MTI Report 05-03

# Can Consumer Information Tighten TheTransportation/ Land-Use Link? A Simulation Experiment

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# CAN CONSUMER INFORMATION TIGHTEN THE TRANSPORTATION/LAND-USE LINK? A SIMULATION EXPERIMENT

March 2006


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a publication of the

Mineta Transportation Institute
College of Business
San José State University
San José, CA 95192-0219

Created by Congress in 1991

# Technical Report Documentation Page

| | | |
|---|---|---|
| 1. Report No.<br>FHWA/CA/OR-2005/03 | 2. Government Accession No. | 3. Recipient's Catalog No. |
| 4. Title and Subtitle<br>Can Consumer Information Tighten the Transportation/Land-Use Link? A Simulation Experiment | | 5. Report Date<br>March 2006<br>6. Performing Organization Code |
| 7. Authors Jonathan Levine, PhD, Daniel A. Rodríguez, PhD, Jumin Song, MCRP, and Asha Weinstein, PhD | | 8. Performing Organization Report<br>MTI 05-03 |
| 9. Performing Organization Name and Address<br>Mineta Transportation Institute<br>College of Business<br>San José State University | | 10. Work Unit No.<br>11. Contract or Grant No.<br>65W136 |
| 12. Sponsoring Agency Name and Address<br>California Department of Transportation<br>Sacramento, CA 95819 | U.S. Department of Transportation<br>Research and Special Programs Administration<br>400 7th Street, SW<br>Washington, DC 20590-0001 | 13. Type of Report and Period Covered<br>Final Report<br>14. Sponsoring Agency Code |
| 15. Supplementary Notes | | |

16. Abstract

Where people live, work, shop, and recreate fundamentally determines their local travel options. In this study, we use an experimental research design to test how strongly the dissemination of integrated accessibility and housing information influences individuals' residential location choices. We hypothesize that individuals who receive information about accessibility to transit and accessibility to important destinations in an area as part of each rental unit listing they see are more likely to choose to live in high-accessibility neighborhoods than are individuals who do not receive such information. This research is motivated by the prospect of using information as a policy intervention to allow householders to self-select into areas that facilitate walking, cycling, transit use, and shorter trips generally.

Our results suggest two main findings: Providing bundled accessibility and housing information resulted in the selection of preferred locations that were closer to major destinations, as compared to the selections of individuals without access to the information; and individuals in the experimental group selected properties closer to transit lines that serve their destinations than members of the control group. Thus, providing housing seekers with information about their transit options from each unit may influence certain population subgroups to choose more transit-friendly locations than they would otherwise select.

Our findings have implications for both the research and policy communities. At the level of public policy, the results suggest that information targeted towards individuals who are relocating can be used to enhance the attractiveness of locations that support multiple travel modes. Transportation and urban planners, health promoters, transit agencies, universities, and other institutions interested in promoting walking, bicycling, and transit use will find our results useful. For researchers, our results provide new evidence about how the connection between transportation and land use can be strengthened through policy attention that focuses on how transportation information can guide locational decisions.

| | | | |
|---|---|---|---|
| 17. Key Words<br>Information dissemination; Public transit; Transportation planning; Urban planning; Urban transportation | 18. Distribution Statement<br>No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161 | | |
| 19. Security Classif. (of this report)<br>Unclassified | 20. Security Classif. (of this page)<br>Unclassified | 21. No. of Pages<br>100 | 22. Price<br>$15.00 |

Form DOT F 1700.7 (8-72)

Library of Congress Catalog Card Number: 2005936823

To order this publication, please contact the following:
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## ACKNOWLEDGMENTS

The principal investigator of this report is Jonathan Levine, Associate Professor and Chair of Urban and Regional Planning in the Taubman College of Architecture and Urban Planning, University of Michigan. Other team members include Daniel A. Rodríguez, Assistant Professor in City and Regional Planning at the University of North Carolina, Chapel Hill; Jumin Song, doctoral student of Urban and Regional Planning, University of Michigan; and Asha Weinstein, Assistant Professor in Urban and Regional Planning at San José State University.

We greatly appreciate the help of the many people who assisted in the completion of this project. Richard Murphy developed the housing search simulation tool used in the experiment. Katja Irvin conducted the literature review, assisted in the development of the conceptual design and specifications for the housing search simulation, and assisted with the development of the survey instrument. Jessica Zgobis took pictures of properties and worked as a lab assistant during the experiment. Finally, we thank Melissa Goldstein, Alan J. Levy, and Julie L. Stetten of University Housing at the University of Michigan, as well as Jessica Good and Craig Snyder at Sites and Sounds, Inc. (Ann Arbor, Michigan), for providing us with the housing data used in the project.

Thanks are offered also to MTI staff, including Research Director Trixie Johnson, Research and Publications Assistant Sonya Cardenas, Webmaster Barney Murray, and Graphic Artist Shun Nelson. Editing and publication services were provided by Irene Rush, Catherine Frazier. and Beth Blevins.

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# EXECUTIVE SUMMARY

Where people live, work, shop, and recreate fundamentally determines their local travel options. These locational decisions are, in part, a function of the information that can be collected about the alternative housing opportunities. This report describes tests of an innovative approach to raise awareness about, and possibly increase the use of, nonauto travel options: providing people seeking housing with good information about their bus, walking, and biking options from every housing unit they consider. We hypothesize that individuals who receive information about accessibility to transit, and to important destinations in an area as part of each rental unit listing they see, are more likely to choose to live in high-accessibility neighborhoods than are individuals who do not receive such information. To date, the concept of providing information to modify people's travel behavior has been implemented in a relatively limited number of ways. The most common approach has been to provide up-to-date (or even up-to-the-minute) information on the status of motorized transportation modes (auto and transit) for individuals making travel decisions. Despite the evident value of short- and medium-term approaches to providing travelers with information, both suffer from an inherent weakness: once the traveler chooses a place of residence, the transportation die has largely been cast. In this study, we take a long-term view of the influence of information on travel choices by examining whether information on transportation options, delivered at the moment of residential choice, can alter one's decisions and thereby change one's transportation environment.

We tested our hypothesis in a laboratory setting, asking 236 University of Michigan (UM) graduate students to select their top choices of where to live after reviewing a database of residential properties custom-designed for this study. To assess the influence of the accessibility information, we divided study participants into two groups. The first group (the control group) received unit information with the attributes currently standard in most private and university housing databases, including price, the number of bedrooms, the availability of off-street parking, and whether the property is within one-third of a mile of a UM campus. The second group (the experimental group) received the same information and also information about how far the unit is from a transit stop, transit service frequency at that stop, and the distance to the closest campus. After choosing their preferred rental properties, participants also filled out a survey on their current travel behavior patterns, desired features in housing, and sociodemographic characteristics.

Statistical comparisons between the properties desired by each group suggest two main findings. First, providing bundled accessibility and housing information resulted in the selection of preferred locations that were closer to major destinations, as compared to the selections of individuals without access to that information. Although we cannot know with certainty that travel behavior differences will ensue from the effects identified in our experiment, the fact that the experimental group chose residences that were more accessibile to destinations suggests likely effects that deserve additional exploration. Providing housing seekers with information about their walking and biking options from each unit has the potential to encourage people to choose housing units that are closer to their major destinations than they would otherwise select.

Second, experimental group members selected properties closer to transit lines serving their destinations than did members of the control group. Certain subgroups of the population were especially likely to select housing units closer to transit than they otherwise would have, if offered bundled housing and accessibility information. In particular, older individuals and those who regularly use the University of Michigan's transit system were more likely to pick housing units close to a transit stop when provided with the transit information. Although our research should be tested in other populations and contexts, our results suggest that providing housing seekers with information about their transit options from each unit has the potential to influence certain population subgroups to choose more transit-friendly locations than they would otherwise select.

Our findings have implications for both research and policy. At the level of public policy, the results suggest that information targeted toward individuals who are relocating can be used to enhance the attractiveness of locations that support multiple travel modes. Transportation and urban planners, health promoters, transit agencies, universities, and other institutions interested in promoting walking, bicycling, and transit use will find our results useful. For researchers, the results shed light on an ongoing debate about the connection between transportation and land use. Some observers assert a strong relationship whereby households are guided by the tradeoff between transportation accessibility and housing cost in their locational decisions; others find in the current auto-dominated transportation environment a weakened relationship under which nonaccessibility factors dominate. Our results suggest a third option: the relationship between transportation and land use is neither inherently weak nor inherently strong: it can be either nurtured or thwarted by policy. Appropriate interventions can increase the capacity of transportation accessibility to guide locational decisions, thus strengthening the transportation/land-use relationship. As this research suggests, integrated transportation and housing information offered to people at the time they are choosing a new home may constitute one of those interventions.

# TRANSPORTATION CHALLENGES: ALTERNATIVES TO THE AUTOMOBILE

In the last three decades, a strong core of policy research and innovation has focused on developing methods to provide travelers with convenient, affordable alternatives to driving. Among the more prominent approaches have been efforts to expand transit service, urban design interventions that make walking and biking safer and more pleasant, and land-use planning techniques designed to make walking, biking, and transit more convenient. Another set of approaches has focused on the question of how to make the public *aware* that good alternatives to driving exist. The best transit system in the world is useless if people do not realize that it could efficiently serve their travel needs. This report describes research testing an innovative new approach to raising awareness about nonauto travel options: providing people seeking housing with information about the bus, walking, and biking options as part of each housing unit listing they review.

The concept of using information provision to improve people's travel options has been implemented in a relatively limited number of ways, and the most common approach has been to provide up-to-date (or even up-to-the-minute) information on transportation modes for individual trip-making decisions. For example, some transit systems have installed electronic message boards at bus stops to alert riders when the next bus will arrive. Several private companies and public agencies are developing systems for alerting drivers to congestion levels on freeways, sometimes predicting trip times based on current congestion levels. These efforts attempt to give travelers transportation information that will enable them to select the modes, or mix of modes, that best serve their needs for a particular trip.

A second, medium-term approach to using information provision to induce people to shift away from solo driving is to provide travelers with one-time, personalized counseling on their travel alternatives. For some time, programs have helped commuters to find a way to carpool, including matching up carpool partners, and some large employers hire commute managers to help their employees identify alternatives to driving. Moving beyond just commute trips, the German firm Socialdata has developed a program it calls "individualized marketing," which in the United States has been tested under the program name TravelSmart®. In the TravelSmart program, participants are asked what travel options they would like to learn more about, provided with the information, and given the option to speak with someone to have further questions answered.[1]

Despite the evident value of these short- and medium-term approaches to providing travelers with information, both suffer from an inherent weakness: once the traveler chooses a place of residence, the transportation die has largely been cast. That is, the relative quality of one's transportation options is determined principally by the transportation options available from one's home. If you live in an area with no or little transit service, even the most accurate and up-to-date information on public transit service in your city is unlikely to induce you to ride the bus. If the closest grocery store to your home is five miles away, no amount of information is likely to induce you to walk there on a regular basis. Transportation decision making involves both short- and long-run decisions, and the choice of where to live is the most important long-run choice. An information policy that focuses only on the daily modal choice may be overlooking valuable opportunities to affect travel behavior.

This study attempts to address the travel information problem at the root by investigating the impact of providing transportation information when people are moving to a new home. It asks whether information on transportation options, delivered at the moment of residential choice, can alter one's residential location and thereby change one's transportation environment. The study was designed as a simulation experiment, whereby a randomly selected group of graduate students (the experimental group) were asked to choose their top five preferred homes from a database of available rental properties. The database provided integrated information on the bus, walking, and biking options from each unit. A control group went through the same process but used a housing database without integrated transportation information. We were thus able to test what impact the integrated transportation information might have on the rental units the experimental group chose.

Members of the experimental group selected residences significantly closer to their campus destinations than those who were exposed only to the conventional information; such a choice, if played out in actual residential location, would make both walking and cycling more realistic transportation options. We found that providing integrated transit information did not induce the experimental group as a whole to select locations closer to bus lines, but certain identifiable subpopulations did locate closer to transit lines.

These results suggest that providing integrated transportation and housing information at the time of a residential decision can influence a household's locational choices. This finding may be relevant to organizations interested in reducing use of the single-occupant auto by their affiliates, or in ensuring mobility to a carless population. These organizations may include universities, agencies promoting commuting alternatives, firms with travel demand management programs, or organizations that help people transition from public assistance to employment.

The current study is based on an experimental design, a rarity in studies of land use and travel behavior. Given the nature of the subject, it is almost never possible—or ethical—to assign randomly selected individuals to control and experimental groups to be exposed to different transportation or land-use environments. This study is experimental in that it is based on random assignment of subjects to different information environments. Differences observed between the control and experimental groups can be attributed—within a margin of statistical error—to the effect of being exposed to integrated transportation and housing information. Although the design is experimental, the study is based on a simulation and stated preferences, rather than actual choice of a residence. How the behavior revealed in the experimental simulation would map to actual residential choice remains uncertain, but the results are promising enough to support the need for a follow-up to this study that would use a similar design but track actual residential choices by members of control and experimental groups who used the database for their actual housing search, not a simulated one.

