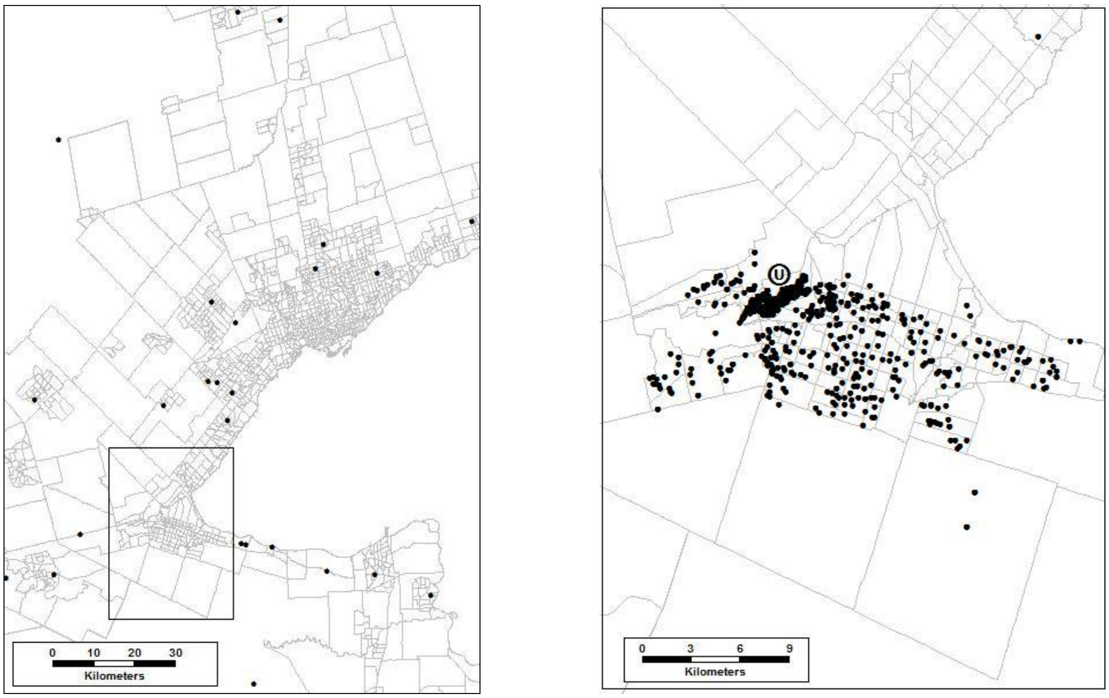

Figure 1.1 Study area and spatial distribution of responses (n=1251)

Table 1.1 Attitudinal variables: response frequency by class (in percentage)

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Traveling makes me nervous	30	47	16	6	1
The personal vehicles I usually travel in are comfortable	0	3	14	63	20
"Getting there is half the fun"	6	24	38	28	5
I like to live in a neighborhood where there's a lot going on	2	20	30	37	10
I often worry about my safety when I travel	16	45	20	16	2
My commute trip is a useful transition between home and school	4	21	38	31	6
We need more public transportation even if taxes have to pay for a lot of the costs	3	19	27	37	14
I like traveling alone	4	25	39	27	4
I use my commute time productively	8	30	34	23	5
The buses I usually travel in are comfortable	4	20	31	41	3
I feel safe and secure when walking in my neighborhood	0	5	14	56	25
I know my neighbors well	19	36	22	19	4
There is a sense of community in my neighbourhood	6	24	34	32	5
Shelters and other public transportation facilites that I commonly use are of good quality	5	22	35	35	3

Another aspect of the survey of direct interest for this research is the set of questions regarding the attitudes of respondents towards travel, land use, and the environment. Information about attitudes was collected after Mokhtarian et al. (2001) by means of attitudinal statements that respondents were asked to assess using a five-point, Likert-type scale from “strongly disagree” to “strongly agree”. The intention of the attitudinal variables is to provide information regarding various factors that could influence the commute experience by transforming it into something more or less enjoyable. A list of attitudinal variables used appears in Table 1.1. Some statements tend to lead to relatively symmetric distributions with “Neutral” as the mode. For instance, roughly as many respondents agree as disagree with the statement “Getting there is half the fun” (32% and 30% respectively). Other statements elicit stronger opinions. For example, 77% of respondents disagree or strongly disagree that traveling makes them nervous. And while 83% of respondents agree or strongly agree that the personal vehicles they use are comfortable, only 44% agree or strongly agree that the public buses they use are comfortable. 85% of respondents feel safe and secure walking in their neighborhood. Two other statements intended to elicit responses regarding the local social environment also display skewed distributions, since 37% agree or strongly agree that there is a sense of community in their neighborhood, and only 23% agree or strongly agree that they know their neighbors well.

1.4 Objectives of the study

The objectives of this study are three-fold. First, to determine the level of enjoyment found by students toward each mode of personal automobile, walk/cycle, and public transit. Second, determine which factors cause students to choose a specific mode over the other available options. Third, propose policy and planning measures that could be implemented to help foster and encourage the use of active modes of travel.

1.5 Organization of the thesis

In Chapter 2, the focus of the thesis is on investigating the possibility that travelers find a measure of enjoyment in their daily commute. Operationally, this is done by comparing three different transportation modes: personal automobile, walk/cycle, and public transit. The target of the analysis is a variable defined as the ratio of ideal to actual commute time; this ratio is interpreted as a desire for more (if ideal exceeds actual commute time) or less (if actual exceeds ideal commute time) time spent commuting. Regression analysis is used to test the relationship between this variable and a wide array of socio-demographic variables and attitudinal scores. The findings of this study support the hypotheses that wanting to travel more or less is, at least partially, determined by commuter attitudes toward travel. The results indicate that those who walk tend to be less dissatisfied with their commute, followed by those who drive a personal automobile and transit users. Furthermore, a number of attitudinal responses are shown to impact the desire to travel more or less, including variables that relate to the social environment, availability of local activities, quality of facilities, productive use of the commute, and the intrinsic value found in the commute travel.

Chapter 2 provides evidence of the factors that influence the enjoyment of the commute experience. However, the question remains of what influences the decision to travel by a specific mode. The logical step then is to investigate the modal choice of individuals. The objective of Chapter 3 is to study the decision of traveling by different modes available to students, including two motorized modes (car and bus) and two active modes (walk and cycle). This study evaluates the reasons why students choose one mode over the other available options by determining which factors influence their decision. Through discrete choice analysis and the investigation of a variety of demographic, neighbourhood and attitudinal factors affecting mode choice, determination of those factors which have the greatest impact on utility of travel by mode was achieved. Findings from this chapter show that the following variables have a significant impact on the level of utility associated with each mode: travel time, owning a parking permit, access time, living solo, living shared, street density, sidewalk density, agreeing that shelters are of good quality, agreeing that the personal vehicle is comfortable, strongly agreeing that the personal vehicle is comfortable, and strongly agreeing to enjoying solo travel. A noteworthy finding in this chapter is a positive utility of time spent traveling by bicycle.

The findings reported in Chapters 2 and 3 provide valuable information about the travel behaviour of students in a university campus, and in particular the role of active travel. Chapter 4 provides a summary of finding of this thesis and a list of recommendations to policy makers and planners on ways to increase the use of active modes of travel. In addition, a list of suggested next steps is outlined as recommendations for future research.

Chapter 2 Analysis of ideal and actual commute time by different modes of transportation

2.1 Introduction

The focus to create policy and gear planning decisions to promote sustainable transportation patterns remains as important as ever, with traffic congestion and commuting times on the rise (Ory et al., 2004; Turcotte, 2005) and the price of oil in the world market becoming ever more uncertain (Almeida and Silva, 2009). The search continues to identify policies that can effectively entice people out of their personal vehicles and into a train or a bus, or to encourage them to use active modes such as walking or cycling. At the root of many policies aimed at influencing travel behavior is the persistent notion that the daily commute is stressful and that any type of commuting is viewed negatively (Lucas and Heady, 2002). Traditional theories found in the economics, planning, and engineering literatures deal with the idea that transportation is a derived demand with the only purpose of getting an individual from origin to destination, or from activity to activity. Under this light, the time spent traveling is always a disutility, a cost to be paid in order to reach spatially dispersed activity locations. This statement, however, may not be true for all, and it has been argued that there may be many who pay this cost gladly, in fact finding a measure of enjoyment and utility in the act of traveling.

The idea that some commuters actually enjoy their commute trip has been explored in the literature, starting with Mokhtarian and Salomon's (2001) argument that instead of the activity generating the trip, it may be the trip that generates the activity.

Recent research tends to support this proposition with findings showing that a positive utility is found even in the most utilitarian of trips, the commute to work (Mokhtarian et al., 2001; Ory and Mokhtarian, 2005; Redmond and Mokhtarian, 2001). There are many different ways commuters may find positive utility in the time spent transitioning between their home and work. Listening to music or audio books, enjoying the scenery, talking on the phone, or sleeping, are just a few of the ways the commute can be made enjoyable and/or useful (Handy et al., 2005; Larson, 1998; Mokhtarian and Salomon, 2001; Salomon and Mokhtarian, 1997). However enjoyable, it is critical to recognize that a positive utility of time spent traveling presents an important challenge to transportation planners, since the implication, as noted by Choo et al. (2005) is "that sizable proportions of the population will be relatively unreceptive to policies intended to motivate reductions in travel". The question must be asked: what is it that makes people enjoy commuting? An improved understanding of the attitudes and behaviors of commuters is a necessary condition to the creation of effective policies intended to encourage more efficient use of transportation. By examining the attitudes of commuters and their opinions about the utility of travel, recommendations can be made as to how policy makers and planners can optimize their efforts to promote more sustainable travel behavior.

Along these lines, the objectives of this chapter are as follows:

1) This is the first time that the survey employed to collect the data analyzed in Redmond and Mokhtarian's influential paper[5] is replicated in a different setting. The results, as shall be seen, provide independent confirmation of the effect of "enjoyment of commuting", or more accurately, a desire to spend more time commuting.

2) Substantial work on the enjoyment of commuting has been conducted in the context of automobile-dominated situations. In some cases, the results regarding the mode of transportation have not been significant (Redmond and Mokhtarian, 2001, see p. 202 and endnote 6). This has left a gap in the literature that other studies have strived to fill by highlighting the importance of the potentially positive affective associations with other modes of transportation, especially walking and cycling (e.g. Anable and Gatersleben, 2005; Gatersleben and Uzzell, 2007; Turcotte, 2005). The attitudes of people towards modes other than car in particular and travel in general, are important factors that policy makers should consider if the intent is to increase transit ridership, walking, or bike use. This research investigates the specific features that elicit positive or negative reactions related to commute time by various transportation modes.