The remainder of this report is organized as follows. The next chapter discusses the existing research relevant to this study and shows how the current research fits into that larger picture. The following chapter explains the specific research design used in the study. A summary of simulation and survey results follows, and the main results section summarizes the effects of providing integrated transportation accessibility and housing information to residential decision makers. We conclude by suggesting the implications of the study for both policy makers and future research.

Appendix A shows the e-mail sent to recruit participants. Appendix B presents the instructions given to the participants who were chosen. Appendix C presents the survey questions that participants were given. Endnotes, a list of abbreviations and acronyms, and a bibliography follow.

# TRANSPORTATION, INFORMATION, AND RESIDENTIAL LOCATION

This study investigates the intersection of research on choice of travel mode, choice of residential location, and how people use information to make decisions. In transportation, studies of mode choice have measured the components of individuals' decisions to travel by foot, transit, automobile, or other modes. Yet the primary shaper of the relative quality of these modes is location. Where one lives, works, shops, and recreates will fundamentally shape the travel options available. Theories about locational choice—especially choice of one's place of residence—are thus central to research on the land-use/transportation interaction. One's choice of location is, in part, a function of the information that can be obtained about it and competing choices. Economists employ the "perfect information" assumption to define competitive markets, yet empirical research suggests that people use information in ways that are more subtle and complex.

These three areas—transportation mode choice, location choice, and use of information—have increased in policy prominence as well. The decrease in highway construction over the last two decades has heightened emphasis on finding innovative strategies that improve operations and management of current assets. Use of innovative information technology (IT) applications is one option that can sustain and revitalize our transportation systems. In contrast to a general focus on adequate information for the modal choice decision, this study considers the provision of bundled transit and housing information as an advanced application enabled—but not currently deployed or under development—by current IT technology. Several transit agencies have adopted IT-based information dissemination strategies, but none have measured their impact on travel behavior, including ridership changes.[2] The paucity of research on the behavioral impacts of providing integrated transit information limits opportunities to improve the performance of transportation alternatives.

## TRANSPORTATION AND RESIDENTIAL LOCATION

### The Current Debate

Although the current study is motivated by the potential for policy to affect travel behavior, its immediate focus is on the residential location decision. Residential location involves two basic choices: housing type and residential environment. These correspond to the geographer's two aspects of location: site and situation. "Site" refers to the characteristics of a place, including attributes of physical layout, social composition, and climate. "Situation" is the position of the location in relation to other places—its relative location. Transportation access—or the ease of reaching one's destinations—is an attribute of situation that circumscribes residential location choice. Thus, while people may focus most overtly on their site requirements in choosing where to live, theories of residential search suggest that people limit their housing search to neighborhoods that fill their situational needs.[3] The outcome is often a compromise between situation and site.[4]

Given residential locators' interest in both situation and site, it is not surprising that research on locational choice has divided between two schools. The first school, which follows Alonso, focuses on the relative costs of transportation and housing in determining residential locational choice.[5] Within this framework, a household has two options: it could locate close to work, where housing prices are presumably high, but transportation costs are relatively low; or it could select a remote location with cheaper land costs but higher expenses for the commute and other trips. The optimal location for the household is the location where the marginal cost of land just equals the marginal savings in transportation costs. In this model, the tradeoff between land costs and transportation costs fundamentally drives residential location. Since land costs are primarily a function of the land's accessibility, it may be said that this model is oriented to the situational characteristics of the location. For the second school, which follows Tiebout, site characteristics such as schools, taxes, crime, and the local environment are the primary forces driving residential choice, with transportation costs playing a smaller role in people's decisions on where to live.[6]

The Alonso school perceives a strong transportation-location link, with transportation costs being a primary driver of locational decisions; under the Tiebout worldview, the transportation-location link is weakened, with households choosing residences on the basis of local attributes with little regard to transportation cost. These two schools lead to different conclusions regarding current transportation and land-use policies. Following Alonso's model, if transportation accessibility remains central to locational decisions by residential, commercial, and industrial actors, changes in metropolitan form—that is, the extent of urban sprawl or compact development—will be sensitive to transportation investment decisions. For example, a decision to expand a peripheral highway could trigger auto-oriented development in the territory it serves; conversely, transit investments hold the potential for supporting compact and pedestrian-friendly development in their vicinity. In the Tiebout framework, residential locators are more motivated by amenities of site than by situation-related attributes such as transportation accessibility. If this is the case, processes of sprawl will occur largely independent of transportation investment decisions. Under this theory, low-density, auto-oriented development has attributes that consumers demand; this market interest is strong enough to produce sprawl even without major supportive transportation investments. Transit investments have little power to spur redevelopment at higher densities, since the improved access that they offer is of little importance to people's locational decisions.

Each position enjoys a measure of empirical support. The "weak link" view tends to be supported by studies that compare actual commuting patterns in a region to those patterns that would theoretically occur if residents were reorganized into homes that minimized their commuting distance. The ratio of the minimized aggregate commute distance to actual distance is taken as a measure of the impact of urban form on travel; where the actual distance is close to the minimum, the physical arrangements of homes and workplaces would seem to be a binding constraint on travel behavior.[7] By contrast, if actual commutes are much higher than the minimum required—and this tends to be the case in most areas—it would appear that nontransportation factors drive residential choice to a greater extent.[8] In addition, survey research that asks people to rank or rate factors influencing their choice of residence tends to reveal relatively low scores for transportation-related factors.[9]

The "strong link" view draws support from empirical studies of residential location that regularly find commute travel time to be the single most influential factor in residential choice.[10] In addition, capitalization studies show that urban rapid transit systems tend to increase property values in their vicinity, suggesting that transit access matters to residential and nonresidential locators.[11]

## The Gap We Fill

The studies described above focus on the transportation/land-use link as expressed in current behavior. Implicit in these studies is the notion that the strength of the connection between transportation and land use is a reality that is there to be measured and is reasonably fixed at any time. The relationship is conceived of as an input to policy making, not the target of directed policy. By contrast, this study is motivated by the idea that the strength of the relationship between transportation and land use may be, in part, an outcome of governmental action. That is, it is neither inherently strong nor inherently weak, but can be strengthened or weakened by policy. Within this framework, even if individuals' preferences are fixed, their capacity to act on these preferences varies according to the transportation, land-use, and information environments that they face. If directed policy interventions, such as providing targeted and timely information, can facilitate choices different from those that might otherwise be made, they can strengthen the observed transportation/land-use link. Such a strengthening offers the potential for policy-driven reductions in, or moderations of the growth in, vehicle miles traveled.

Table 1 describes the relationship between research in travel behavior and in transportation information provision; each has short- and long-term dimensions, but research into long-term decision making impacts of transportation information is currently lacking. This study seeks to contribute in this area.

**Table 1 Correspondence Between Transportation Information Provision and Land Use/ Transportation Behavior Research**

| | Land Use/Transportation Behavior Research | Information Provision |
|---|---|---|
| Short-term decision making | Travel behavior (trip generation, modal choice, route choice, and so on) | Itinerary planning, real-time information, multimodal traveler information |
| Long-term decision making | Locational choice and its implications for travel options | Currently lacking information to facilitate the transportation/land-use relationship |

## THE ROLE OF INFORMATION IN DECISION MAKING

This project considers information provision as a potentially useful policy tool to alter people's residential choices, and, indirectly, their travel behavior. Yet people's use of information in decision making is far from straightforward. Research has considered strategies people use to sift through information, and the conditions under which information is accepted and used. Of particular importance is the use of information in changing people's behavior, which is difficult when that behavior is habitual.

One starting point for imagining an individual's use of information is the "perfect information" assumption: markets in perfect competition are, by definition, characterized by individuals who possess complete and accurate information about all options available to them. This notion is a poor match for many situations, however. Economists generally assume that people will rationally acquire information up to the point that the marginal value of the information is equal to the marginal cost of acquiring it. To put it more simply, people stop collecting information once they realize that the benefits of new information are unlikely to make it worth the effort of searching for that information.

Herbert Simon has argued that even this assumption of rational information acquisition is an inadequate descriptor of people's use of information; instead, their behavior better matches a concept of **bounded rationality** entailing four components:

- The **principle of intended rationality** says that although people are goal-oriented, they are influenced by a range of thoughts and emotions and the complexity of the environment; the standard assumptions of economic rationality are not supported.
- The **principle of adaptation** says that the "task environment" forms most human behavior. According to Simon, "There are only a few 'intrinsic' characteristics of the inner environment of thinking beings that limit the adaptation of thought to the shape of the problem environment. All else in thinking and problem-solving behavior . . . is learned and is subject to improvement."
- The **principle of uncertainty** says that uncertainty is more fundamental to choice than probability calculus implies. If one is not clear about *the factors involved in a problem*, this uncertainty affects the entire decision making or problem-solving process.
- The **principle of trade-offs** is explained by Simon's idea of satisficing. In contrast to the standard assumption in economics that people thoroughly evaluate all their options and then choose the *optimal* one, Simon asserts that individuals merely evaluate their options until they find one that is *satisfactory* to them.[12]

The four principles imply that the link between providing people with information about travel options and changes in their travel behavior may not be straightforward. There is only modest evidence that people change their travel behavior as a result of receiving new information. It has been found that transit users tend to make scant use of information resources such as maps and schedules when they are available.[13] In general, research shows that regular users of transit prefer reliability over real-time information; they are reluctant to invest the time to access information when it is available, preferring to rely on established habits that require little thought.[14] Nonregular users of transit may be even more impervious to efforts at information dissemination. One approach to this question is to characterize travelers, both those who accept and those who ignore proffered transportation information, with an eye toward developing information provision strategies for each. Colorfully, Mehndiratta, et al., labeled the various groups as "control seekers," "webheads," and "low-tech information seekers."[15]

Information use in transportation has been the subject of experimental research designs as well. For example, Kitamura, et al., used laboratory interviews to assess the types of information that are important to travelers, the impact of exposure of information on attitudes, and user receptiveness.[16] Abdel-Aty surveyed travelers in San José and Sacramento to implement a stated preference experiment on the impact of information provision on modal choice.[17] Mahmassani and Liu employed an experimental simulation design to test factors affecting decisions on when to switch departure times and routes, with an eye to the design of Advanced Traveler Information Systems (ATIS).[18] Other evaluations of Advanced Public Transportation System (APTS) and ATIS deployments have tended to use quasiexperimental evaluation research designs.[19] The strength of these designs is in their realism; because they are based on actual choices, they eliminate the possibility of strategic or otherwise erroneous statements of preference. While these studies have the advantage of being carried out under real-world conditions, the vagaries of APTS and ATIS deployment, coupled with the countless other uncontrolled changes affecting travel patterns, have frequently led to ambiguous outcomes.

An overall theme emerging from studies of information use in transportation is the importance of the habitual, satisficing, or otherwise less-than-optimizing behavior of travelers. While standard models assume that people rationally evaluate travel options for each trip, as a practical matter, several factors lead to a fair degree of inertia in travel behavior; travelers tend to rely on established behavioral patterns, and it is hard to budge people from these habits. Under ordinary circumstances, travelers make occasional "strategic" choices to change mode over the long term, but day-to-day modal choice tends to be "tactical" (that is, derivative from their long-term behavior); therefore, people are unlikely to change their patterns just because they are given new information.[20]

Travel behavior has been characterized as a habit, an observation with significant implications for an information-based strategy aimed at encouraging people to change their travel behavior.[21] Habitual behavior is characterized by lack of awareness, in that people do not think about their actions; by efficiency, in that actions are carried out with little effort; and in some cases, by lack of control. Because habitual behaviors are taken without conscious thought, it is hard to change them by providing information, since most people are unlikely to pay attention. The more habitual the behavior, the less the actor seeks or is even amenable to new information that might lead to altered behavior. In one study, drivers with stronger habits systematically sought out less travel information than those whose habits were weaker.[22]

On the surface, the habitual nature of most daily travel seems to imply that it is useless to try to encourage people to change their travel behavior habits by giving them information; people who habitually rely on their cars will be relatively impervious to information on alternative travel options. This conclusion implies that short-run information-provision strategies aimed at influencing people's daily choice of travel modes are likely to have only limited effect. However, psychological research offers some hope for information provision as an effective policy to promote behavioral change, at least under certain circumstances. Habits tend to be environmentally conditioned: the immediate surroundings send cues that trigger habitual behaviors. Thus, a particular social environment might trigger smoking or drinking; habitual consumption of fast food might be stimulated by the proximity of outlets. It stands to reason that travel behavior also is triggered by environmental cues. One might expect the environmental dimension to trigger travel behavior more strongly than other habits, since the purpose of transportation is connected to the physical environments of one's origin and destination.

The observation that habits are largely environmentally triggered offers an insight into how information can stimulate behavioral change: information that comes at the moment of a change in one's environment is likely to be received better than at other times. The time when people move to a new home should be a moment when they are more susceptible to behavioral change in general, including information-induced behavioral change. For example, Verplanken and Wood documented a change in students' exercise habits associated with a shift to a different college campus.[23] Heatherton and Nichols found that, in general, moving to a new location increased the likelihood that people successfully translated a desired shift in some aspect of their lives to an actual change.[24] Bamberg, Rölle, and Weber examined the effects of offering a free bus ticket to people who had just moved, demonstrating that recipients responded with increased transit riding.[25] A period of shift in one's environment can be thought of as a special window of opportunity when a number of rigid habits become temporarily looser, until a new set of environmentally conditioned habits sets in.

This notion that people are more open to changing pre-established habits during times of change has clear implications for travel behavior; the time when an individual or household relocates to a new environment is a particularly opportune moment during which new travel behavior is formed. Thus, providing people with information about their travel choices during this window of time is more likely to stimulate them to use the information than providing the same information at other times.

However, psychological research into the modification of habitual behavior suggests a second principle: intervention should occur "upstream" of the behaviors that it is trying to affect.[26] That is, treating the behavior at its point of expression may be less effective than altering some precursor trigger to the behavior. In the case of transportation, residential location can be seen as a precursor behavior that is "upstream" in the causal chain from travel behavior. In this sense, providing people with information about their travel choices before they choose a new home may be more influential than providing travel mode information at the time of the trip itself.

None of the above is to imply that driving is a bad habit that is analogous in its health or moral implications to smoking or overeating. Driving is frequently the most rational travel choice for individuals in the environments of U.S. metropolitan areas. Nevertheless, it may have some habitual aspects that render travel decisions less than optimal, even for the individual. Transportation planners are regularly frustrated by the sight of people driving distances that they could easily have walked, or drivers circling for parking when a short bus hop would have saved them time. The natural inclination in these instances is to redouble efforts at information provision. A focus on the habitual nature of driving behavior can assist in developing a program of information that has a greater likelihood of success. The current study is structured around this notion.

## TRANSPORTATION CHOICE AND RESIDENTIAL CHOICE

A policy designed to increase the use of transportation alternatives should be based in a theory of people's choice of transportation modes. Since the development of McFadden's discrete choice framework for transportation demand analysis,[27] the determinants of modal choice have been described with great consistency; as such, they underpin the analysis described here. People consider total trip times when choosing among travel modes, but they find the time spent outside the vehicle (for example, in walking, waiting, or transferring) several times more onerous than that spent in the vehicle itself. In addition, transfers between vehicles carry a utility penalty beyond the time involved in switching between vehicles. Service cross-elasticities between competing modes—for example, the effect of an improvement in auto service on transit usage—tend to be greater than price cross-elasticities (for example, the impact of transit subsidy on use of the drive-alone mode).[28] The availability of free parking is among the most significant determinants of use of the drive-alone mode.[29]

For policymakers interested in improving the market share of nonautomotive modes, the problem is that much of the above is effectively predetermined by patterns of land use. With significant investment, a high level of transit service can be deployed in limited corridors. However, where development is not concentrated in those corridors, use will be slight because the physical environment presents the opposite conditions from those that support transit: walk time is great, transfers are many, highway level of service is high, and free parking is plentiful. In this environment, transit can attract people without cars, but faces nearly insurmountable barriers in attracting riders who have the option to drive. Pedestrian trips are even more spatially conditioned, with the majority under one-half mile in distance. Thus a policy of enhancing transportation options is intimately related to the locational choices people make, and these depend in part on the information that they can assimilate.

Information about residential location opportunities tends to deteriorate with distance; these spatially determined limitations on information availability have been shown to influence the patterns of residential relocation within metropolitan areas. Most people move relatively short distances. They also tend to move within the same sector of the metropolitan area; for example, a resident of the northeast corner of the city is much more likely to move to a northeastern suburb than a northwestern suburb. Palm and Davis explored the effect of the less spatially conditioned Internet-based information on this pattern: Would Internet users exhibit a less constrained pattern of relocation?[30] In fact, Internet use was associated with neither greater distance nor more sectoral switching. The mere fact of an information-rich environment does not necessarily affect housing-search patterns. The question of whether a targeted policy of information provision can affect households' locational decisions remains. Because such decisions effectively determine the relative attractiveness of the modes—for example, by placing the individual within or beyond walking access to a direct transit trip to his or her destination—they underpin the location-transportation relationship and appear to be a natural target for information dissemination.

# STUDY METHODS

To test the hypothesis that individuals choosing where to live are more likely to prefer a rental unit with good transit and/or walking access to destinations if they are provided with this kind of accessibility information as part of their initial housing search, we followed a classical experimental research design in a laboratory setting. We brought 236 University of Michigan (UM) graduate students into a computer laboratory, where they were asked to select their top five choices of where to live after reviewing a database of residential properties that was custom designed for the study. The study used data from actual rental properties gleaned from the UM off-campus housing database. To assess the influence of the transit information, we divided study participants into two groups. The "control" group received information about each rental unit, in table form, that included only the attributes currently standard in most private and university housing databases, such as price, the number of bedrooms, and the availability of off-street parking. In different laboratory sessions, the "experimental" group received the same information, plus additional information about how far the unit is from a transit stop, the transit service frequency and directness, and distance to the part of the university campus that the student visits most often. Data on housing opportunities were presented to the experimental group in map form, with each property classified according to its accessibility to the individual's campus (Table 2). After choosing their desired rental properties, all participants filled out a survey that asked about their current travel behavior patterns, desired features in housing, and sociodemographic characteristics.

**Table 2 Definitions of Accessibility Ratings As Presented in the Information System**

| Level of Accessibility | Description |
|---|---|
| Excellent | Walking distance from campus (0.5 mile) or bus route (0.33 mile) with no transfers and less than or equal to 15 minutes frequency |
| High | Walking distance to bus route (0.33 mile) with no transfers and greater than 15 minutes frequency |
| Medium | Walking distance to bus route with one transfer, regardless of frequency |
| Low | None of the above |

The strength of this research design lies in its ability to overcome sample selection bias and provide an unambiguous indication of causality. These advantages are particularly useful for research on information and travel behavior. Although some researchers have argued that experimental designs are limited in their ability to predict effects to the general population or effects that can be translated to other populations,[31] others maintain that it is of critical interest to understand the effects of policy interventions at the individual level before attempting generalizations.[32] As a stated-preference study, this research was able to present the "treatment" of information provision that is unavailable in the real world, yet its findings are subject to the caveat that we did not establish with certainty people's actual residential-choice behavior if faced with these information systems.

## HYPOTHESES AND OUTCOME VARIABLES

The main expectation of our study is that integrated accessibility and housing information presented in the context of a residential relocation will influence people to select residences with higher accessibility than they would have without the integrated information.

- One dimension of increased accessibility is proximity to destinations. We hypothesize that individuals exposed to integrated transportation-housing information will choose residences that are closer to major destinations relative to individuals not receiving the information.
- A second dimension is proximity to transit lines. We hypothesize that individuals exposed to the integrated information will choose housing closer to transit lines in general, and to those serving their destinations in particular.
- A third dimension is accessibility provided by transit to regional destinations. We hypothesize that individuals exposed to the integrated information will select properties that are served by transit routes with higher frequency and route diversity than the properties selected by participants not exposed to the information.
- Fourth, we expect that the above effects are likely to be more pronounced among some sociodemographic groups than others. These are expected to be groups that are "swayable"—they do not have strong a priori commitments to the auto, transit, or walking modes. Groups determined to walk would be expected to seek residences close to their destinations with or without an information system; groups of regular bus riders already know where the routes are and need no information system to help guide them in their residential choices. If transportation "fence-sitters" can be identified, these are likely to be the groups most amenable to behavioral change through information provision.

Given our hypotheses, Table 3 identifies four categories of dependent or outcome variables, which are used in our analysis. They include local access to transit; access provided *by* transit in terms of service frequency and destination diversity; and the nonmotorized accessibility to major destinations in the area. The transit variables are key characteristics of transit service.[33] The accessibility variables correspond to research suggesting that proximity to destinations is critical for the viability of nonmotorized transportation modes.[34]

Comparisons of the average value of each outcome variable between experiment and control groups will identify the desired effects. To determine the statistical significance of continuous outcome variables between the experimental and the control groups, we use analysis of variance (ANOVA). For proportion-type variables, such as the percentage of units selected within one-quarter mile of a bus stop, we used ordered logistic regression with the proportion as the dependent variable and a dummy variable identifying group membership as the independent variable.[35] The significance of the dummy variable coefficient reveals statistically significant differences between the two groups.

**Table 3 Outcome Variables**

| Outcome | Units | Statistical test |
|---|---|---|
| *Access to transit* | | |
| Average network distance to transit from top three | Miles | ANOVA |
| Average network distance to transit from top five | Miles | ANOVA |
| Average crow-fly distance to transit from top three | Miles | ANOVA |
| Average crow-fly distance to transit from top five | Miles | ANOVA |
| Average network distance to high-quality transit from top five. (This is defined as a bus route with no-transfer service to the destination of interest—central campus or one's home campus—and a service frequency of 15 minutes or better.) | Miles | ANOVA |
| Percent of three most preferred properties within 1/4 mile of transit route | % | Ordered logistic |
| Percent of five most preferred properties within 1/4 mile of transit route | % | Ordered logistic |
| Distribution of choices between properties by accessibility ranking | % | Chi-Square, Kendall's tau-b |
| *Service frequency* | | |
| Total buses per hour within 1/4 mile of top three | # of buses/hr | ANOVA |
| Total buses per hour within 1/4 mile of top five | # of buses/hr | ANOVA |

**Table 3 Outcome Variables (Continued)**

| Outcome | Units | Statistical test |
|---|---|---|
| *Destination diversity* | | |
| Sum of the number of routes within 1/4 mile of top three | # of routes | ANOVA |
| Sum of the number of routes within 1/4 mile of top five | # of routes | ANOVA |
| *Pedestrian accessibility* | | |
| Average network distance to closest destination from top three | Miles | ANOVA |
| Average network distance to closest destination from top five | Miles | ANOVA |
| Average sum of network distance to main destinations from top three | Miles | ANOVA |
| Average sum of network distance to main destinations from top five | Miles | ANOVA |

## THE STUDY SETTING: UNIVERSITY OF MICHIGAN GRADUATE STUDENTS

The participants in the study were all graduate students enrolled at the University of Michigan, in Ann Arbor. Ann Arbor, a town of 120,000 people, [36] is located in southeast Michigan, 45 miles west of Detroit. The University of Michigan (UM) is a central element of life in Ann Arbor and one of the main employers—one of every three adults in the city is employed by the university.[37] Surrounding Ann Arbor are the neighboring communities of Ypsilanti, Saline, Dexter, and Barton Hills, where some UM students live. Collectively, Ann Arbor and these nearby local jurisdictions comprise the Ann Arbor metro area (Figure 1).