In concrete terms, the analysis helps to uncover the attitudinal variables that impact the difference between actual and ideal commute time, or in other words, a

[5] According to ISI Web of Science, Redmond and Mokhtarian (2001) is the 2nd most cited paper (out of 20) published in the journal Transportation in 2001, and the 14th most cited of 1,021 papers published in 2001 in journals with "Transportation" in the title.

person's desire to spend more or less time commuting, from the perspective of three modes: walking, transit, and car. As discussed by Redmond and Mokhtarian (2001, p. 184), consonance between these two measures of travel time (actual and ideal) would be indicative of satisfaction with the commute experience, whereas deviations in either direction would represent dissatisfaction. More specifically, a positive deviation is interpreted as a desire to spend more time commuting, and a negative deviation as a desire to spend less time commuting. It is hypothesized that people tend be more satisfied, or may even wish to spend more time commuting, when traveling by car or active modes (walking/cycling) because they have a greater amount of control over their travel and are able to interact with their environment. On the contrary, greater dissatisfaction and a consequent desire for shorter commutes are expected for transit, because of the association with lack of flexibility, long waiting times, and the unpredictable nature of transit.

2.2 Background

Mokhtarian and Solomon (2001) state that the "utility for travel has three components: the utility for the activity at the destination, the utility for activities that can be conducted while traveling and the enjoyment of the act of travel itself". Assuming that the utility of the activity at the destination can be controlled, the utility of traveling depends on whether pleasurable or enjoyable activities can be conducted during the trip, and on the perception of the trip itself as being somehow desirable or beneficial.

With respect to the act of traveling, activities conducted while traveling that may increase utility include talking on a mobile phone, browsing the internet through mobile and wireless devices, conversing with other passengers, listening to books on tape, listening to music, news or talk shows on the radio, reading, or even sleeping (Handy et al., 2005; Larson, 1998; Mokhtarian and Salomon, 2001). Some individuals use their commute time to think and relax, and may consider this a time to 'shift gears' and a useful transition between home and the workplace (Mokhtarian and Salomon, 2001). In an attempt to decrease any negative aspect of commuting, many individuals adopt coping mechanisms that increase the amount of benefit the commute can provide. This concept is discussed in detail by Larson (1998), who describes how individuals customize their commuting environment to allow their travel time to be as enjoyable and productive as possible. Mobile communications make it possible for commuters to talk to friends and family, book appointments and make other personal phone calls as well as to use the commute time to work by conversing with co-workers or clients while driving. Other, more recent advancements in technology, allow commuters to talk, hands free, on their mobile phones, check email and surf the internet on their in-car computers, watch television screens that are installed directly into the vehicle console and plan their trips with advanced Global Positioning Systems (GPS) software – all within an arm's reach. These new technologies help individuals cope with the act of traveling and may even make it enjoyable.

The other component that may positively affect the utility of travel (i.e. travel for its own sake) is gained through intrinsic aspects such as the positive sensation of speed and movement through the environment, the scenic beauty of a landscape and interacting with the outdoors (Mokhtarian and Salomon, 2001). Traveling in an automobile allows an individual to experience variety, gain first-hand information about one's surroundings, the opportunity to exhibit a skill such as maneuvering a vehicle, or even use their travel time to escape for a period of time (Mokhtarian and Salomon, 2001). Furthermore, Mokhtarian and Salomon (2001) propose that the joy certain individuals find in undirected travel, such as motion, control and exposure to scenic beauty, may also be found in mandatory travel such as commuting. This provides reason to evaluate the connection between an individual's attitudes toward travel and their level of travel enjoyment with regards to their daily commute. It is important to determine not only the attributes that commuters define as providing utility in their travel, but also to find out which ones are most important to the individual (Johansson et al., 2006). In particular, Steg (2005) points out that "policy makers should not exclusively focus on instrumental motives, but they should also consider the many symbolic and affective values of various modes of transport". Anable and Gatersleben (2005), for instance, show that the affective responses of people who walk tend to be positive. This is the case of responses to "Stress", "Relaxation", and even "Freedom" compared to drivers. When compared to car, the responses are similar for "Excitement", and the only response that receives a more positive response for car is "Control".

The connection between affective values and travel behavior has been established in previous research. The literature identifies an extensive set of attributes that are generally important to people and that can be associated with reasons explaining why some find utility in travel. Mokhtarian et al. (2001) state that "a positive affinity for travel, like most characteristics, is universal to some extent, but distributed unevenly across the population, depending on personality, lifestyle, travel-related attitudes, mobility constraints, demographic characteristics and the mode and purpose of a particular trip". Enjoyment of commuting, an affective value, has received particularly extensive attention in studies, for example by citing the motto "getting there is half the fun" (Ory and Mokhtarian, 2005). Contrary to the popular conception that time spent traveling is a cost to be minimized, the research from California furnishes evidence that travelers find enjoyment in their daily commute. Redmond and Mokhtarian (2001), for instance, report that very few individuals in a sample of commuters in California express a desire to either avoid their commute altogether or a preference for very short commutes (1.2% reported an ideal commute time of zero minutes, and 0.6% reported an ideal commute time of 1-4 minutes). Ory et al. (2004) find that "only 40 percent of the sample dislikes (31%) or strongly dislikes (9%) commuting, while 21 percent actually enjoy the activity". This may be related to the ability of individuals to adopt coping strategies that help to reduce their stress and increase the productivity of their travel (Larson, 1998). Indeed, respondents who feel that their commute time is productive have been shown to display a much higher liking for their commute (Ory et al., 2004; Ory and Mokhtarian, 2005).

As previously noted, besides a few examples, most of the research done in the past two decades in terms of looking at personality, attitudes and behavior as it relates to travel, has been focused on the personal automobile and transit (Anable and Gatersleben, 2005; Gatersleben and Uzzell, 2007), as researchers concentrated on motorized mobility and strived to determine the factors that make car use apparently more enjoyable. Now that some evidence of a positive utility of commuting exists, and the symbolic, psychological and affective motives attached to car use are better understood (Steg, 2005), investigation should turn to analyzing the reasons for enjoying or not commuting by other forms of transportation (Redmond and Mokhtarian, 2001, p. 202). While relatively little has been reported with respect to active transportation, the existing evidence is tantalizing. A report by Turcotte (2005), notable for its use of a nationally representative sample of commuters based on Canada's General Social Survey, indicates that 38 percent of car drivers like commuting compared to 28 percent of transit users. In contrast, the percentage of people who like their commute is 47 for walkers and 57 for cyclists. Based on these statistics, active transportation seems to be more conducive to an enjoyable commute than any motorized mode. The question remains, are there any attitudinal factors that can help to explain these differences between modes? This is the objective of the analysis reported below.

2.3 Data and Methods

The focus of this chapter is on the difference between ideal and actual commute time. Ideal commute time was asked at the beginning of the survey, and actual commute time only much later in the survey to avoid rationalization bias (Redmond and Mokhtarian, 2001, pp. 183-184). The question was formulated in this way (after Redmond and Mokhtarian, 2001): "*Some people may value their commute time as a transition between home and school, while others may feel it is stressful or a waste of time. For you, what would be the ideal ONE-WAY DOOR-TO-CLASSROOM or DOOR-TO-SCHOOL OFFICE travel time (in minutes).*" Figure 2.1 is a histogram showing the distribution of ideal and actual commute times. Mean actual commute time is 23.91 min and mean ideal commute time is 13.50 min. These two variables are compared in Figure 2.2 by means of a scatterplot of actual versus ideal commute times by three modes of transportation: active transportation (walking/cycling), transit, and car. If these two measures of travel time were more or less consonant, most points would be near the 45 degree line. As it is, the scatter of points is disperse, with a majority of them falling under the 45 degree line, indicating a preference towards ideal commuting times that are shorter than actual travel times. Accordingly, this would be interpreted as a degree of dissatisfaction with actual commuting time on the part of many travelers. The pattern observed in these figures is strikingly similar to that observed in Figures 1 and 2 in Redmond and Mokhtarian (2001). Given the important contextual differences between the two studies, in terms of geographic setting (California and Canada), socio-demographic characteristics (residents of neighborhoods and university students), and temporal frame (1998 and 2008), the results in this study provide independent confirmation of the dissonance between ideal and actual commute times, and lend credence to the idea that this pattern may in fact be relatively common.

An important point to note with regards to the data relates to the utility of the trip, which, as discussed before, depends in part on the utility of the activity at the destination. This raises a key issue noted by Mokhtarian and Salomon (2001), who suggest that when individuals are asked about their feelings towards traveling to certain destinations they are not necessarily responding to the positive utility of travel, but are responding to their feelings about the destination. In other words, it is possible that the desire for longer trips can be confounded with the trade-off for higher quality activities at the end of the trip. An advantage of working with these sample data is that all travelers go to the same destination for the same objective. This means that the quality of the activity at the destination is more or less bounded, as opposed to a situation where respondents work or study at different firms/schools, in which case the quality of the experience at the end of the trip would presumably be more varied. The fact that all respondents travel for the same purpose to the same location increases the potential that any departures detected in the desired commute with respect to the actual commute can be related primarily to the activities during the trip and the trip itself, as opposed to primarily to the destination.