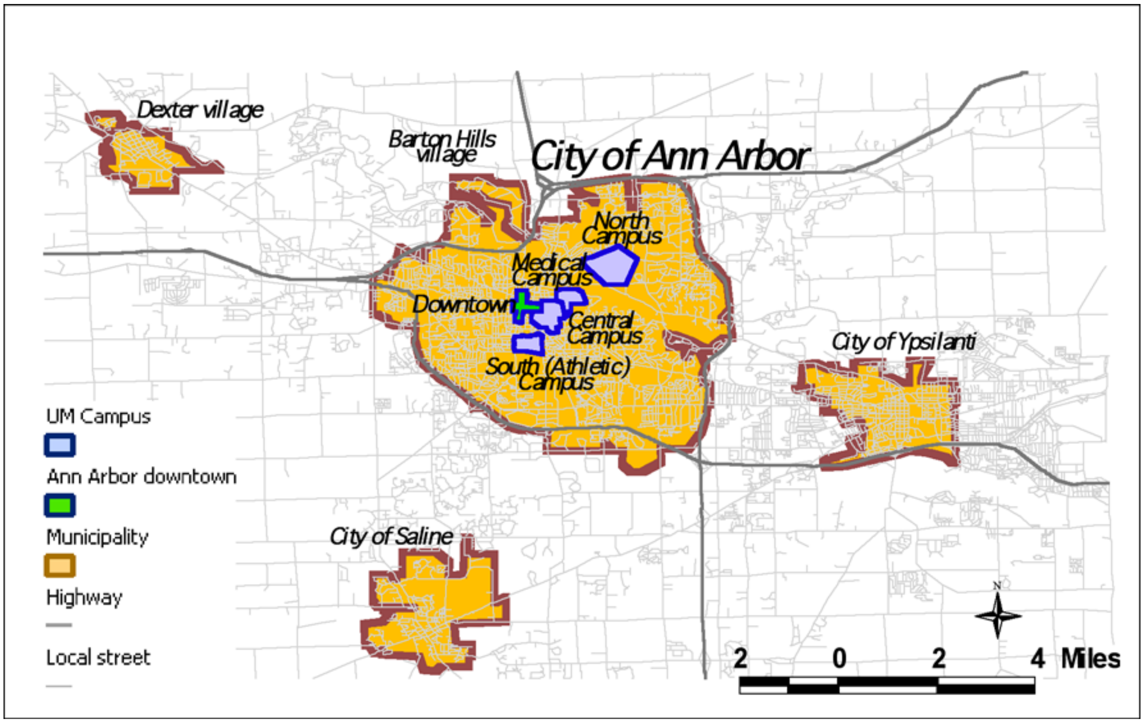


**Figure 1 Ann Arbor Metro Area**

The UM campus is divided into four distinct areas: the Central, North, Medical, and South Campuses. Central Campus, the main campus, is located close to downtown Ann Arbor (Figure 2). North Campus, located about two miles from Central Campus, contains the College of Engineering and the Schools of Music, Art, and Architecture and Urban Planning. The Medical Campus includes the university hospitals and relevant academic facilities. South Campus, known as the Athletic Campus, includes only athletic facilities. Since no regular academic activities occur there, it was excluded from this study.

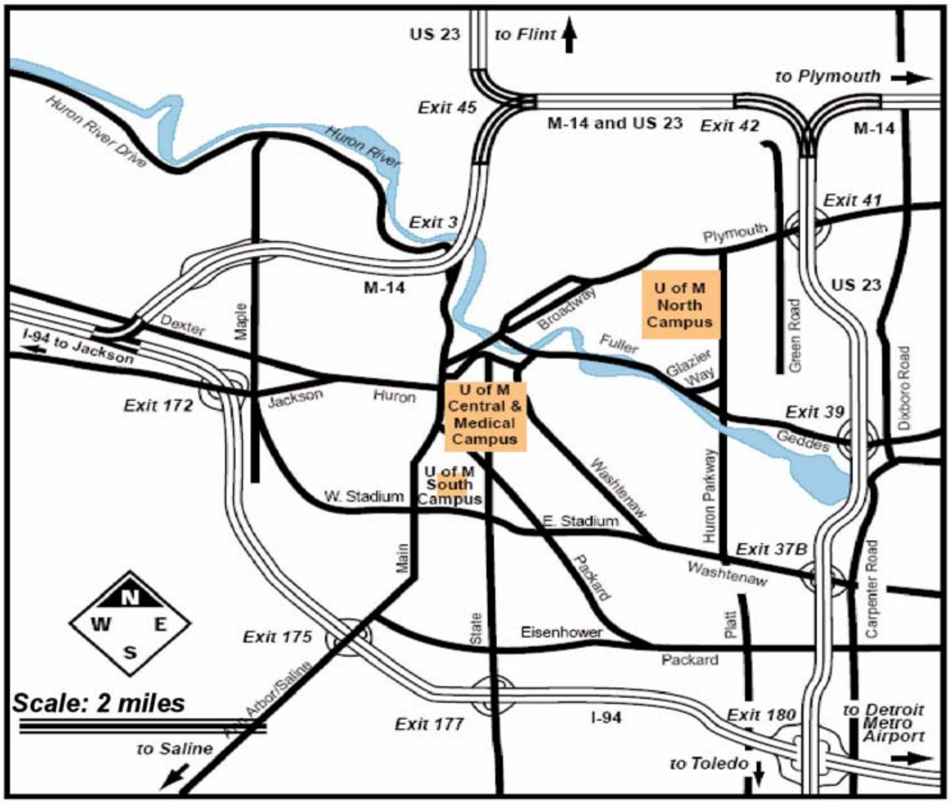


**Figure 2 The University of Michigan Campuses**

Source: University of Michigan Regents, Parking & Transportation Services[38]

The Ann Arbor metro area offers various transportation options for the campus community. Parking for students is limited, and many lots require taking a bus to the campus, so many students do not drive themselves to campus. Bicycles are popular, and there are also university and a public bus services.

The Ann Arbor Transportation Authority (AATA), which operates the area's public transportation system, provides relatively extensive bus service throughout the whole metro area (Figure 3). As of August 1, 2004, all UM faculty, staff, and students receive free, unlimited access to AATA, making the bus a more attractive option for some. The routes cover most of the metro area, including downtown Ann Arbor, major shopping malls, and the UM campuses. There is a bus stop within a quarter mile of almost any location in Central Campus and the downtown area.

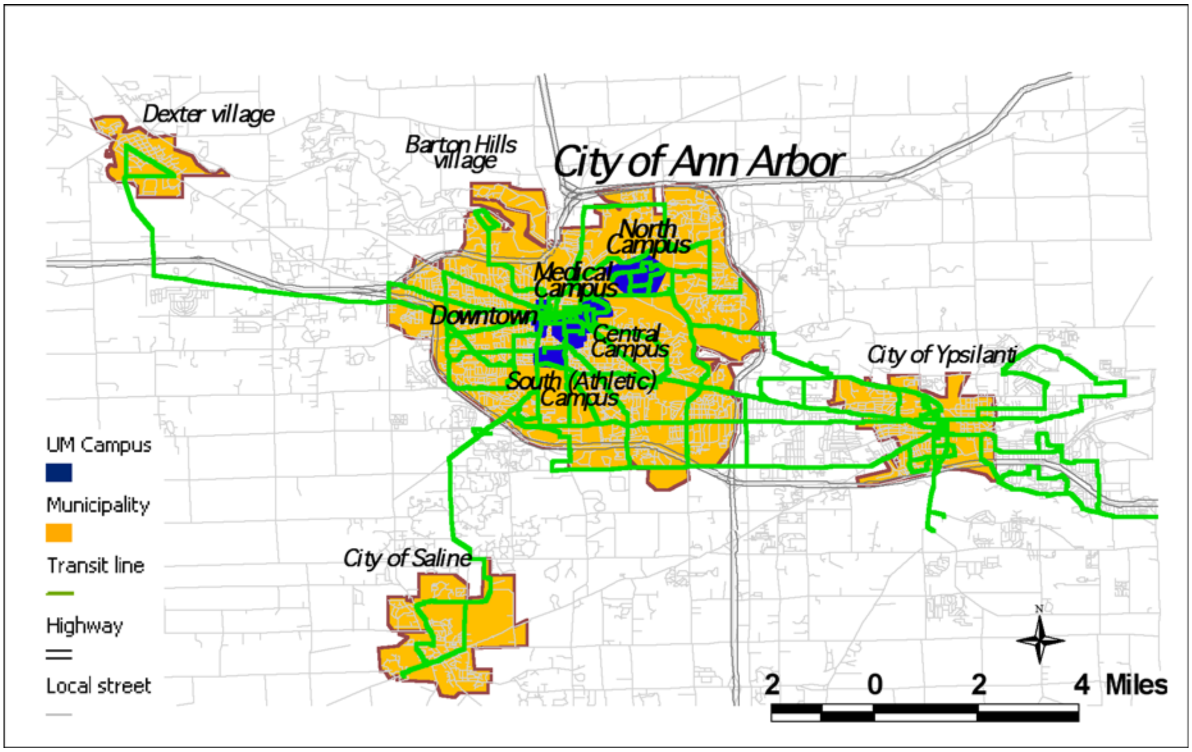


**Figure 3 UM Transit System and Ann Arbor Transportation Authority Route Map**

Note: Dark thick lines are transit lines operated by either UM or the AATA

In addition to the AATA bus service, the university runs campus buses (UM transit) at a ten-minute frequency that connect the major UM parking lots with the Central, Medical, South (Athletic), and North Campuses. The buses do not just serve drivers—some students use the buses to move among the campuses, rather than just as transportation between the parking lots and the campuses.

## OVERVIEW OF THE EXPERIMENTAL PROCEDURE

To examine the influence of integrated accessibility and housing information on the location decisions of individuals, we used an experimental research design. In a laboratory setting, 236 UM graduate students used a simulated rental housing database to select the five properties they would be most interested in renting. We divided participants into two groups: each received a different simulated housing database, and they engaged in the simulation separately. The control group received only the type of unit information currently standard in most private and university housing databases. The experimental group received the same information, plus information about how far the unit is from a transit stop, transit service frequency and directness, and distance to the campus location the student said he or she visits most often. To further improve the experimental group's ability to choose a unit based on its accessibility, they were able to view a map that showed all the units. By comparing the housing choices selected by each group, we were able to assess the extent to which the additional accessibility information provided to the experimental group led them to choose more transit-friendly or pedestrian-friendly rental units.

Participants completed these exercises during hour-long sessions at on-campus computer labs, the Duderstadt Center Windows Training Room on North Campus (Figure 4) and the Shapiro PC Computing Classroom on Central Campus. Twenty-four sessions were held between February 10 and February 25, 2005. The hour-long format afforded participants ample time to complete the simulation and survey.


**Figure 4 Duderstadt Center Windows Training Room on North Campus**

Each hour-long session included three phases. First, participants were shown a welcome screen on the computer that gave instructions for completing a simulation exercise and survey. At this time, participants were also asked to give their informed consent to participating in the exercise (see Appendix B). Next, participants completed a simulation exercise in which they browsed through a simulated rental housing database, called the "simulation tool," to select the five properties they would be most interested in renting. The control group participants were given 15 minutes and the experimental group 25 minutes for this part of the exercise.[39] A small number of participants asked either to print hard copies of their search results as they worked, or to explore a commercial on-line map such as Yahoo maps. Those who asked were allowed to do so in order to mimic the real housing search environment. This enabled control group users to see a geographic display of candidate properties if they were inclined to do so. Access to the Internet would, in principle, allow them to see information on transit lines as well, though few respondents took advantage of this opportunity. For the final step, participants had 15 minutes to complete a Web-based survey.

## DETAILED DESCRIPTION OF THE SIMULATION TOOL

We developed a Geographic Information Systems-based housing search application using the ESRI software package ArcGIS and Visual Basic Programming language. The housing search tool the control group used mimicked currently available on-line housing search applications; the experimental group received a version that had transit and pedestrian accessibility information added. The experimental group also saw the available units on a map, instead of merely in a text list as the control group saw them.

To create a realistic set of rental units for study participants to look at, we based the simulation tool on real properties listed in UM's on-line database of available housing. This database, maintained by the University Housing office, is the system most UM graduate students use to find living arrangements. The 286 properties included in the study came from the 9,324 units retrieved on July 28, 2004.

The specific properties and the total number were carefully selected to provide study participants with a diverse set of choices. First, we enumerated the key attributes that we wanted to be represented in the rental units, including accessibility, price, unit type, and number of bedrooms. The accessibility-price combination was assumed to be the central attribute pair, and rental prices and access to campus were each recoded into four categories. Units were selected to ensure that a choice of units was available at each price-accessibility combination. Attention was paid to other attributes, including bedrooms, furnished versus unfurnished, on-street versus off-street parking, and in-building laundry facilities, to offer a range of housing choices to participants. As a check, both the geographical distribution of samples and summary statistics for attributes was analyzed, and some outliers were removed. With this design, we ended up with 286 properties. Figure 5 shows the study area and a distribution of sampled properties, and Table 4 presents summary statistics on the chosen property set with respect to several key attributes.

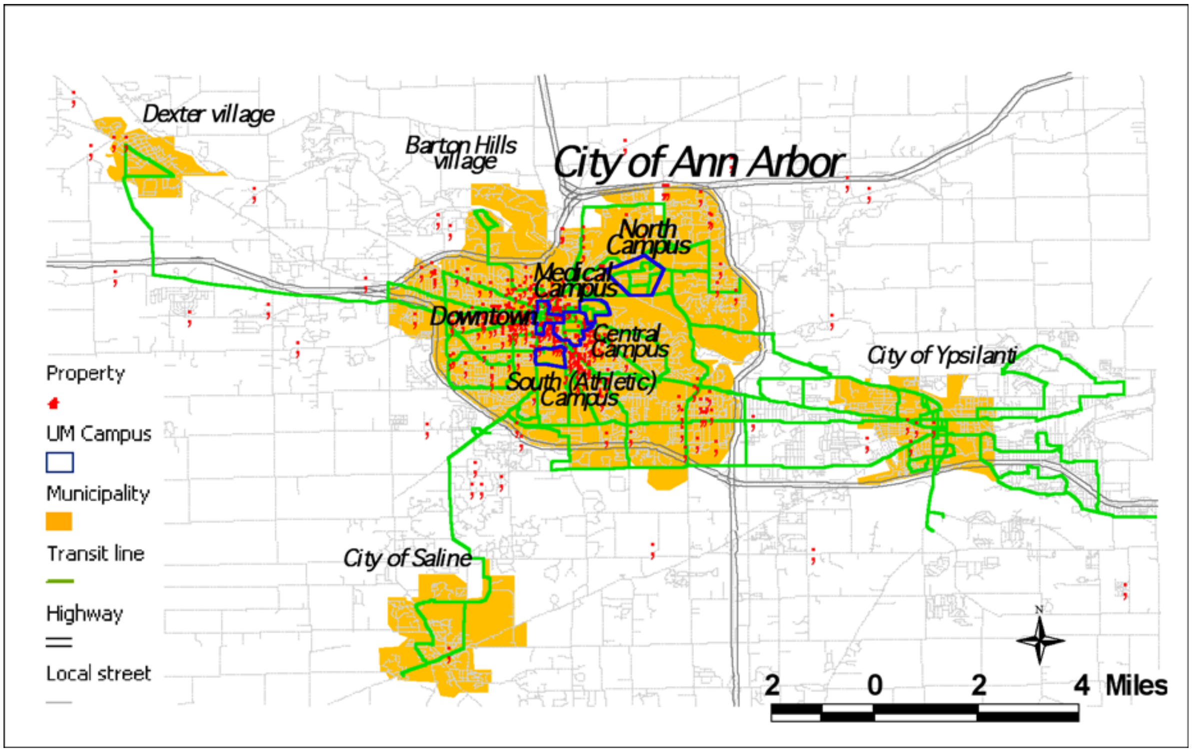


**Figure 5 Study Area, Transit Routes, and Distribution of Sampled Properties**

**Table 4 Description of Variables and Summary Statistics**

| Description of variables | Mean | S.D. | Min | Max | Obs. |
|---|---|---|---|---|---|
| Monthly rent ($) | 880.46 | 637.74 | 250 | 5800 | 286 |
| Bedrooms* (number) | 1.59 | 1.22 | 0.5 | 6 | 286 |
| Furnished (1=yes, 0=no) | 0.23 | 0.42 | 0 | 1 | 286 |
| Pets allowed (1=yes, 0=no) | 0.37 | 0.48 | 0 | 1 | 279 |

**Table 4 Description of Variables and Summary Statistics (Continued)**

| Description of variables | Mean | S.D. | Min | Max | Obs. |
|---|---|---|---|---|---|
| Parking (1=on premises, 0=no parking or on street) | 0.78 | 0.42 | 0 | 1 | 286 |
| Laundry (1=yes, on premises 0=no) | 0.83 | 0.38 | 0 | 1 | 286 |
| Smoking (1=yes, 0=no) | 0.34 | 0.48 | 0 | 1 | 286 |
| Wheelchair accessible (1=yes, 0=no) | 0.05 | 0.21 | 0 | 1 | 263 |
| Unit type (1=apartment, 2=house, and 3=room) | 1.67 | 0.80 | 1 | 3 | 286 |
| Distance to closest transit stop (miles) | 0.47 | 0.53 | 0.01 | 4.19 | 286 |
| Distance to Central Campus (miles) | 2.09 | 2.19 | 0.20 | 14.50 | 286 |
| Distance to North Campus (miles) | 3.33 | 2.00 | 0.62 | 15.04 | 286 |
| Distance to Medical Campus (miles) | 2.34 | 2.11 | 0.20 | 14.80 | 286 |
| Distance to downtown Ann Arbor (miles) | 2.08 | 2.11 | 0.17 | 15.58 | 286 |
| * Studio apartments and single rooms were recoded as 0.5. | | | | | |

The housing search tool comprised four main pages: the *search page*, which allowed participants to search for units according to various criteria; the *search results page*, which showed participants all the properties that met their search criteria; the *unit details page*, which showed all the attributes about any unit of interest; and the *comparison page*, which showed, in table format, the key attributes of up to ten properties that interested the participant. The experimental group also saw a fifth page, the *transit detail page*, which provided detailed information about bus routes and schedules. A more detailed description of each page follows.

## Search Page

The search page allowed participants to search the housing database according to various criteria. For the control group, these were unit type, rent price, number of bedrooms, laundry on premises, furnished, off-street parking, and within 1/3 mile of campus (Figure 6). For the last variable, distance to campus, participants were asked which of the three main university campus sites they visited most often, the Central, Medical, or North Campus, and distance was calculated from that site.

Participants in the experimental group received the same search criteria, with the additional option of searching for units “close to bus,” defined for them as within 1/3 mile from a bus stop (Figure 7).

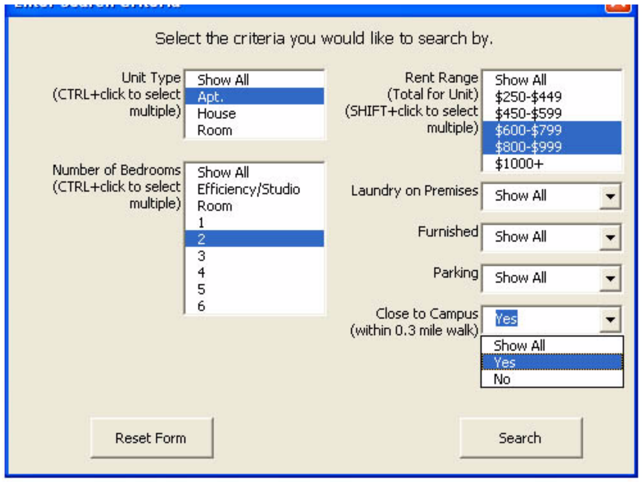


**Figure 6 Search Page for the Control Group**

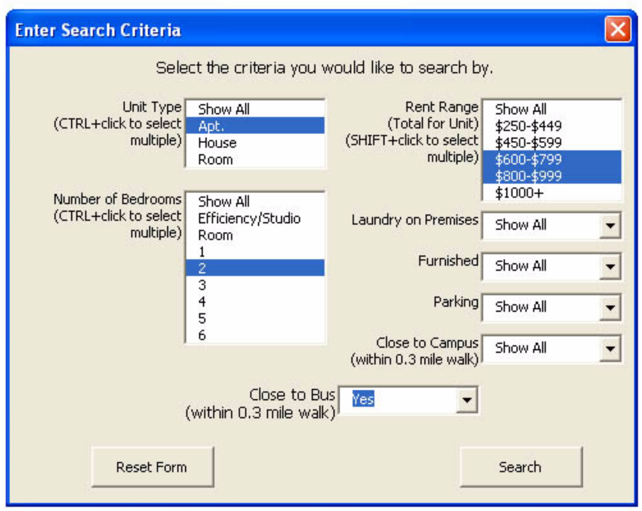


**Figure 7 Search Page for the Experimental Group**

## Search Results Page

Once participants selected their search criteria, they were shown all units that matched. For the control group, this was presented as a simple table showing the address and rental price for each unit (Figure 8). For the experimental group, the search results appeared in map format (Figure 9); each available unit appeared as a dot on the map, color coded by its accessibility rating. The three campuses and all bus routes also were shown on the map, to help participants orient themselves.