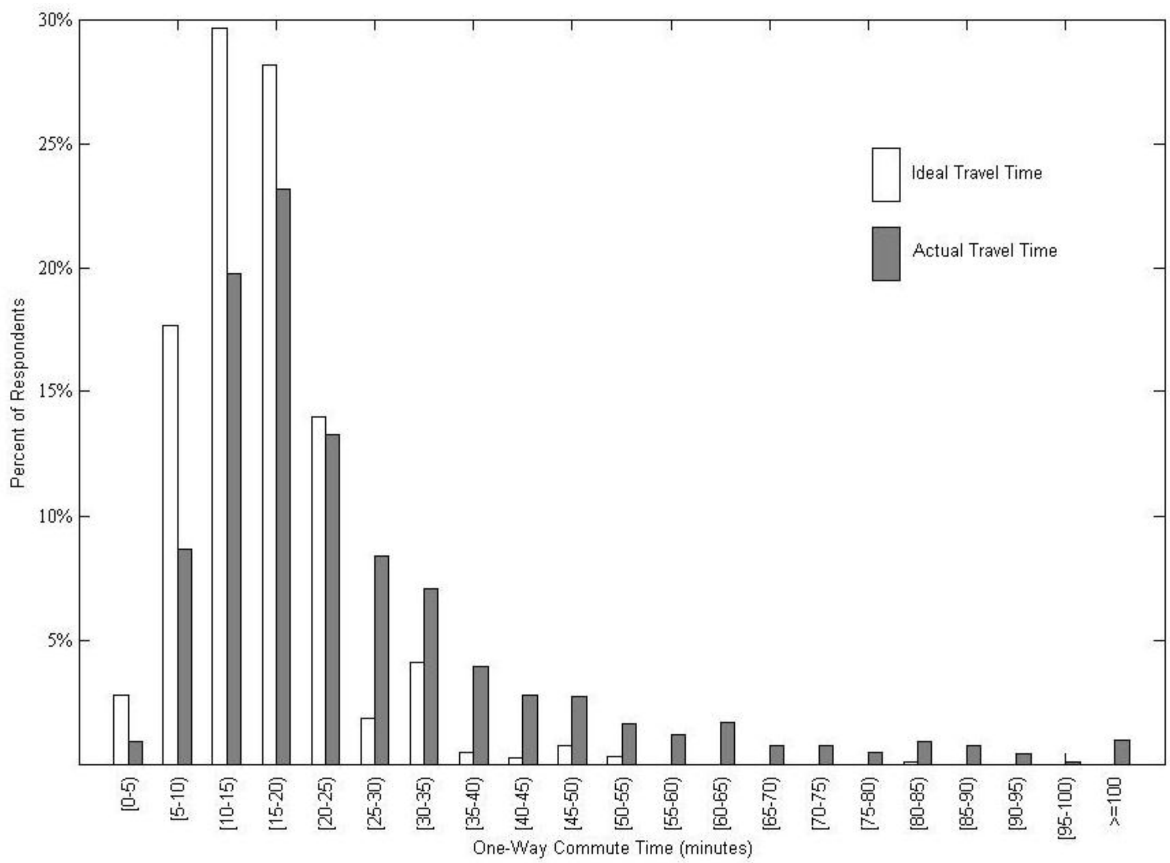

Figure 2.1 Actual versus ideal commute time by time category

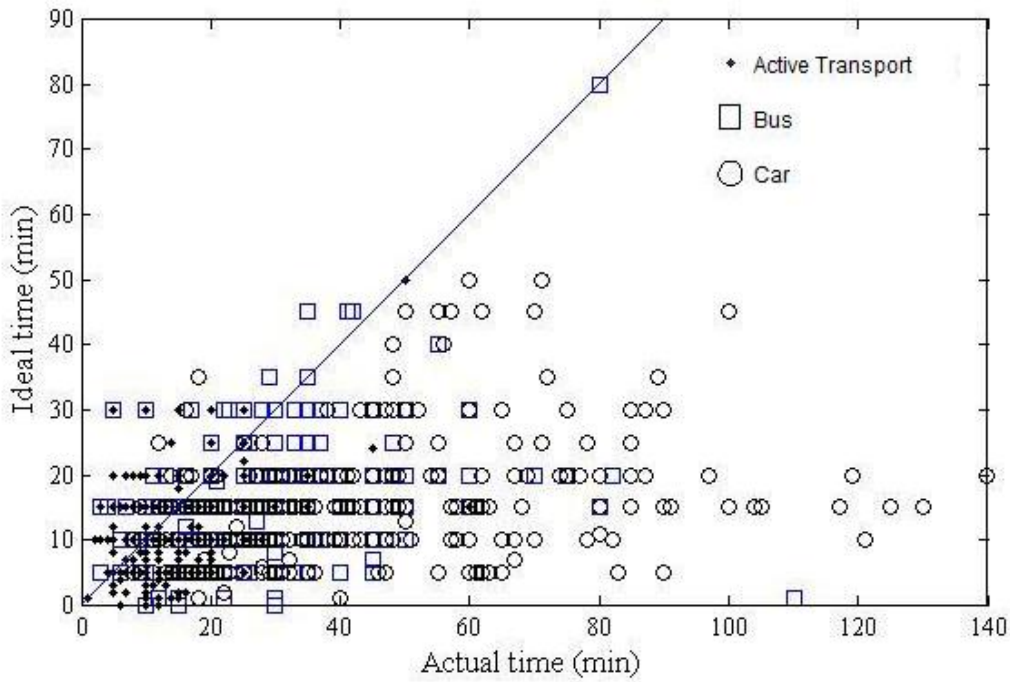

Figure 2.2 Actual versus ideal commute times by mode of transportation (n=1251)

2.4 Methods

Regression analysis is implemented to test the relationship between a set of explanatory variables and a dependent or objective variable. In previous research, Redmond and Mokhtarian (2001) modeled ideal commute time (*IT*). This was done using objective mobility (actual commute time or *AT*) as an explanatory factor in addition to other variables, and using a tobit model for censored variables (since *IT* is invariably equal to or greater than zero). In the present case, the dependent variable is defined as a ratio in the following way:

$$R = \frac{IT - AT}{AT} = \frac{IT}{AT} - 1 \qquad (2.1)$$

Note that in this definition, if a traveler is satisfied with her commute time, R is zero. In other cases, the value of R (positive or negative) is a measure of how much more or less the traveler would like to travel relative to actual commute time. $R \times 100$ is the percentage increase or decrease needed in actual travel time to meet the ideal commute time. The variable is not bounded at zero and the coefficients have a natural interpretation as percentage differences with respect to actual travel time. Analysis can be conducted using linear regression, by specifying the dependent variable as a function of a linear combination of K explanatory variables:

$$y_i = \sum_{k=1}^{K} x_{ki}\beta_k + \varepsilon_i \tag{2.2}$$

In this equation, x_1 is usually defined as 1 for all i to give a constant term, and ε_i is the usual random term. With regards to the attitudinal variables, it is possible that some attitudes will influence the response of the traveler with respect to some modes but not others. For instance, feeling safe and secure walking in the neighborhood could increase the enjoyment/utility of walking, but may not have an impact on the desire to travel more or less by car. Anable and Gatersleben (2005) present evidence that the affective response is in general not constant across modes of transportation. In order to determine the impact of different attitudes on the ratio of ideal to actual commute time by mode, the model was expanded by introducing interactions between the three modes of transportation and the different attitudinal scores. The model takes the following form:

$$R_i = \alpha + \sum_s \beta_s SD_{si} + ACTIVE\sum_w \varpi_w X_{wi} + BUS\sum_h \gamma_h X_{hi} + CAR\sum_c \theta_c X_{ci} + \varepsilon_i \tag{2.3}$$

SD are the socio-demographic attributes of the traveler (age, gender, visa status, etc.) *ACTIVE*, *BUS*, and *CAR* are indicator variables that take the value of 1 for the mode of transportation used by the traveler and 0 for the rest. The $X_{\bullet}$ terms are either a constant value or an indicator variable for one attitudinal score drawn from the pool of available variables (see Table 1.1). The same attitudinal score may appear in interaction with different modes. It is important to note that one constant term in the interaction terms must be set to zero in order to avoid perfect collinearity. In other words, one mode must be selected to act as a reference. Also, the attitudinal scores are not interval/ratio variables and therefore should be introduced as levels in the regression equation, and *not* as continuous variables. All variables used in the analysis are indicator variables, and therefore the coefficients times one hundred are interpreted directly as the percentage change in *R* expected due to belonging to a given class (mode, or mode-attitudinal response combination).

Preliminary exploration of the data revealed problems with non-normal residuals – unsurprisingly, given the skewed distribution of the dependent variable (see Figure 2.1), but nonetheless problematic from a modeling standpoint. In order to rein in on this problem, a set of auxiliary variables was introduced as part of the regression equation. Two indicator variables are used to identify regime changes in the regression equation. These variables are defined for commuters with extreme differences in their ideal and actual commutes, and for these variables we select the observations in the 90^{th} to 99^{th} percentile of the observations (109 observations) and the top one percentile (16 observations). The coefficients for these variables can only identify changes in the intercept of the regression function, and help to reduce the lack of normality detected in the error terms, but are otherwise uninformative. A third auxiliary variable is obtained that employs the information contained in the geographical references of the observations. The coordinates of geo-referenced variables can be used to define a matrix of spatial relationships **W**, typically representing the pattern of contiguities between spatial observations based on a Voronoi tessellation. This spatial weights matrix **W** is commonly used in the spatial statistics and econometrics literature to implement statistics of spatial autocorrelation or spatially autoregressive models (Anselin, 1988; Cliff and Ord, 1973; 1981; Getis, 2009; Griffith, 1988). In addition, Griffith (2000) demonstrates how **W** can be used to generate synthetic map patterns, or spatial filters, that can help to address the violation of key assumptions in regression analysis such as non-independent residuals. The procedure to generate a spatial filter is to obtain the eigenvectors of the following matrix:

$$\left(\mathbf{I}-\mathbf{1}\mathbf{1}'/n\right)\mathbf{W}\left(\mathbf{I}-\mathbf{1}\mathbf{1}'/n\right) \tag{2.4}$$

where **I** is the identity matrix, **1** is a $n \times 1$ vector of ones, and **W** is the contiguity matrix of the system. The *n* eigenvectors represent latent map patterns, and combinations can usually be found that proxy omitted variables responsible for regression residual problems. The precise selection and number of eigenvectors for a filter depends on statistical criteria. Since they are orthogonal and uncorrelated, it is possible to follow a step-wise procedure whereby an eigenvector is introduced into the model and its significance is tested. The first significant eigenvector (i.e. the first to achieve a regression coefficient with a *p*-value of less than 0.10), is multiplied by its corresponding coefficient and introduced as an explanatory variable in the subsequent search for additional eigenvectors. Other significant eigenvectors are incorporated as part of the filter by summing them, after multiplying by their corresponding regression coefficient, to the previous version of the filter. In this application, it was found that using a synthetic variable greatly helps to control the problem of non-normal residuals initially detected. In addition to assisting with the problem of non-normality, spatial filters help to ensure that the coefficients in the model are not afflicted by omitted variable bias (Greene, 2002). Further technical details regarding the use of spatial filters can be found in Griffith (2000; 2003), and Getis and Griffith (2002).

2.5 Results and Discussion

The results of the analysis appear in Table 2.1. An extensive specification search was started with an exhaustive set of explanatory variables that included socio-demographic attributes (gender, age, vehicle ownership, licensing status, level of studies, and visa status) and attitudinal scores. The search proceeded by removing from the model, in a stepwise fashion, variables with non-significant coefficients. The final model obtained in this way retained a number of attitudinal variables, but only one socio-demographic attribute, namely the visa status indicator that identifies domestic (Canadian) students, in addition to the indicator variables for mode of transportation.

Considering first the constant term of the model, it should be noted that the results indicate that other things being equal, the typical student commuter would like to travel approximately 32.4% less than she is currently doing, regardless of mode of transportation (see negative coefficient of the constant term). This is consistent with the pattern observed in the scatterplot in Figure 2.2. The desire for shorter commutes is slightly less pronounced for Canadian students. As seen in the table, being a Canadian citizen has a small but positive effect on the desire to spend time travelling. The results suggest that domestic students have (other things being equal) a preference for spending approximately 7.5% more time in their commute, thus reducing slightly the general desire to spend less time commuting. This positive effect may well reflect cultural differences with respect to travel and mobility relative to international students, particularly those coming from outside of North America, although lacking further information about the place of origin of respondents, this cannot be definitively concluded.

Table 2.1 Regression analysis of desire to commute by mode, socio-demographic attributes, and attitudes

VARIABLE	ESTIMATE	p-value
CONST	-0.3238	0.000
Canadian	0.0752	0.006
ACTIVE (WALK/CYCLE)	Reference	
Getting there is half the fun (SD)	-0.2278	0.00
Getting there is half the fun (SA)	0.1628	0.00
Commute trip is useful transition (A)	0.0304	0.04
Commute trip is useful transition (SA)	0.0789	0.01
I like to live in a neighborhood where there is a lot going on (A)	0.0656	0.00
I like to live in a neighborhood where there is a lot going on (SA)	0.0493	0.04
I like traveling alone (SD)	0.1106	0.00
Neighborhood is a community (SA)	0.0688	0.05
BUS	-0.2491	0.00
Commute trip is useful transition (SD)	-0.1497	0.01
Commute trip is useful transition (D)	-0.0662	0.02
Commute trip is useful transition (A)	-0.0622	0.01
I like traveling alone (D)	-0.0973	0.00
I like traveling alone (A)	-0.1279	0.00
I like traveling alone (SA)	-0.1648	0.00
Shelters and other bus facilities are good quality (A)	0.0825	0.00
Shelters and other bus facilities are good quality (SA)	0.2307	0.00
CAR	-0.2056	0.00
Getting there is half the fun (SD)	-0.1148	0.01
Getting there is half the fun (D)	-0.0833	0.00
Commute trip is useful transition (D)	-0.0696	0.01
I like traveling alone (D)	0.1286	0.00
I like traveling alone (A)	0.0979	0.00
I use my commute time productively (D)	-0.0473	0.06
I use my commute time productively (A)	0.0693	0.02
Extreme (90^{th} to 99^{th} percentile: 109 observations)	0.9703	0.00
Extreme (top percentile: 16 observations)	3.2994	0.00
Spatial filter	1.0000	0.00

R^2= 0.889, R^2_{adj}=0.867, s=0.206, n=1251

With respect to the effect of mode of transportation, it is noted that active travel was used as the reference mode in the analysis. Given this, it is clear that people who drive an automobile or ride transit wish in general to spend less time in their commute compared to students who walk or cycle to school. The table shows that car drivers would like to travel 20.6% less, and those who use public transportation would rather travel 24.9% less than they are currently doing. This result shows that dissatisfaction with the time spent commuting is a common experience; however, active travelers appear to be less dissatisfied with their commute than users of other modes. People who use public transit are, other things being equal, the least satisfied commuters in this analysis. The coefficients for mode relate to the direct effect of the form of transportation used on the desire for more or less commute time, and the results are consistent with previous findings, especially by Turcotte (2005), an author who reports that more transit users dislike their commute than car users; in contrast, about 50% of people who walk dislike their commute.

This analysis confirms the hypothesis that the effect of attitudinal responses varies across modes of transportation. Five attitudinal variables were found to be significant for active travelers, three attitudinal variables were significant for transit users, and three were significant for car users. Two attitudinal variables were significant across all three modes: "Commute trip is a useful transition" and "I like traveling alone". "Getting there is half the fun" was significant for walking/cycling and car, but not for transit. Other attitudinal variables were specific to modes. Interestingly, two attitudinal variables for active travel relate to the local environment: "I like to live in a neighborhood where there is a lot going on" reflects an attitude towards the range of activities available locally, whereas "There is a sense of community in my neighborhood" is associated with the social environment. "I know my neighbors well" was not significant, which is consistent with the findings of du Toit et al. (2007) in a case study of Adelaide, Australia, where a sense of community was shown to influence walking for transportation, but the relationship with social interaction (e.g. acquaintance with the neighbors) was less strong. One attitudinal variable for the case of transit relates to the quality of the facilities provided by the bus operator, including shelters. It is interesting to note that more respondents agree with the statement that buses are comfortable than agree that shelters and facilities are of good quality, and that level of comfort of the vehicles was not significant in the models. This result suggests that improving the quality of shelters should be a higher priority. As well, it may be related to the common finding that people tend to perceive time spent waiting for transit as being more onerous than time spent in the vehicle traveling. The last significant attitudinal score was associated with travel by car, and related to the productive use of the commute, a factor that is commonly cited in previous studies as being of interest for describing the positive utility of traveling.

One intriguing finding refers to the quality of the attitudinal responses for students using the different modes. Students who are active travelers and strongly agree with the statement "Getting there is half the fun" also display a relatively strong preference towards longer trips, and would, other things being equal, like to spend approximately 16.3% more time commuting than they are currently doing. Since the average actual walking/cycling travel time is about 13.79 minutes, this implies that for respondents who value the intrinsic aspects of traveling, or traveling for its own sake, there is a preference towards spending about 2.25 more minutes traveling. The effect is even larger, if negative, for students who strongly disagree that getting there is half the fun, and these respondents would on average like to travel about 3.14 minutes less. The results also provide evidence that commuting by active modes serves as a valuable transition between home and school. Travelers who agree or strongly agree that the trip to school is a useful transition would like to have commutes that are between 3% and 7.9% longer.

One attitudinal score is indicative of the social dimension of traveling. Students who indicate strong disagreement in response to the statement "I like to travel alone", and therefore would presumably rather travel in the company of others, would prefer on average to spend approximately 11.6% more time traveling than they are currently doing. This result is given credence by the common sight of students walking to campus in small friendly groups, while engaged in animated conversation. Two other attitudinal variables are interesting for their relationships to the local environment. One of the statements used to elicit an attitudinal response refers to the number of activities available locally. Active travelers that express a preference for living in neighborhoods where many activities are available, also tend to display a preference towards longer commutes. The effect is slightly weaker if the respondent strongly agrees with the statement (+4.93%) compared to a respondent who simply agrees (+6.56%). This suggests that a degree of separation between extra-curricular and academic activities may be desirable for those students who like to live in lively neighborhoods.

The last significant attitudinal variable associated with active travel identifies the quality of the social local environment, and a positive association with the desire to conduct longer trips. Students who strongly agree that there is a sense of community in the neighborhood would like, other things being equal, to spend approximately 6.9% more time traveling than they are currently doing. In order to provide some sense about the magnitude of these effects, consider a student who walks and is positive in her attitudes. This student thinks that getting there is half the fun, values the time spent traveling as a useful transition, dislikes traveling alone, but rather likes living in an active neighborhood where there is a sense of community. Given this profile, the average response would be a preference towards spending approximately 6.7 more minutes commuting with respect to duration of the average walking trip, or an increase of nearly 40%.

The second mode considered in our analysis is transit. The results indicate that transit users would like to spend less time in their commute if they disagree that the commute trip is a useful transition (by about 15% less if they strongly disagree and by about 6.6% if they simply disagree). Notably, even if the student agrees that the commute is a useful transition, the negative association remains, and the traveler would still like to travel about 6.2% less. In other words, agree or disagree that the commute trip serves as a buffer between home and school, transit users still would like to travel less. Students that use transit, just like those who walk or cycle to school, also appear to perceive the commute experience through a social lens. Unlike active travelers, however, the response is negative. The effect, moreover, tends to be fairly strong. In this way, those who strongly agree that they like to travel alone (which would be an extraordinary occurrence when using transit) would like to spend approximately 16.5% less time traveling, while those who simply agree with this statement would like to spend about 12.8% less time traveling. Since average commute time for transit users is 42.36 minutes, this implies that students who presumably do not like traveling with others would like to spend respectively about 5.4 and 7 less minutes in their commute. Even students who disagree with this statement, and would therefore rather travel accompanied, would like to reduce their commute time by about 4.1 minutes or 9.7% with respect to the average actual travel time. The only positive coefficient obtained for the case of public transportation concerned the quality of shelters and other facilities provided by the transit operator. Other things being equal, transit users who agree that shelters and facilities are good quality would like to travel about 8.3% more, while those who strongly agree would like to travel about 23% more. This desire to travel more, however, needs to be understood within the context of the generally negative response associated with public transportation. Thus, even the positive response of those who strongly agree that facilities are good quality (+23%) is not enough to completely offset the general desire to travel less by bus (-24.9%).

The last mode in our analysis is car. The attitudinal response with respect to the statement “Getting there is half the fun” shows that, unlike active travelers, there is little appreciation for the intrinsic value of traveling by car among its users. Two coefficients are negative and significant, and indicate that students who strongly disagree that getting to their destination is part of the joy of traveling would like to travel about 11.5% less, whereas those who only disagree would like to spend about 8.3% less time traveling. Car users do not appear to derive value from their commute experience, if it is considered a useful transition. Students who disagree that the trip is a useful transition display a desire to spend approximately 7% less time commuting. It is interesting that one of two positive responses relates to a utilitarian aspect of the trip, if the time spent commuting is used productively. Students who agree with the statement "I use my commute time productively" wish, other things being equal, to make trips that are approximately 7% longer. Since the average commuting time for car users is about 29.2 minutes, this indicates a desired time increment for the commute trip of about 2.02 minutes. Students who disagree with the statement "I use my commute time productively" would like to spend about 1.38 less minutes traveling to school. The social dimension of traveling by car produces mixed results. Whereas the response was positive for students who walk or cycle, indicating a predominantly social view of the mode, and negative for transit riders, car use is associated with a positive response to both disagreeing and agreeing with the statement "I like traveling alone", although the effect is slightly weaker for students who prefer traveling alone. This result hints at some potentially interesting possibilities for an examination of car pooling as a social activity.

The last set of variables in the model is comprised of three auxiliary variables introduced with the main purpose of mitigating the effect of non-normal residuals. The spatial filter variable does not require much discussion, as it is essentially a statistical instrument that proxies for omitted relevant variables. Two dummy variables used to identify regime changes for commuters with extreme commuting desires are positive and large in magnitude. These variables are relatively uninformative, and yet it is notable that they seem to capture most of the desire to spend more time commuting. Clearly, this effect is above and beyond that retrieved by the socio-demographic and attitudinal variables available to us for this analysis. It is interesting to note that of 109 observations in the top 90th to 99th percentile, 93 correspond to students who walk or cycle, 11 are car users, and only 5 are transit riders. Comparison of the proportions of observations by mode among these extreme observations (93/109=0.8532 walk or cycle, 11/109=0.1009 car, and 5/109=0.0459 transit respectively) to the overall proportion of travelers by the same modes (0.5508, 0.2062, and 0.2430 respectively), makes it clear that the desire to spend more time commuting is largely dominated by active travelers. This picture is further emphasized by the observations in the top 1 percentile, since 12 out of 16 observations correspond to active travelers, and 4 out of 12 to car users. It is particularly important to mention the interpretation of the results presented in Table 2.1 with respect to the reality of these extreme commuter being able to travel between 97% and 330% longer than they are currently doing. In this study, each individual who chose to cycle to school also stated that walking was a viable alternative (see Table 3.1), which shows that each of these cyclers lives in close proximity to the university and that increase travel time by 300% is a realistic option.

2.6 Summary and Conclusions

Recent research in the field of transportation suggests that there is joy and a positive utility to be found in travel that extends to utilitarian travel such as commuting. This situation, if true, poses an important challenge for planners and policy makers who strive to decrease automobile travel. It is therefore important to determine why people enjoy their commute. Much of the leading research has explored commuter attitudes toward travel, land use and the environment to gain a better understanding and insight into commuter travel behavior. However, the majority of previous literature is focused on automobile travel, with a limited amount highlighting attitudes toward travel by other modes. Furthermore, key empirical findings (in particular those due to Redmond and Mokhtarian, 2001) had not been yet replicated in a different context. This study provides independent confirmation of the effect of traveler's attitudes on the desire to spend more or less time commuting. In addition, the analysis delves into the issue of differences by mode of transportation, considering active travel, car, and transit.