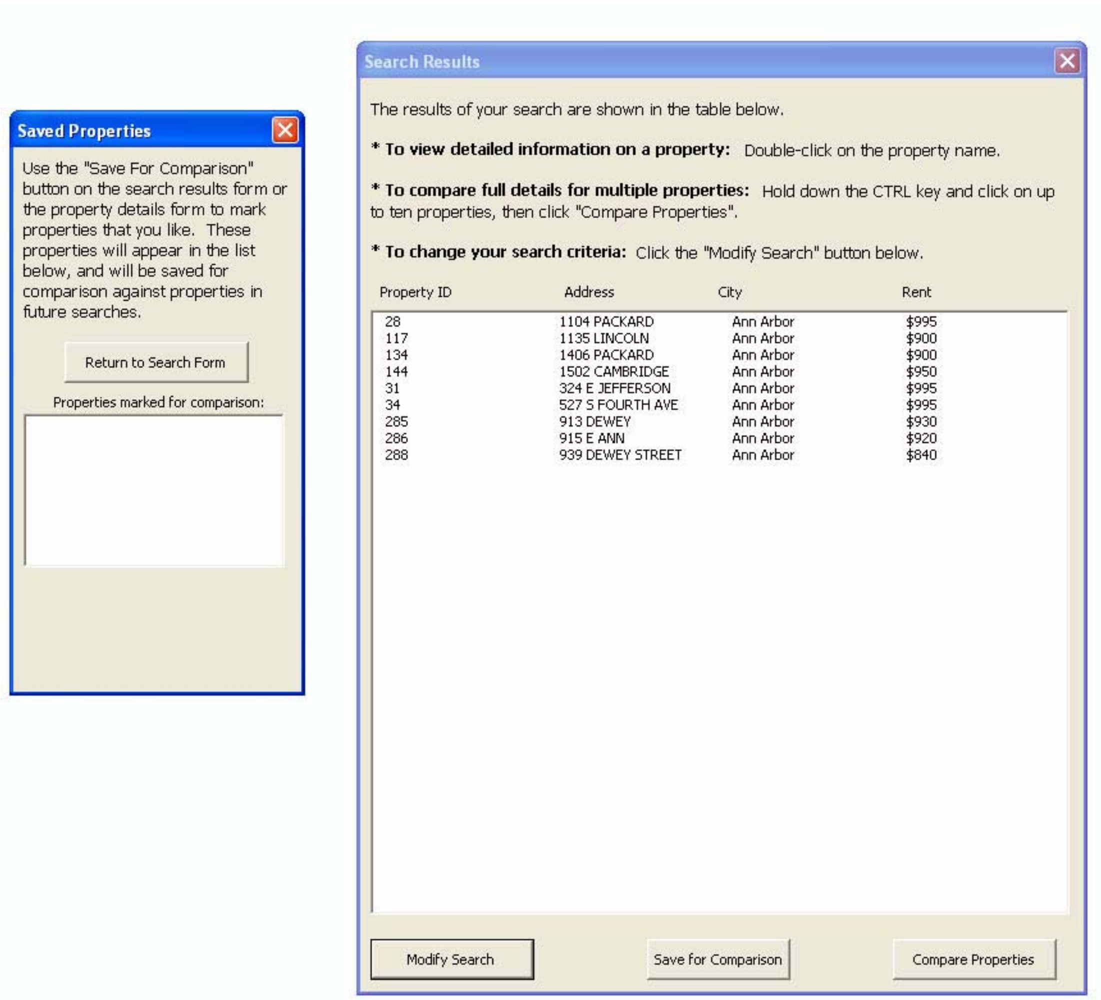


**Figure 8 Sample Search Results Page for the Control Group**

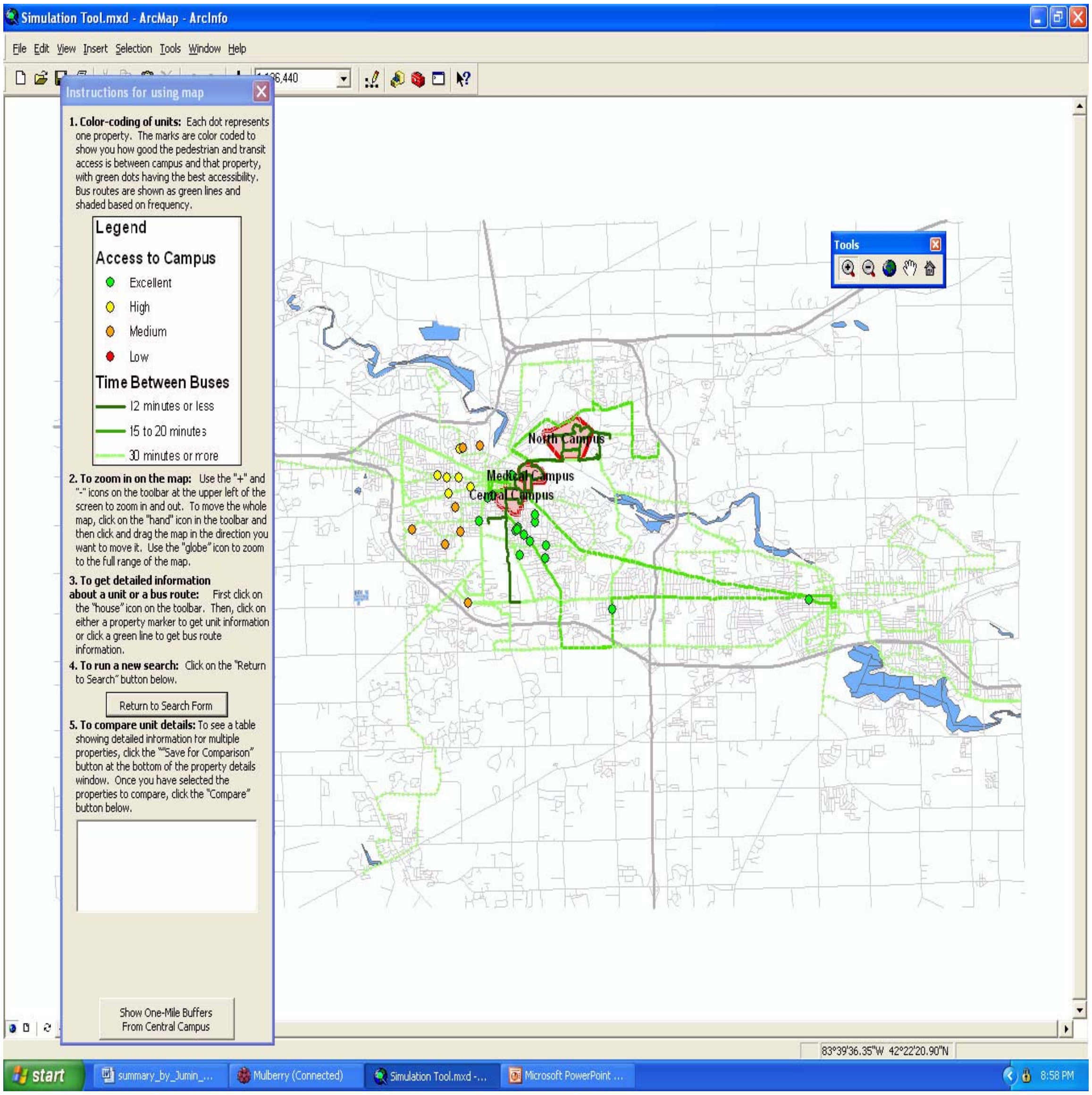


**Figure 9 Sample Search Results Page for the Experimental Group**

A sidebar (Figure 10) explained to participants how to interpret the special features of the map. The map displayed the units as different colored dots, where the colors represented how accessible the unit was to the respondent's selected campus. This measure of accessibility incorporated the distance from the unit to the campus that the participant visited most often, and the quality of bus service nearby.[40] Bus routes also were color coded according to service frequency, with the dark green routes having the most frequent service.

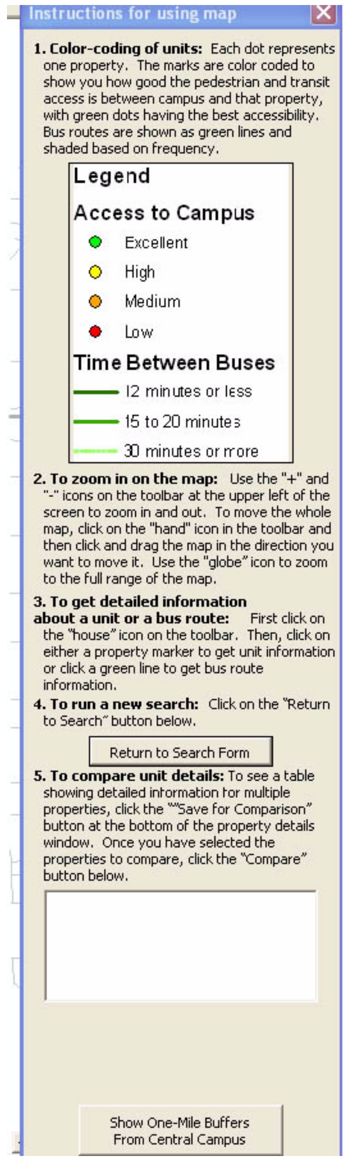


**Figure 10 Instructions for Using the Map Shown to the Experimental Group**

## Unit Details Page

For the experimental group, detailed information about a unit or a bus route was provided on a unit detail page. This page showed property information, address, proximity to campus and transit, and transit frequency and transfers. For all properties, the page also displayed photos of the property and its neighborhood. The version of the unit details page shown to the control group was similar, except that it did not provide information about transit frequency and transfer (Figure 11 and Figure 12).

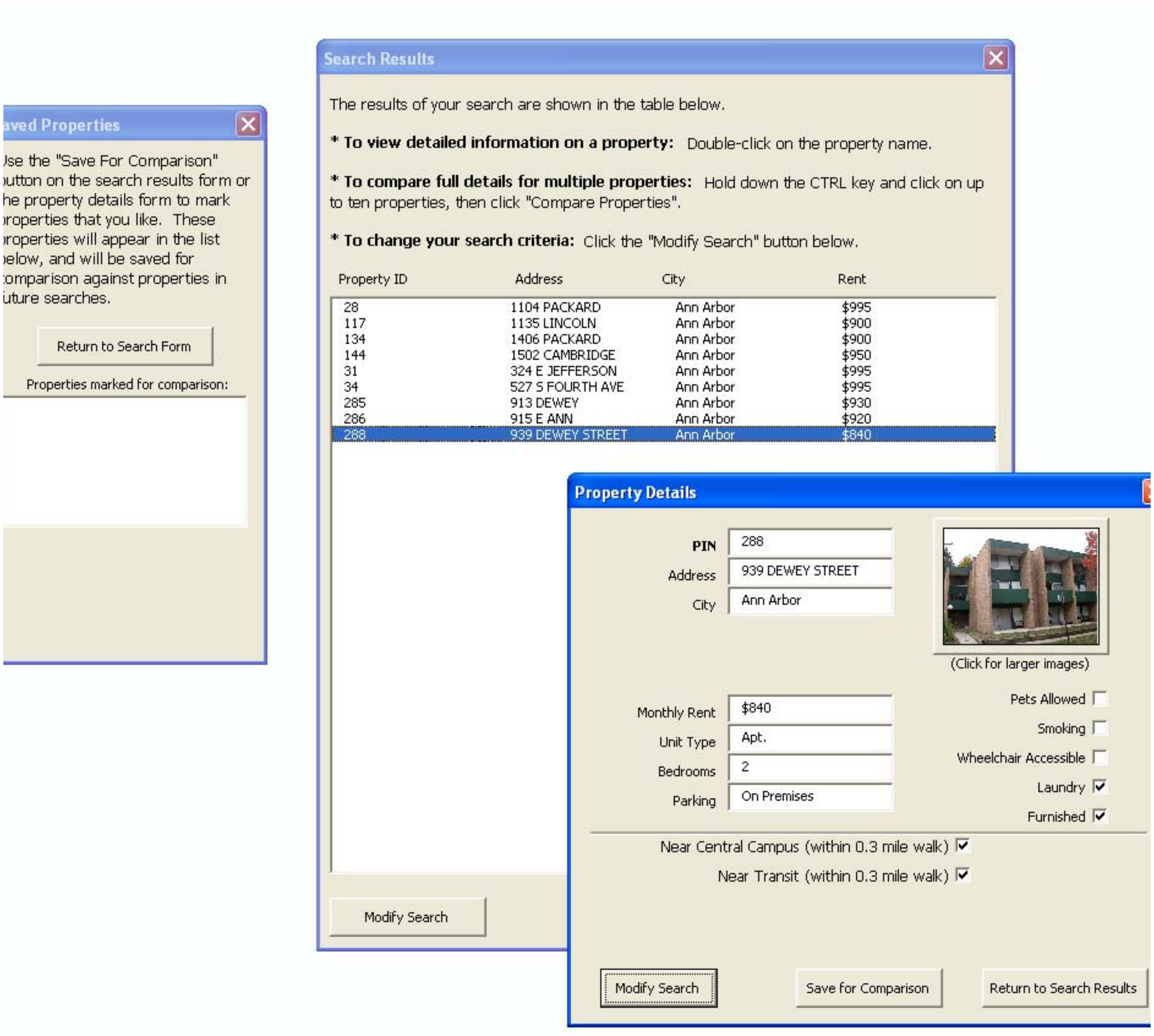


**Figure 11 Sample Unit Details Page for the Control Group**

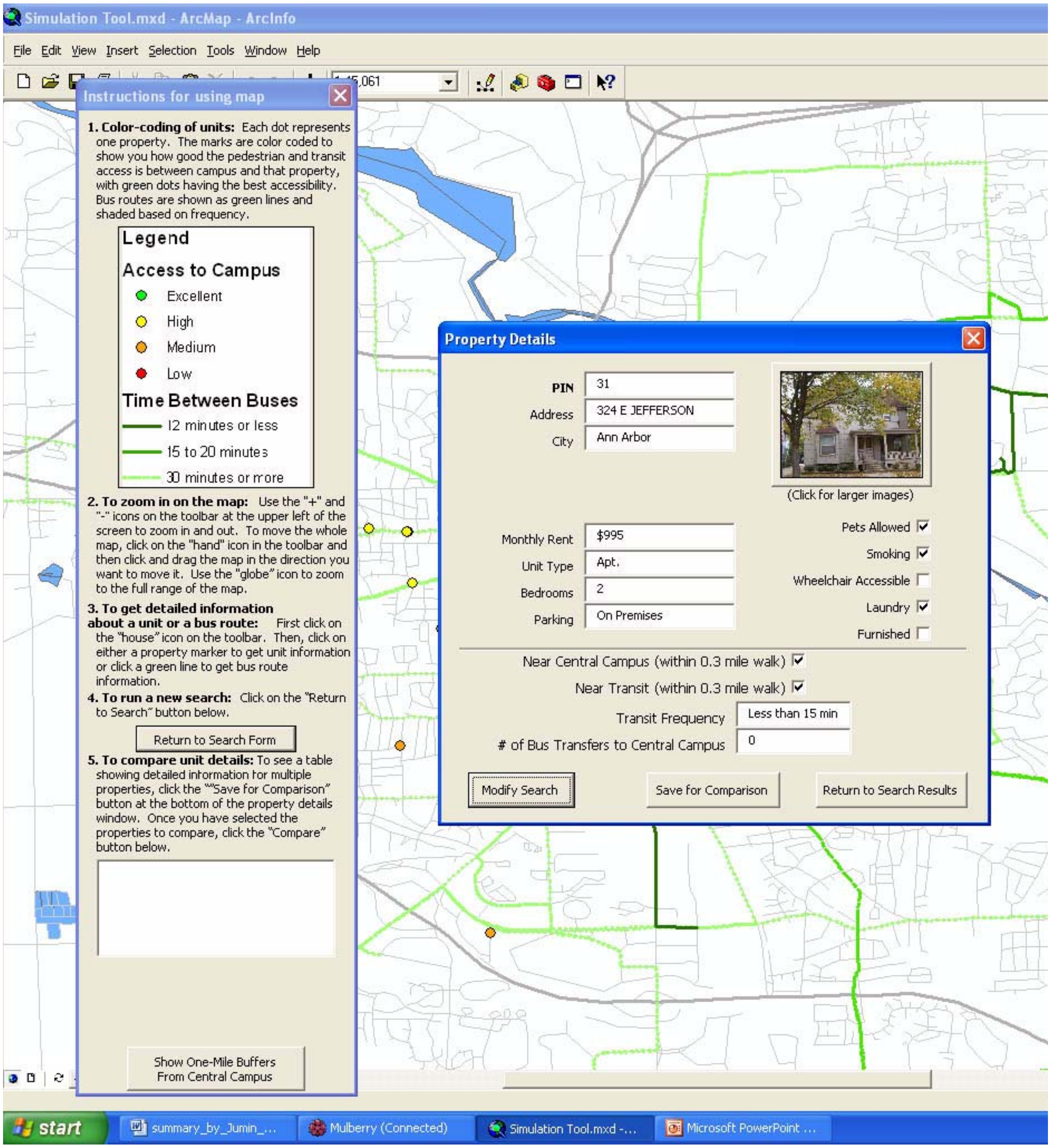


**Figure 12 Sample Unit Details Page for the Experimental Group**

## Transit Details Page (Experimental Group Only)

The experimental group also had the option to see detailed information about the service on any bus line, as explained in the instructions for using the map (Figure 10). Clicking on any bus line brought up a page with the route and schedule information for that bus line (Figure 13).