The analysis in this chapter focused on the gap between ideal versus actual commute time as a means to interpret commuter satisfaction by each mode (Redmond and Mokhtarian, 2001). By exploring the relationship between attitudes and commute satisfaction by each mode, a better understanding of the reasons why people are (dis)satisfied with the duration of their commute was obtained. An interesting finding is that the typical commuter would like to decrease the commute time regardless of mode used. To return to Choo et al. (2005)'s assertion "that sizable proportions of the population will be relatively unreceptive to policies intended to motivate reductions in travel", our findings indicate that most travelers are likely to be receptive to changes in cost, including car users. Thus, even if these results confirm previous research indicating that being able to use the commute time productively increases the desire to travel longer for car users, the results are still encouraging from the perspective of reducing rampant automobility. A policy challenge emerges for transit as a competitive mode, since this modes appears to be intrinsically associated with a desire for shorter commutes, and when attitudes are incorporated, their effect is mostly to increase the degree of dissatisfaction (e.g. for example, travelers who prefer to travel alone). An intriguing finding is related to the positive effect of attitudes towards good quality of shelters and infrastructure; recent research is beginning to make headway into developing an understanding of the "place-making" of transit facilities (Lownes et al., 2010).

An important finding in this research that is worth emphasizing here is that active travelers are relatively less dissatisfied with their commute time compared to car and transit users, and under certain conditions appear in fact to be willing to spend some more time traveling to school. The relatively small amounts of time involved for active travelers (approximately 6.7 extra minutes one way for the ideal profile and average commute duration) should not be dismissed as inconsequential. Current guidelines for physical activity and public health issued by the American College of Sports Medicine and the American Heart Association (Haskell et al., 2007) include the basic recommendation to do moderately intense cardio for 30 minutes a day, 5 times a week. A student who walks briskly or cycles to school on average 11 minutes and can be encouraged to extend the commute time by a few more minutes per day will likely exceed the daily activity recommendation, with potentially important impacts on health status. This presents new opportunities, as well as incentives, for the implementation of policies that encourage *more* active travel, as opposed to the usual policy challenge of *reducing* motorized travel.

In terms of specific policy initiatives, the possibility emerges to try to leverage the social aspects of travel to achieve desirable outcomes. For instance, students seem to respond to their social environment when traveling by car (a factor that could be used to increase carpooling), and also when traveling by active modes (which suggests the promotion of walking as a social activity). Recent research is now investigating the potential of social networks and social influence as tools to improve policy analysis and implementation (e.g. Dugundji et al., 2008; Dugundji and Walker, 2005; Goetzke, 2008; Paez and Scott, 2007). This stream of research, however, is still very new, and specific policy instruments remain vague and untested. Other policies are better established and institutions already exist that could implement them. For example, significant variables associated with active travel include living in a neighborhood with lots going on and a sense of community. In Hamilton, an incorporated partnership, the Campus Town Association (CTA), brings together the association of residents of Ainslie Wood and Westdale (the neighbourhoods around the university), the Westdale Business Improvement Area, and McMaster University[6]. The objective of CTA is to make this one of the best near-campus communities to live in North America. The results of this analysis suggest that: 1) maintaining a vibrant mix of activities; and 2) working together to foster and maintain a sense of community; are important to achieve this objective. An incidental benefit could be to make the area also one of the healthiest near-campus communities in the region.

[6] See http://www.awwca.ca/about/

Chapter 3 Modal choice of students considering active modes of travel

3.1 Introduction

Automobile dependency in North America contributes to economic, environmental, and social issues at both the local and global scales. The transportation sector accounts for a large proportion of carbon dioxide (CO2) emissions, and thus contributes to global climate change (Marsden and Rye, 2010; Schmidt and Meyer, 2009; Unger et al., 2010). With car usage on the rise, this environmental impact will become more significant, likely worsened by traffic congestion and increasing commuting times (Ory et al., 2004; Turcotte, 2005). Poor air quality related to mobile emissions (Wallace et al., 2011; Wallace and Kanaroglou, 2008), and sedentary lifestyles associated with automobility (Frank et al., 2004; Heart and Stroke Foundation, 2010) also pose risks for public health.

Policies aimed at addressing transportation-related issues can vary in implementation costs and effectiveness (May et al., 2000; May and Crass, 2007). The cost of providing infrastructure to support various modes of transportation varies widely, with subway lines costing approximately $250-$300 million/km, Light Rail Transit at $35-$40-million/km for surface lines or $150-million/km for underground, busways costing $25-$50-million/km, or the installation of bike lanes for as little as $3,100 - $31,000/km (Metrolinx, 2010; Walkinginfo.org, 2011). Judging from the state of congestion in many North American cities, it seems clear that investment to date in road infrastructure has fallen short of alleviating many of the most pressing problems in transportation, even when discounting the effect of induced demand (Mokhtarian et al., 2002). As a counter-example, investments in comprehensive bicycle infrastructure and programs have been demonstrated to generate important gains in cycling shares (Pucher et al., 2010).

Despite the potential benefits of alternative modes of transportation, public policy remains fixated on the primacy of automobility. In Canada, for instance, important investments in transportation infrastructure have been recently made that continue a trend that favors motorized, mostly private, mobility. The Southern Ontario Highway Program (SOHP) is a $3.4-billion, five year investment in highway construction falling under the government's broader infrastructure investment plan called ReNew Ontario (Ministry of Transportation of Ontario, 2010). In the City of Hamilton, recent road construction projects include the Red Hill Valley Expressway, a 7 km, 225-million dollar project to connect two major arterials within the city. A vast majority of funds for transportation infrastructure are for roads. The budget for Hamilton, approved in principle in January 2011, supports $210-million in infrastructure investments, including over $70-million to road infrastructure (City of Hamilton, 2011). In contrast, the Cycling Master Plan for the city, Shifting Gears, has an estimated cost of implementation for the city-wide cycling network of $51.5-million over a 20-year period, or a mere $2.5-million annually (City of Hamilton, 2009). This is, however, at a time when annual City allocation to cycling infrastructure improvements is $890,000.

Given large disparities in cost and effect, there is a need to target policies that can better achieve broader sustainability goals related to the environmental, economic and social impacts of transportation. Considering the fact that current motorized technologies are highly reliant on fossil fuels, while active modes have the lowest impact on the natural environment such as greenhouse gas emissions (Kennedy, 2002; Public Health Agency of Canada) active travel is, of all forms of personal transportation, the only one that is truly environmentally sustainable. Active travel is an economic and efficient way to transport people from origin to destination (Handy et al., 2010), and carries additional benefits in terms of increasing physical activity and reducing the health impacts associated with sedentary lifestyles (Heart and Stroke Foundation, 2010; Morency et al., 2007; Public Health Agency of Canada).. However, dispite active modes being the most sustainable, their uptake remains modest: 2006 Census data indicate that in the City of Hamilton 5.47% of people walk to work and 0.98% cycle.

These statistics suggest that there is great latent potential for adoption of alternative modes of transportation (Mackett, 2003; Maibach et al., 2009; Morency et al., 2007; Van Exel and Rietveld, 2009). A challenge faced by planners is the attachment of the general population to private vehicles for reasons other than utilitarian, since policies may not have the desired effect, or may fall short from providing the required incentives/disincentives to curb automobility (Choo et al., 2005; Steg, 2005). As described in Chapter 2, travelers may find a measure of enjoyment in their commute, an effect that has been documented for users of motorized modes in previous research (Basmajian, 2010; Bergstad et al., 2011; Diana, 2008; Hagman, 2010; Mokhtarian and Salomon, 2001; Ory and Mokhtarian, 2005; Redmond and Mokhtarian, 2001; Steg, 2005). However, the evidence with regards to active travel is more limited (see Chapter 2 and Anable and Gatersleben, 2005; Gatersleben and Uzzell, 2007; Turcotte, 2005), and in need of additional research, since the policy challenges may be radically different: instead of discouraging a behavior (i.e. automobility), an enjoyment of active travel may facilitate the promotion of a desirable behavior. There is thus a need to develop a better understanding of the factors that underpin the decision to use active modes transportation.

The objective of this chapter is to investigate the factors that influence the modal choice of a sample of university students. This complements previous research that focused on the enjoyment of the commute experience, specifically the desire to travel more or less when commuting by different modes presented in Chapter 2. As seen there, the students who were more likely to express a desire to spend more time commuting are those using an active mode. It is appropriate to now ask why respondents choose one mode of travel over the available alternatives.

As will be shown below, the results of the analysis indicate that modal choices are influenced by a combination of costs such as travel time, individual attitudes, and environmental factors such as street density and sidewalk density. A key finding is a significant, and positive, coefficient of time spent traveling by bicycle, which furnishes further evidence to complement previous findings of the intrinsic value of using this active mode of transportation.

3.2 Background

A number of factors are known to influence decisions concerning the use of different transportation modes. These include cost and other variables related to the different modes, such as socio-demographic characteristics of the traveler, land uses, and the attitudes of the individual towards travel.

In general, the literature provides evidence that people wish to limit the amount of time they spend traveling and accessing their mode of transportation. According to Mackett (2003) time constraints and travel time rank high on the list of reasons for travelers to use a car. Concerns over travel time and access time are shown to be especially important for those who choose transit. Access to mobility tools is also a factor that influences modal choices. Owning a car and having access to a vehicle have both been shown to increase automobile use, through the generation of a choice set, and also the formation of habits (e.g. Cao et al., 2009; Kim and Ulfarsson, 2008). In particular, Cao et al. (2009) find that those who own a bike cycle more, which suggests that travel behavior is influenced by the availability of modes.

Personal socio-demographic characteristics such as gender and household type are also factors commonly found to affect mode choice.

The literature shows that there are differences in travel behavior of men and women. Kim and Ulfarsson (2008) find that females have a higher proportion of short automobile trips than males. Zolnik (2010) reports that average commute times are longer and vehicle ownership is higher for men, which Zolnik attributes to men earning higher wages and having a higher rate of full-time employment, compared to the female survey respondents. Differences are also apparent with respect to active modes of transportation. Gatersleben and Appleton (2007) find that cycling is more common among men than women. This finding is corroborated by Stronegger et al. (2010), who found that men preferred cycling, while women preferred walking, in a study that assessed gender-specific links between local infrastructure and amount of walking and cycling for transportation. Stronegger et al. (2010) also suggest that this is perhaps due to woman's feelings of perceived safety and choosing to access amenities at shorter distances from home due to household and family responsibilities.

Household structure is also known to impact travel behavior. Cao et al. (2009) find that the number of children under the age of five in a household tends to reduce the auto trip frequency, which may be due to time constraints and inconveniences of taking children out, whereas Kim and Ulfarsson (2008) report that presence of children is linked to a greater aversion to walking compared to families without children.

Early evidence about the relationship between mode choice and the urban environment suggests that built density is associated with higher shares of pedestrian activity (Cervero and Gorham, 1995). Certain forms of network design (i.e. grid-based) have also been shown to increase walking (Cervero and Kockelman, 1997). These results find confirmation in other recent transportation research. For instance, Cao et al. (2009) report that residents in urban environments are more likely to walk or cycle, partly due to mixed land uses that support walking and biking trips and discourage auto trips. Consistent with this, Kim and Ulfarsson (2008) provide evidence that short automobile trips are observed more often in less urbanized areas, compared to short bus trips and walking trips that are more frequent in urbanized areas. Marshall and Garrick (2010) find that the share of active modes of travel in a selection of cities in California is positively affected by street and intersection density, but tends to decrease if the streets involved are major roads.

In addition to the factors cited above, there is an increasing interest in the effect of attitudes and perceptions on travel behavior. As shown in Chapter 2, using active modes of transportation can lead to a certain preference for longer commute times, especially when combined with favorable attitudinal variables such as agreeing with the statement "getting there is half the fun", and having a sense of community in the neighborhood (also see Whalen et al., 2011). The effect of attitudinal factors has also been observed in smaller scale, qualitative research of cycling, which shows that those who have adopted cycling as a mode choice have positive perceptions of cyclists and cycling in general, compared with those who have not adopted cycling as a form of transportation (Gatersleben and Appleton, 2007; Gatersleben and Haddad, 2010). The effect has not, been observed before in larger statistical samples.

3.3 Data and Methods

The dependent variable of interest is the modal choice of individual student travelers for their trip to school. The four modes considered are cycling, walking, HSR (the local transit provider), and car. Captive travelers (those who stated that they did not have alternatives available) were removed from the dataset to retain only respondents who in principle had a choice. The size of the sample after cleaning includes 1,384 individual records.

The number of users of each mode, as well as the numbers who also had other alternatives available, are shown in Table 3.1. It can be seen there that cycling was a feasible alternative for 381 users, of whom 48 travelers chose this mode. Walking was a feasible alternative for 920 respondents, of whom 721 actually walked. HSR was available to almost every single respondent in the sample (1,331 travelers), and it was selected by 336. Car was an option for756 respondents, and 281 used it to travel to school.

Table 3.1 Modal choices and alternatives available to travelers in sample

		Number of users with others modes available in addition to chosen mode			
Mode	Number of actual users	Cycling	Walk	HSR	Car
Cycle	48	(48)	48	46	16
Walk	721	277	(721)	673	223
HSR	336	47	126	(336)	236
Car	281	9	25	276	(281)

All respondents who cycled could have walked instead, and almost all of them could have taken the bus. In contrast, less than half had access to a car. The smallest overlap in terms of available modes is between car and active modes: of 281 car users, cycling was a feasible alternative only for nine, and walking only for 25. For a majority, however, transit was available as an alternative mode of transportation. Walking is the most popular mode of transportation in this sample, and for a vast majority of those who walked HSR was a possibility, followed by cycling, and car.

Explicative variables considered for the analysis can be grouped as follows: (1) attributes of the different modes; (2) socio-demographic characteristics of the respondent; (3) features of the built environment; and (4) individual attitudinal variables.

Regarding the attributes of different modes, travel time, access time, and vehicle ownership have been shown to impact mode choice, as described previously. The dataset included a fairly comprehensive set of variables. In terms of attributes of the different modes, the variables used are access time (time to reach the entry point of the transit network), egress time (time to destination from the stop point of a motorized mode), transfer time (time spent in-between transit connections), number of connections for transit trips, vehicle ownership, shared access to the vehicle, possession of a McMaster parking permit, and bicycle ownership.

Socio-demographic variables considered are gender, employment status, citizenship, age, year of study, housing type, living arrangements, number of years living in the current residence, presence and number of children, and status as primary care giver if children are present. As stated previously, socio-demographic variables have been shown to have a significant impact on the mode of transportation used.

Neighborhood characteristics relating to the built environment heavily impact mode choice through the perception of safety and accessibility to amenities. As described in the literature review above, infrastructure, level of urbanization, and perceived safety, can impact a person's choice of travel mode. A number of different factors were calculated for the dissemination area using a Geographic Information System, based on the place of residence of the respondent. These are housing density, intersection density, sidewalk density, street density, and the ratio of the built area (square footage) to the area of the corresponding parcel of land.

As shown in Chapter 2, attitudinal variables may influence the experience of traveling and have the potential to help enhance the level of utility that individuals gain from certain aspects of travel. As described in previous literature, there is evidence of a level of enjoyment found in the daily commute for a variety of reasons, including interacting with nature, being with others and taking time to relax between work/school and home (Handy et al., 2005; Larson, 1998; Mokhtarian and Salomon, 2001; Salomon and Mokhtarian, 1997).

3.4 Methods

The explicative variables were analyzed by means of a discrete choice model. Discrete choice models are routinely used in transportation research to retrieve unobserved utility functions for the alternatives based on revealed preferences and explicative factors (Ben-Akiva and Lerman, 1985The nested logit model was initially attempted that grouped two motorized and two active modes in one nest, and car, transit, and active modes in another. After these efforts did not prove successful (convergence was not achieved) a multinomial logit model was estimated. Accordingly, the probability of individual *i* choosing alternative *j* is given by the following formula:

$$P_{ij} = \frac{e^{V_{ij}}}{\sum_k e^{V_{ik}}} \tag{3.1}$$

where *V* is the systematic component of a net (random) utility function:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{3.2}$$

Equation 3.1 is derived under the assumption that the random terms e_{ij} follow the Extreme Value Type I distribution. The systematic utility V is defined as a function of the explicative variables and estimable linear parameters. Estimation was conducted using the software BIOGEME (Bierlaire, 2003).

3.5 Results and Discussion

The results of estimating the utility functions for the four modes in the analysis using a multinomial logit model appear in Table 3.2. Where appropriate, cycling was selected as the base (i.e. reference) mode for the definition of the utility functions. Thus, the alternative specific constants, and attributes that are specific to the individual and her environment are all given in reference to cycling.

A specification search was conducted, starting with a comprehensive model that was sequentially reduced to a final model based on the significance of the variables. Not all variables initially considered for the analysis were significant. For instance, individual attributes such as gender, years in residence, and others, were not significant. The remaining variables in the final model are all significant at $p \leq 0.05$. Blanks in the table indicate that a variable was not entered as part of a specific utility function (e.g. parking permit was entered only in the utility of car), or that the coefficient was not significant at a minimum level of 5% (e.g. the coefficient of street density in the utility of walking was not significant). The table reports the value of the log-likelihood of the null model and the full model. A likelihood ratio test rejects the hypothesis that these two models are identical, and indicates that the full model represents a significant gain in information contents. The goodness-of-fit of the model can be assessed by means of McFadden's ρ^2

coefficient, which for parsimony reasons can be adjusted (penalized) for a number of coefficients estimated. The adjusted ρ^2 of 0.495 can be considered a good fit.

Table 3.2 Multinomial logit analysis: Factors that influence the utility of each mode

	$V_{cycling}$	$V_{Walking}$	V_{HSR}	V_{Car}
Constant	-	12.4 (<0.001)	9.47 (<0.001)	6.19 (<0.001)
Cost variables				
Log of Travel Time (min)	3.07 (<0.001)	-	-	0.575 (<0.001)
Travel Time (min)	-	-0.1140 (<0.001)	-	-
Access Time (min)	-	-	-0.0896 (<0.001)	-
Parking Permit (yes=1)	-	-	-	2.36 (<0.001)
Living Arrangement				
Living Solo (yes=1)	-	-2.36 (0.030)	-1.83 (0.060)	-1.89 (0.050)
Living Shared (yes=1)	-	-2.75 (<0.010)	-3.22 (<0.001)	-3.8 (<0.001)
Environmental Variables				
Street Density (km/km^2)	-	-	0.135 (<0.001)	0.133 (0.010)
Sidewalk Density (km/km^2)	-	-	-0.0667 (<0.001)	-0.0586 (<0.001)
Attitudinal Variables				
Shelters are good quality (Agree=1)	-	-	0.448 (0.010)	-
Vehicle is comfortable (Agree=1)	-	-	-	0.847 (0.010)
Vehicle is comfortable (Strongly Agree=1)	-	-	-	0.88 (0.020)

N= 1,385
L(0)= -1,197.47
L(β)= -583.63
ρ^2= 0.513
Adjusted ρ^2= 0.495

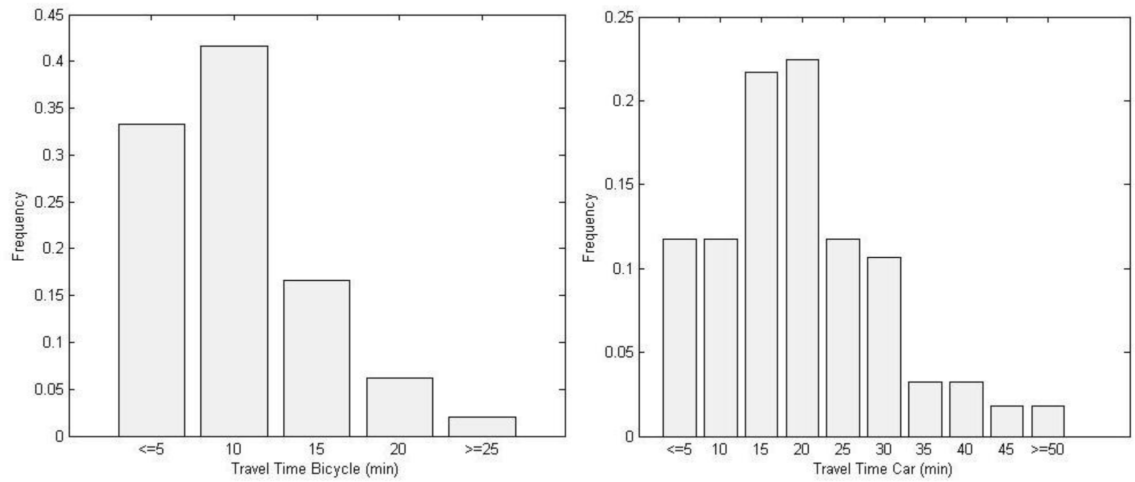

Figure 3.1 Distribution of travel time by bicycle and car

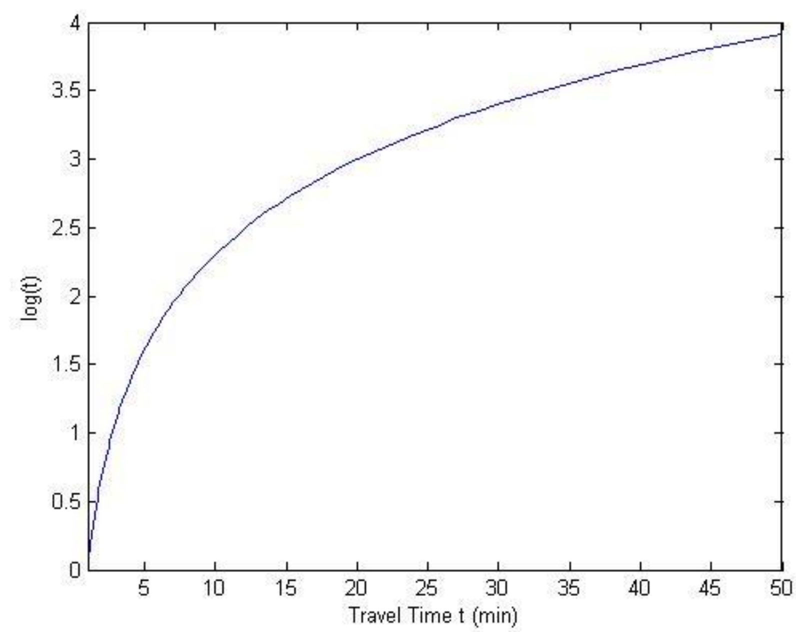

Figure 3.2 Non-linear transformation of travel time

Considering the ordinal nature of the utility functions (i.e. an alternative will be selected if it offers the highest utility, regardless of the magnitude of the differences), it is clear that, other things being equal, the mode that offers the highest utility to student travelers is walking, followed by HSR, car, and cycling. The status of cycling could be explained by the fact that it may be the most difficult mode to adopt. Cycling demands a greater effort, physical and otherwise, compared to walking or any of the motorized modes. In evaluating the motivators and deterrents of bicycle use, Winters et al. (2011) describe how the burden of responsibility is placed on the cyclist to plan ahead and have the appropriate gear. Experience with the mode or pre-existing attitudinal factors may also play a role in this, as previous research shows that those who have not considered cycling have the least positive attitude towards it (Gatersleben and Appleton, 2007; Gatersleben and Haddad, 2010). When considering the experience of travelers riding in an automobile, taking transit, or walking, it is understood how those modes are more easily adopted. For example, walking only requires comfortable shoes; taking transit is a common occurrence beginning in grade school and requires possibly only a transit map to get to a chosen destination. Driving a vehicle could be seen as somewhat of a rite-of-passage for many North American teenagers. In comparison, becoming a cyclist requires training, in addition to knowing the rules of the road, not as a driver, but as a cycler – something that may be found most confusing as many roadways are not designed to accommodate cyclists well. Sharing a busy one-way street that is five lanes wide and has a speed limit of 60 km/h can be intimidating to most new cyclists. Learning how to integrate with fast-moving automobiles on a busy street which lack bike lanes requires a certain amount of determination.