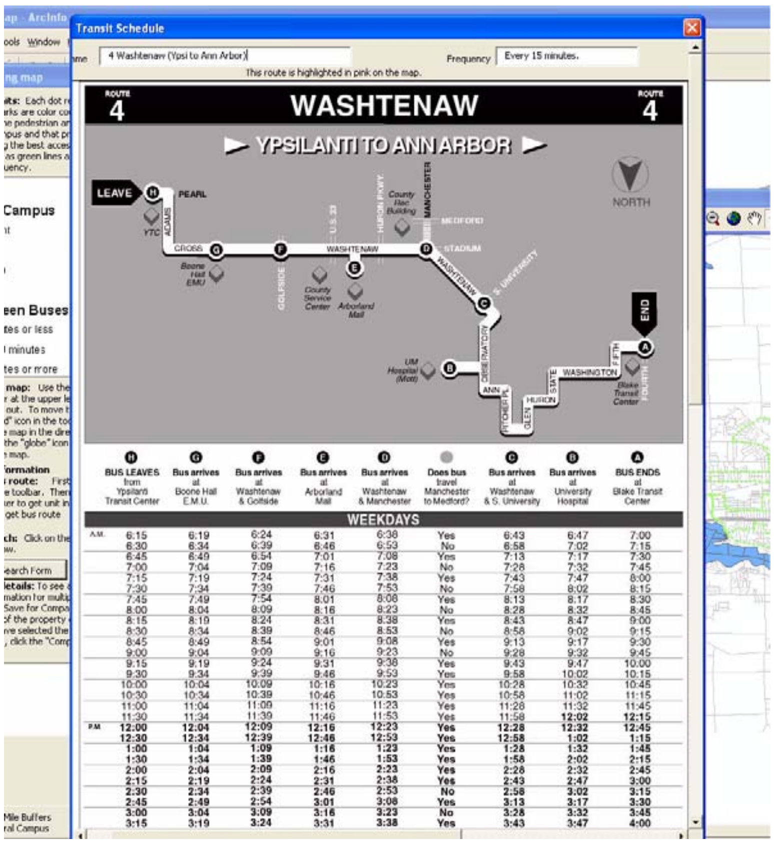


**Figure 13 Sample Transit Details Page for the Experimental Group**

## Results Comparison Page

The results comparison pages allowed participants to see the detailed unit information for multiple rentals of interest, all in one table, facilitating comparison of properties. The criteria were displayed as rows, and the data on each unit showed up in a column. The comparison pages were similar for the control and experimental group, except that only the latter received information on the variables “Close to Transit,” “Frequency of Bus to Campus,” and “Bus Transfers to Campus” (Figure 14 and Figure 15).

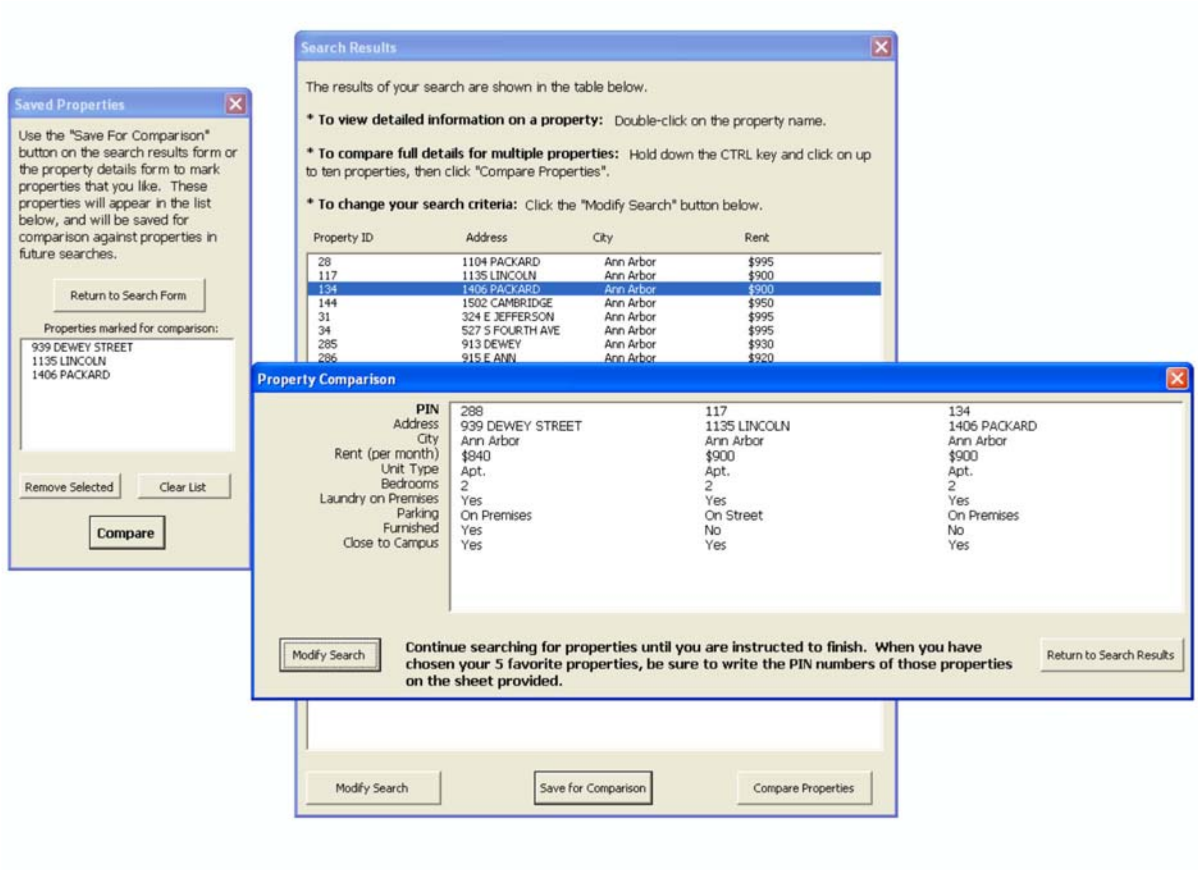


**Figure 14 Results Comparison Page for the Control Group**

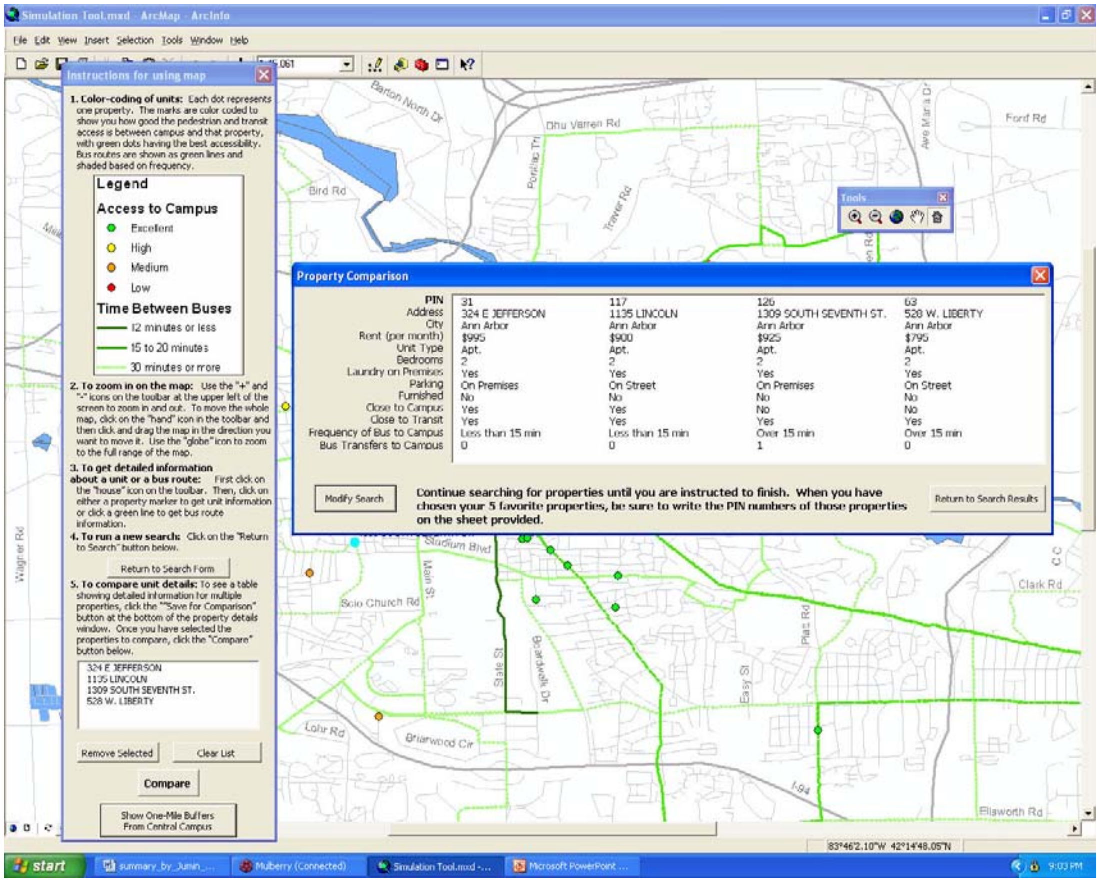


**Figure 15 Results Comparison Page for the Experimental Group**

## PARTICIPANT SELECTION AND RECRUITMENT

To recruit participants, we sent e-mails inviting UM graduate students to participate in the experiment. Graduate students were used in this study because of their experience with the off-campus housing market. The invitation e-mail was sent to more than 70 student e-mail lists on campus. To avoid bias toward transit-oriented units, graduate students in architecture, urban design, and urban planning were excluded, since these students are more likely to be sensitive to issues of transit use than the general population. To encourage students to participate, the e-mail mentioned that participants who completed the exercise would receive $20 in cash at the end of the experiment. See Appendix A for a copy of the recruitment E-mail text.

To determine the sample size needed to obtain statistically significant results from the experiment, a power analysis was performed. The aim of the power analysis is to identify the sample size to successfully detect 80 percent of the time if there was a 0.25-mile difference between the experimental and control groups in the distance from the selected rental unit to a bus stop. The power analysis suggested a total sample size of 230 participants (115 in the experimental group and 115 in the control group).[41]

We obtained 520 responses to our recruitment e-mail within three days of sending out the invitation, and 487 of these met our criteria as valid potential participants. Note that the distribution of UM's student population by campus is 20 percent Medical, 30 percent North, and 50 percent Central. Participants were admitted to the study until the minimum number of 230 participants was met. In the end, 236 participants took part in the simulation exercise and survey. The study population was selected to reflect the population distribution across the three campuses. This was because the quality of transit service to the campuses varies, and the strength of the results could be affected by the distribution of the study population between campuses. Half of the study population was randomly assigned to the control group and half to the experimental group.

## THE PARTICIPANT SURVEY

After participants used the housing search tool to select the five rental properties that most interested them, they completed an on-line survey conducted through the Website SurveyMonkey.com. The survey was organized into five sections. The first section asked participants to indicate the five rental units they had selected from the simulation exercise, by typing into the survey the "Property Identification Number" (PIN) for the five housing units that they identified as most interesting. The second section collected information about the factors that participants value when choosing a place to live. The third section asked participants about their attitudes, preferences, and behavior related to daily travel and housing. The fourth section collected demographic and background information about both the participants and their household members, including age, income, and current home location. The last section asked participants to evaluate how easy the housing search tool was for them to use. (See Appendix C for a copy of the full set of survey questions.)

# SUMMARY OF SIMULATION AND SURVEY RESULTS

This chapter and Table 5 summarize the results for the four sections of the survey that collected information on the characteristics of respondents (Appendix C). It presents summary statistics for participants' sociodemographic characteristics (survey section IV), current travel patterns (survey section III), preferences for selecting where to live (survey section II), degree of exposure to transit service (survey section II), self-assessed inconvenience of using transit (survey section II), and ease of using the simulation tool described in the previous chapter (survey section V).