In contrast to the finding that cycling provides the least amount of utility overall (other things being equal), it is notable that the log transformation of travel time on a bike contributes the highest positive amount to the utility of cycling. This coefficient is also positive and significant for time traveling in a car, which is in accordance with the previous work on the positive utility of travel. It is important to describe the meaning of the log transformation in this sense. This value shows that the effect of travel time is non-linear and the increments in utility increase at a decreasing rate for large values of travel time, as can be seen in Figures 2.3 and 2.4.

The finding of a positive utility of cycling time is in line with previous studies showing that active modes, and particularly traveling by bicycle, are the most enjoyable forms of transportation (see Chapter 2 and Turcotte, 2005). It seems as though cycling is not an easy mode to adopt; however, those who adopt cycling as a form of transportation derive a measure of utility from the trip itself – due to the sensation of movement, the value found in exercising, or other reasons – which contrast with the view that time spent traveling must represent a disutility. Conversely, the coefficient for travel time by walking is negative. This may suggest that aspects of speed and manoeuvring a vehicle are the factors that contribute most to positive utility found in travel, and is consistent with the notion that time spent in a trip is detrimental to the overall utility of a mode of transportation The results also indicate that access time further depresses the utility of transit.

As expected, owning a parking permit increases the utility of traveling by car, by a relatively large margin. Permits at McMaster are granted for a flat fee that offers unlimited access to the parking lots. The implication is that parking permit holders have not only already spent a significant amount of money to own a car, but also, given the lack of sensitivity to usage of parking facilities, lack incentives *not* to use that car as their main mode of transportation to the university. Aligning with findings by Cao et al. (2009) and Kim and Ulfarsson (2008), among others, once a vehicle is readily available it becomes much easier to choose driving over other available alternatives. Gaining experience and familiarity in using a particular mode, such as using it to travel an identical route and distance each day is expected to increase the reliability of that mode, which can be explained in that the individual knows how long it takes them to travel to work or school in their car, where to expect delays, and which parking lot to find the best parking space.

In terms of living arrangements, and keeping in mind that the reference is living in the family residence, living solo and in shared accommodations decreases the utility of every single mode except cycling (reference), again by relatively large margins. Alternatively, this can be seen as cycling being the most attractive alternative for individuals not living with their families. This could be related to the experience of a student moving to a new place, and a renewed willingness to experiment with alternative transportation, as opposed to continuing an established routine that most likely already involves using a family car. While we tested a variable related to shared access to a vehicle and found it not significant, for those living in shared accommodations sharing a vehicle with friends (competitive access) may also be a factor.

Of the array of built environment variables tested, only two factors were significant. These variables are consistent with findings associated with research on urban and suburban travel (Cao et al., 2009; Kim and Ulfarsson, 2008), and indicate that street density increases the utility of car and transit, whereas sidewalk density decreases the utility of these two motorized modes. The relationship is intuitive since areas that support vehicle traffic (by having a greater road density) will be more conducive to using a car or finding transit services, while areas that provide facilities for walking will also increase the utility of this mode, and perhaps as a side effect, the utility of cycling as well.

The last class of variables tested for the model includes a broad range of individual attitudinal factors. Four factors were significant in the analysis of mode choice. The first one, agreeing that shelters provided by the transit agency are of good quality, entered only the utility of HSR. The coefficient indicates that this perception/attitude tends to increase the utility of transit. Combined with previous results reported in Chapter 2, the implication is that good quality shelters not only help to offset some of aspects that make traveling by transit an unpleasant experience, but also increase the probability that the mode will be chosen. Agreeing and strongly agreeing that the vehicle used for transportation is comfortable increases the utility of traveling by car. To round up the investigation in Chapter 2, it is worthwhile to mention some of the attitudinal variables that were not significant in this analysis of mode choice. There appear to be some factors that positively influence the travel experience. In the case of active modes, this includes an affinity for living in places where a lot is going on, and experiencing a sense of community in the neighborhood. In the case of car, being able to use the commute time productively was associated with a desire for somewhat longer commute times. None of these factors were significant. It appears then that while there might be some overlap in cases (e.g. the quality of shelters positively influences the probability of choosing transit and the desire to spend more time traveling), the attitudinal variables that influence mode choice and the enjoyment of the commute experience are generally different. This is relevant because these are separate processes with distinct policy implications: travel by more or less sustainable modes, and the amount of travel by the selected mode.

3.6 Summary and Conclusions

In this chapter the mode choice decisions using a sample of university students was examined. Consistent with the literature on mode choice, this paper provides evidence that there are aspects of the traveler, the modes used, and the environment, which influence the utility of the various modes.

By focusing on the determinants of active modes, evidence of a positive utility of travel time by bicycle is seen when conducting the log transformation of the variable. The only other paper to quantitatively investigate the enjoyment of traveling by active modes is that by Turcotte (2005). This chapter then complements other research, mostly based on qualitative approaches and/or relatively small samples, which also highlights some of the aspects of cycling that individuals may find enjoyable. From a social perspective, those who cycle perceive cycling more positively than those who drive (Xing et al., 2010), which is consistent with previous investigations of the social aspects of mode choice (Gatersleben and Appleton, 2007; Gatersleben and Haddad, 2010; Gatersleben and Uzzell, 2007).

In addition to providing evidence of a positive utility of time spent cycling among university students, as can be seen by the log transformation of the variable, a number of other relevant findings are noteworthy. For instance, it can be seen that those who are invested in a comfortable vehicle and a parking permit may not consider selecting other modes to travel to campus, even if available. In addition, it can be seen that urban design parameters that support vehicle traffic (higher road density, lower sidewalk density) are conducive for people to use their automobiles. While not explicitly the focus of this research, there are tantalizing hints that experience or lack thereof with different modes, is an important topic for further research.

The findings from this study have policy implications, in terms of support for programs and infrastructure that encourage active travel.

An overarching theme from the previous literature, which also resonates in the findings of the current study, is that those who adopt cycling derive utility from their cycling trips. Programs to educate young people on rules of the road for walking and cycling, expose them to riding a bicycle in gym class and include information on sustainable transportation options can help to encourage active modes to be adopted at a younger age, before they begin to relate to a certain mode, or become comfortable in their personal automobile. The investments into parking permits that are paid for on a monthly basis encourage auto users to again, make a commitment to driving every day. Policies that support the availability of flex-passes, or ten-park tickets that do not expire, will encourage auto users to employ an alternative mode. For example, if a parking permit is paid per month and an individual decides to ride transit, walk, or cycle once each week, they are then paying for their parking permit, as well as paying for their bus ticket four times each month. If paying to park on a daily basis, one may consider walking on nice days or purchasing a bicycle to use.

Promoting “bike to school” days and carpooling as a social activity may also help to encourage people to get the most out of their commute by biking to work, and reducing the impact of vehicular traffic. Events that encourage people to try an active mode and celebrate the success of those who do may be effective at fostering change.

More broadly, the results indicate that the built environment also can encourage or deter the use of certain modes. Municipal policies that support infrastructure such as bike lanes and good-quality sidewalks can not only increase the perception of safety, but also awareness that supporting active transportation is a priority for policy makers and planners. Those who experience municipal sidewalks that have been neglected to be ploughed, or intersections that force pedestrians to cross three times to reach their destination, will feel that priority has been placed elsewhere. Substantial investment in road construction, but failure to make less expensive investments such as providing a bike lane or paint a bicycle division between connecting bike ways will elicit greater frustration and contempt from active commuters with their chosen mode.

It is clear that greater representation of active travel as part of the mix of modes in the transportation systems requires commitments at different levels: from individuals to their health and their personal finances; from employers to the well-being of their employees and to their budgets; and from local and other governments to the creation of economically, environmentally, and socially sustainable cities. The challenges are not trivial, but the rewards are potentially large.

Chapter 4 Conclusions and Recommendations

The research reported in this thesis provides information and insights necessary to make recommendations for policy makers and planners on ways to increase the use of active modes of travel. With economic constraints on municipal, provincial and federal governments, as well as private institutions, to be able to maintain, improve and expand on existing infrastructure to facilitate effective movement and decrease congestion, there is pressure to ensure that any investment produces a desired outcome at a reasonable cost. Environmental concerns that transportation accounts for a significant proportion of greenhouse gas emissions, and the knowledge that shifting to active and sustainable modes would help achieve emission reductions provides support for investing in infrastructure to support these modes. Societal costs of auto-dependant societies and neighbourhoods that do not support walkability and bikability are increasing, leading to higher levels of chronic disease such as obesity resulting, at least in part, from leading a sedentary lifestyle. Increasing the use of active travel is an obvious method to achieve the desired environmental and societal outcomes. However, there is also a requirement to ensure that the methods employed are economically sustainable.

Investing in infrastructure that will achieve the desired outcome in a way that is economically favourable is a requirement for success and further growth and development. Investing in any infrastructure that does not produce the desired outcome, in this case shifting from a personal vehicle to active modes of travel, will be economically unsustainable. This may also produce negative consequences in any future movement forward due to political unease regarding further failure. Gaining an understanding of commuter attitudes towards travel by various modes is believed to be an integral component to developing effective policies and plans that will facilitate sustainable outcomes. It is believed that if change to policy and plans can align with commuter attitudes and ideas then the goal of creating a modal shift will be highly successful. Therefore investment into infrastructure, policy and future planning will have a better "return" through achieving the desired results. Ultimately, if policy makers and planners can invest in those aspects of active transportation that are most desired, provide the greatest amount of enjoyment, and produce the highest level of utility, commuters will be more willing to switch modes. Furthermore, and specific to this thesis, it is anticipated that if enjoyment and utility are found through consistent use of active modes, developing these habits now will encourage individuals continue to use the mode beyond their time at university.

With a population of ~23,000 students and ~7,500 employees, and not discounting the large amount of visitors, McMaster has the ability to influence a considerable number of individuals on a daily basis. By influencing policy through representation on university committees that create and pass policy, and by sharing information through academic conferences, as well as representation on City committees that draft and submit policy, it is anticipated that learning's and successes had at McMaster will provide and set a high standard of best practice to be utilized by other institutions and municipalities. As noted previously, initial findings show that the daily commute is found by some to elicit a certain amount of enjoyment, which poses a problem for policy makers and planners. The study in Chapter 2 did however find that those who chose to cycle enjoy their commute more than those who drove, and much more than those who walked and took public transit. It was also seen that the social nature of commuting and living in an area that provided a sense of community also supported active commuting. Chapter 3 presents a critical evaluation on specific factors that have been previously shown to impact a commuter's attitudes toward travel by mode and the level of utility each mode provides. It is important to make note here that, as stated in Chapter 1, the transportation survey that was used to conduct this research took place in the winter months of February and March. As such, these results, which present a positive response to active travel, may actually be quite conservative, as one would expect a more positive response tied to active travel in the summer months. The findings presented in Chapter 3 provide a more conclusive understanding of the required objectives that must be met when making recommendations. A list of recommendations has been produced as a result of the findings from this thesis. Each point is discussed with respect to the findings presented in Chapters 2 and 3 and includes suggested next steps for future research and practical measures.

4.1 Suggestions for Future Research

The research reported in this thesis suggests a number of items to add to the agenda.

First, given its connection with a desire to spend more time walking or cycling to school, an extended investigation of the factors that affect "sense of community" appears to be warranted. The theoretical underpinnings for such investigation can be furnished by the work of Grannis on neighbourhoods, networks, and communities (Grannis, 2009).

Second, the social aspects of traveling continue to be an intriguing if somewhat underdeveloped area of research. These findings suggest their importance, but qualitative research could greatly improve our understanding of the specific aspects of social interactions that are important while on the move.

Finally, as repeatedly emphasized throughout the thesis, the target population in this study is unlikely to represent the general population of the host city. Previous research findings by others have emphasized the primacy of the private car for segments of the population that could reasonably be described as closer to the general population than students. In contrast, these findings suggest that for students a desire for longer commuting times is not only the province of the automobile, but also of cycling. This opens up some interesting research windows: Why is it that students seem to enjoy this form of active transportation, and what can be done in this life transition to improve the chances that "good" travel habits are maintained in the post-university life? That the effect of life transitions is important appears to be beyond question, and is certainly not lost on automakers that target commercial campaigns specifically to college students. Perhaps a better job can be done by educating students about "location smart" residential choices and the potential life-long benefits of remaining an active traveler for as long as possible.

4.2 Recommendations

As it has been found that commuters find more utility in those modes for which they have made an investment into, the goal of the first set of recommendation is to reduce the investments that are required to be made in order to utilize the personal automobile. This is relevant to the auto-dependent culture of North American societies, where a growing amount of the population is relying on the personal automobile as their primary option for transportation. Once the initial investments are made, such as purchasing a vehicle and the required insurance, as well as purchasing the monthly or annual permit to park the vehicle, the reliance has begun. As seen from other previous studies, once the commuter becomes comfortable and familiar with their chosen mode, a greater amount of dependence is associated. Furthermore, this dependence is interpreted or understood by the user as a level of utility obtained from employing that mode over the other available options. In order to combat not only the dependence that results from initial investment, but also in further use and familiarity, the following recommendations are made:

1. Implement a "flex-pass" program for parking permits. Rather than requiring employees and students to invest in parking their vehicle through the current system of monthly or yearly permits, McMaster could offer the option of a 10-park pass that will, in essence, provide an economic incentive for walking or cycling, and a disincentive for driving to campus. Next steps to implementing this policy are to work with campus stakeholders to design a flex-pass permit that meets the needs of the campus community as well as implement and communicate a pilot program to conduct an initial analysis of the initiative. Furthermore, there must be a critical evaluation on the outcome of the program to determine if the desired modal shift is occurring, which can be done through a user survey. If more monthly permit holders are switching to a flex-pass than non-permit holders, then there is justification for the program to be expanded and continued.
2. Implement a car-sharing program for McMaster faculty, staff, and students. Offering the opportunity to rent a car from a location on main campus will discourage the initial investment required to purchase a vehicle and insurance. The next steps to implementing this initiative are to determine a car-sharing provider and offer a vehicle at an on-campus location, which McMaster has recently done. Further promotion and communication to all prospective, incoming, and new students and employees to McMaster University will contribute to the programs success.
3. Continue to implement and support Bike to Work and School Day events. Encouraging commuters to try cycling to campus will encourage those who have the opportunity to try cycling to receive prize incentives for doing so. Each opportunity a commuter takes to adopt an active mode of travel will increase their comfort and familiarity with it. Bike to

Work and School Day events are provided twice annually. McMaster should continue to support this initiative through communication and future expansion.

4. Continue to support and host the annual Clean Air Commute challenge. McMaster hosts the annual Clean Air Commute challenge, which encourages staff, students, and faculty to take a sustainable mode of transportation for one week and log their progress. This event is facilitated by a third party and includes municipalities and major employers within the Greater Toronto and Hamilton Area (GTHA). The event has previously provided prize incentives, free local transit on one day of the challenge, a Bike to Work or School Day, a Carpool Day, a group walk, and an event kick-off and information fair. Again, this event should continue to be supported and expanded upon at McMaster University.

In addition to decreasing the required investment into the use of personal automobile and increasing opportunities for staff, students, and faculty to become familiar with sustainable modes of travel, the study findings show that utility is obtained when traveling in areas that support the commuter's chosen mode. If investment is made to improve transportation infrastructure supporting the use of sustainable modes, a higher level of utility and adoption will be seen. As a closely related finding, commuters also obtain more utility when infrastructure is of good quality and comfortable. The second set of recommendations focus on ways in which infrastructure improvements can be made through policy and plans at the municipal level as well as at McMaster University:

1. Maintain representation on the Light Rail Transit (LRT) Advisory Group. McMaster should maintain cross-campus representation on the City's LRT Advisory Group to

ensure that the needs of the campus population are being provided to the City's LRT Committee. McMaster currently has an LRT Advisory Group that is advising the City of Hamilton and consultants of the stated needs of the McMaster population as determined by a recently conducted campus-wide survey. McMaster should continue their collaboration with the City on the LRT project and any other similar committees or working groups that arise.

2. Uphold representation on the City of Hamilton's Pedestrian Advisory Group (PAG). Similar to the above, McMaster should maintain representation on the City of Hamilton's PAG. This group is responsible for submitting draft policy and plans to the City's residents, through a series of Public Information Centres, for feedback, and ultimately submitting a proposed Pedestrian Master Plan to City Council for review and acceptance. McMaster currently has representation on the PAG and should continue to utilize the information available from this and similar studies to advocate for the needs of the members of the McMaster community.
3. Ensure continued representation and growing participation on the City of Hamilton's Transportation Management Association (TMA) and with Smart Commute Hamilton. The relationship with Smart Commute, a sub-division of Metrolinx for the GTHA, is maintained and supported by the Hamilton TMA. The TMA is a group of individuals representing large businesses and organizations across the City of Hamilton to promote and advocate for increased use of sustainable transportation. Events such as Bike to Work/School Day and the Clean Air Commute are facilitated jointly through Smart Commute Hamilton and the TMA. In addition, Smart Commute provides each organization with a baseline survey upon registration as well as financial support and

resources to promote sustainable transportation within each organization. A prime example of an invaluable resource is McMaster's online ride-matching service, CarpoolZone, which is facilitated and managed by Smart Commute. McMaster should continue to maintain representation on the TMA and registration with Smart Commute, but should also encourage McMaster's satellite campuses to provide a representative, as each geographic location and population presents different challenges and provides different opportunities with respect to increasing use of sustainable modes of transportation.

4. Support and encourage opportunities for bicycle maintenance and repair. The McMaster Student's Union provides a bicycle co-op service through MACycle. The student-lead service has a work shop on campus whereby employees and volunteers of the co-op assist their members in proper bike maintenance and repair. McMaster should highlight and communicate this valuable service and provide opportunities to showcase this and similar resources which are provided on campus to McMaster employees and students.
5. Install more bike racks. Providing bicycle parking facilities in prime locations will support safety and convenience of choosing to cycle to and from McMaster. McMaster should annually review the current number and location of campus bike racks as well as engage in community consultation to ensure that the quantity and placement of racks aligns with the needs of the community. McMaster has engaged in the process above in 2009, 2010, and 2011. This process should continue in future and should also expand to include options for more secure bike storage facilities on campus.
6. Communicate and highlight the importance of bicycle engraving and provide the service at no-charge to McMaster employees and students. McMaster's Security Services

currently provides this service to the McMaster community at no-cost; however the service is not widely communicated. McMaster should provide opportunities through events and awareness campaigns to promote this opportunity. Events such as Bike to Work/School day and the Clean Air Commute which take place in May and June annually will be most beneficial at reaching McMaster employees, while additional events such as Car Free Day in September will provide a more opportune time to communicate to students or faculty who may have been on research leave.

7. Ensure all new buildings are equipped with End of Trip Facilities. Having the ability to shower and change clothing when arriving to campus after an active commute to work/school is essential for many who travel long distances or who travel in extreme weather conditions. McMaster has implemented a Sustainable Building Policy which requires all new buildings and major renovations to meet a minimum certification of L.E.E.D (Leadership in Energy and Environmental Design) Silver. Part of the L.E.E.D certification process encourages the incorporation of End of Trip Facilities. McMaster should advocate for inclusion of these facilities in all new buildings and major renovations as supported by the L.E.E.D. process. In addition, as there are currently a number of these facilities on campus currently, they should be communicated to McMaster employees and students through a variety of sources.
8. Engage in community consultation and conduct campus-wide commuter surveys. Continual investigation of employee and student attitudes towards travel is integral to being able to provide the programs and infrastructure that align with their needs as they relate to sustainable modes of travel. A recently-released campus-wide commuter survey is anticipated to contribute to this understanding and provide the information necessary to

align programs and infrastructure improvements to meet the needs of the Master Community. The results of this survey should be communicated to McMaster staff and students. This, or a similar, survey should be conducted semi-frequently to ensure that the defined objectives are not just devised from a snap shot in time, but continue to align with the changing needs and values of McMaster's commuters. In addition, community interview and consultation should be conducted to confirm and better understand survey findings.

Ultimately, McMaster University has the opportunity and responsibility to influence adoption and use of sustainable modes of transportation to and from campus that will transcend beyond the campus bounds. As employees and students at McMaster will go on to commute and travel in cities and countries around the globe, they will have a much broader impact than that which is limited to the university campus. With respect to the overall sustainability of transportation at McMaster, the goal is to ensure that as many programs as possible are provided to McMaster employees, students, and visitors to allow them to make the most environmentally, socially, and economically sustainable choice available to them. There are many programs currently underway, as well as many new and additional opportunities to be taken advantage of. It is anticipated that the research conducted, and recommendations provided, within this thesis will help to facilitate effective and sustainable outcomes at McMaster University and have a positive impact on a much broader level as those values extend to cities and countries around the world.

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