**Table 5 Summary Statistics of Selected Survey Responses**

| Description | Mean | S.D. | Min. | Max. | N |
|---|---|---|---|---|---|
| *Sociodemographic characteristics* | | | | | |
| Age (yrs.) | 25.7 | 4.0 | 20 | 52 | 235 |
| Sex (1=Female) | 0.56 | 0.5 | 0 | 1 | 236 |
| Midpoint of yearly income range ($1,000s) | 22.7 | 17.1 | 5 | 75 | 225 |
| Current monthly rent or mortgage ($1,000s) | 0.70 | 0.50 | 0 | 5 | 232 |
| Affordability (% of monthly income for housing) | 60.1 | 65.2 | 0 | 576 | 222 |
| *Current travel patterns* | | | | | |
| % of UM trips by UM transit | 17 | 22.3 | 0 | 100 | 236 |
| % of UM trips by nonmotorized modes | 35.2 | 34.6 | 0 | 100 | 236 |
| % of UM trips by AATA | 15.2 | 25.3 | 0 | 100 | 236 |
| % of non-UM trips by nonmotorized modes | 26.9 | 33.1 | 0 | 100 | 225 |
| % of non-UM trips by AATA | 6.9 | 19.9 | 0 | 100 | 225 |
| % of non-UM trips by car | 63.1 | 38.1 | 0 | 100 | 236 |
| % of ALL TRIPS (UM & non-UM) by car | 42.6 | 28.3 | 0 | 100 | 236 |
| *Locational preferences* | | | | | |
| Closeness to destinations among top three reasons to choose a residence (1=Yes) | 0.58 | 0.50 | 0 | 1 | 236 |
| Transit nearby among the top three reasons to select (1=Yes) | 0.22 | 0.42 | 0 | 1 | 236 |
| *Transit convenience and exposure* | | | | | |
| Know how to use bus (or know how to find out) (1:Strongly Disagree; 5:Strongly Agree) | 4.46 | 0.81 | 1 | 5 | 235 |

**Table 5 Summary Statistics of Selected Survey Responses (Continued)**

| Description | Mean | S.D. | Min. | Max. | N |
|---|---|---|---|---|---|
| Transit is inconvenient (1:Strongly Disagree; 5:Strongly Agree) | 2.68 | 1.18 | 1 | 5 | 236 |
| Was there a period in life when used transit regularly (1=Yes) | 0.86 | 0.34 | 0 | 1 | 236 |
| *Search tool ease* | | | | | |
| Ease of using tool (1:Very difficult; 5:Very easy) | 4.13 | 0.81 | 2 | 5 | 236 |

The average age of participants was 25.7 years, 56 percent were female, and all had some yearly household income. The yearly average income reported was $22,700. Average current monthly rent or mortgage payment was $695, with some participants reporting no payments and others reporting up to $5,000 per month. We combined the monthly payments for housing with the income data to calculate a measure of housing expenses (monthly housing expenditures as a percentage of monthly income). Participants spent an average of 60.1 percent of their household income in rent payments, with one participant spending 5.7 times his or her monthly income. Although these percentages are high compared to that of the general population, it is not unexpected to find that students tend to spend a high percentage of their monthly income on housing. Because our focus is on graduate students, it is likely that some students have little income but are tapping into personal savings to pay for housing while in graduate school.

With respect to travel patterns, respondents reported that almost 67 percent of their trips to campus were by bicycle, pedestrian, or transit modes. By contrast, participants reportedly made 63.1 percent of all other trips during the same period by car, either as the driver or passenger. This trend for participants to use nonauto modes for trips to campus, but cars for most other trips, is consistent with the urban spatial structure of Ann Arbor, where parking is ample and at low cost at most destinations, except in the town's center and at the university.

The survey assessed what qualities of the rental unit, building, and neighborhood participants valued the most by asking them to evaluate how important each of 17 characteristics would be to them, assuming that the rent or purchase price were held the same for all properties (Table 6). Participants rated these factors using a scale of one (unimportant) to four (very important). Collectively, their responses were interpreted as preferences guiding residential locational decisions. Summary statistics for the 17 characteristics show significant variation in the criteria that participants deem important.

The average rating for quiet units, safety, on-site parking, and size was relatively high, while the average ratings for school quality, building amenities (for example, an on-site pool or gym), and property type (condo, single family, or townhouse) were the lowest. When asked to select their first, second, and third priorities from among the list of 17 attributes, 57.6 percent selected proximity to destinations among their top three criteria, but only 22 percent selected transit proximity among their top three criteria (Table 5). Further analyses revealed that participants making a higher percentage of their trips using the AATA were more likely to identify transit proximity as a criterion in selecting housing locations than participants making fewer trips using AATA. Our findings are consistent with the view that multiple factors influence people's location decision making.

**Table 6 Summary Ratings of Factors Influencing Choice of Housing**

| | Survey Section II, Question | Mean | Std. Dev. | N |
|---|---|---|---|---|
| Size of the housing unit | a | 3.12 | 0.76 | 234 |
| Onsite parking | i | 3.28 | 0.92 | 236 |
| Close to campus | k | 3.14 | 0.86 | 236 |
| Close to work | l | 2.51 | 1.07 | 236 |
| Shops and services nearby | m | 2.68 | 0.91 | 236 |
| Safety and security | g | 3.25 | 0.81 | 236 |
| Quiet inside the housing unit | h | 3.39 | 0.75 | 236 |
| Good schools for children | n | 1.35 | 0.79 | 236 |
| Lively neighborhood | o | 2.07 | 0.97 | 235 |
| Neighborhood amenities (parks, streetscape, etc.) | p | 2.36 | 0.95 | 235 |
| Nice neighbors | q | 2.61 | 0.89 | 234 |
| Public transportation nearby | j | 2.88 | 1.04 | 236 |
| Single-family house (as opposed to apartment, condo, or townhouse) | b | 1.86 | 1.02 | 234 |
| Amenities (e.g., pool, gym) | c | 1.81 | 0.89 | 236 |
| Attractive building (exterior and interior) | d | 2.89 | 0.84 | 236 |
| Note: For this rating scale, 1 = unimportant and 4 = very important. | | | | |

With respect to transit convenience and prior exposure to transit use, Table 5 suggests that most participants know how to use the bus system or how to find out information about it. To our surprise, 86.4 percent of participants have used transit regularly during a period of their life. This suggests some level of exposure to the benefits and drawbacks of transit use. Opinions are more mixed regarding the inconvenience of taking transit. Responses vary widely, with the average response leaning toward disagreeing with the statement "Taking public transit is inconvenient" (1: Strongly Disagree; 5: Strongly Agree). Although expected, this variation prompted further analysis of respondents viewing transit as more or less inconvenient. We found that participants who did not identify transit proximity among the top three criteria for choosing a property were more likely to express strong agreement with the statement that public transit is inconvenient. Participants who did not know how to use the bus system and participants who rely on the automobile for most of their trips also viewed transit as inconvenient.

To inquire about the user-friendliness of the search tool, participants were asked to rate it; they tended to find it easy or very easy to use. The mean rating of 4.13 out of 5, where 5 represented "very easy," indicates that the search tool functioned well for participants.

# LOCATIONAL EFFECTS OF THE EXPERIMENT

This section summarizes the effects of providing integrated transportation accessibility and housing information to residential decision makers. The section begins by summarizing the characteristics of properties selected by all participants regardless of whether they belonged to the experimental or the control group. The section then compares the outcome variables of individuals in the experimental and control groups, including whether subgroups within the experimental group might have been more or less susceptible to acting on the information provided. The final component of this section presents differences in preferred housing properties among subgroups of individuals, irrespective of whether they were in the control or experimental group, shedding light on the personal characteristics that make people more likely to walk or use transit.

## PROPERTIES SELECTED BY PARTICIPANTS

The single most important type of data collected from our experiment was the residents' choice of the rental properties that most interested them. Table 7 shows descriptive statistics for the outcome variables of properties selected by participants, regardless of participants being in the control or experimental group. One finding from the descriptive statistics is that results are quite similar whether we examine the top three properties or the top five properties selected by participants. Other findings are that the average distance from the selected housing units to a transit stop was 0.4 mile, and the average distance to the closest campus was 1.2 miles. In almost 90 percent of cases, the units selected were within 0.25 mile of transit. The properties selected had an average of 3.5 buses per hour within 0.25 mile of each property, and an average of 6.8 different routes serving each property.

Compared to the characteristics of all the properties available to choose from in the database (Table 3), participants selected properties that were on average closer to transit and closer to the campus destinations. This preference for units accessible to the campus reflects the importance of UM as a desirable destination for our study population. Almost 90 percent of the most-preferred properties fall within 0.25 mile of transit, yet the mean (and median) distance to transit from all properties available was almost 0.47 miles. This suggests that participants were selecting preferred properties near transit stops.

## Table 7 Summary Statistics for Outcome Measures for All Properties Selected by Participants

| Outcome | Units | Mean | Std. Dev. |
|---|---|---|---|
| *Access to transit* | | | |
| Average network distance to transit from top three | Miles | 0.407 | 0.305 |
| Average network distance to transit from top five | Miles | 0.408 | 0.236 |
| Average crow-fly distance to transit from top three | Miles | 0.320 | 0.233 |
| Average crow-fly distance to transit from top five | Miles | 0.319 | 0.178 |
| Average network distance to high-quality transit from top five | Miles | 0.717 | 0.962 |
| % of three most preferred properties within 1/4 mile of transit route | % | 88.1 | 21.3 |
| % of five most preferred properties within 1/4 mile of transit route | % | 89.0 | 16.7 |
| *Service frequency* | | | |
| Total buses per hour within 1/4 mile of top three | # of buses/hr | 3.521 | 1.495 |
| Total buses per hour within 1/4 mile of top five | # of buses/hr | 3.479 | 1.286 |
| *Destination diversity* | | | |
| Sum of # of routes within 1/4 mile of top three | # of routes | 6.718 | 4.579 |
| Sum of # of routes within 1/4 mile of top five | # of routes | 6.729 | 3.939 |
| *Pedestrian accessibility* | | | |
| Average network distance to closest destination from top three | Miles | 1.152 | 0.970 |
| Average network distance to closest destination from top five | Miles | 1.172 | 0.884 |
| Average sum of network distance to main destinations from top three | Miles | 7.406 | 4.050 |
| Average sum of network distance to main destinations from top five | Miles | 7.486 | 3.665 |
| The summaries are for properties independent of the # of times they were chosen by participants. N=236. | | | |

# LOCATIONAL DIFFERENCES BETWEEN CONTROL AND EXPERIMENTAL GROUPS

## Effects on Transit Accessibility

Comparing the mean values of the outcome variables for the experimental group with the control group suggests that there is no difference between groups in the distance to bus stops for the top three and top five preferred home locations (Table 8). We also found no difference in the number of routes serving the preferred locations of participants in the control and the experimental groups. However, we find some evidence that participants in the experimental group located in areas with higher transit service frequency, although the difference in service frequency between 3.3 and 3.6 buses per hour (a 10 percent difference) seems to have little practical relevance.

**Table 8 Mean Value of Outcome Measures for the Control and Experimental Groups**

| Outcome | Mean Group Value | | p-value |
|---|---|---|---|
| | Control | Experiment | |
| *Access to transit* | | | |
| Average network distance to transit from top three | 0.424 | 0.390 | 0.409 |
| Average network distance to transit from top five | 0.426 | 0.390 | 0.251 |
| Average crow-fly distance to transit from top three | 0.329 | 0.311 | 0.578 |
| Average crow-fly distance to transit from top five | 0.328 | 0.311 | 0.464 |
| Average network distance to high-quality transit (to home campus) from top five | 0.837 | 0.596 | 0.000*** |
| Average network distance to high-quality transit (to central campus) from top five | 0.653 | 0.510 | 0.001*** |
| % of three most preferred properties within 1/4 mile of transit route † | 86.70 | 89.50 | 0.502 |
| % of five most preferred properties within 1/4 mile of transit route † | 86.93 | 91.13 | 0.302 |
| *Service frequency* | | | |
| Total buses per hour within 1/4 mile of top three | 3.363 | 3.674 | 0.121 |
| Total buses per hour within 1/4 mile of top five | 3.304 | 3.655 | 0.037** |
| *Destination diversity* | | | |
| Sum of # of routes within 1/4 mile of top three | 6.499 | 6.924 | 0.525 |

### Table 8 Mean Value of Outcome Measures for the Control and Experimental Groups (Continued)

| Outcome | Mean Group Value | | p-value |
|---|---|---|---|
| | Control | Experiment | |
| Sum of # of routes within 1/4 mile of top five | 6.401 | 7.053 | 0.211 |
| *Pedestrian accessibility* | | | |
| Average network distance to closest destination†† from top three | 1.292 | 1.015 | 0.030** |
| Average network distance to closest destination†† from top five | 1.325 | 1.020 | 0.008*** |
| Average sum of network distance to all destinations simultaneously from top three | 7.965 | 6.864 | 0.038** |
| Average sum of network distance to main destinations simultaneously from top five | 8.081 | 6.894 | 0.013** |

** and *** denote significance at a 95% and 99% level of confidence, respectively.
† Ordered logistic model used.
†† Closest destination refers to the closest of the following destinations: Central Campus, North Campus, Medical Campus and downtown Ann Arbor. Together, these comprise the major destinations commonly accessed by graduate students. For the measurement units of each outcome variable, see Table 7.

By contrast, the average network distance to *high-quality* transit differed significantly between the control and experimental groups. The experimental group located nearly 0.25 mile closer on average to transit lines offering a no-transfer trip to their main campus destination and service at intervals of 15 minutes or better. It is not surprising that the effect of the information is felt regarding high-quality transit and not transit lines in general. First, the overall average distance to a transit stop (0.4 mile) was quite small. For this reason, there was little room to improve that distance with transit information. Equally important, the information system itself did not seek to guide respondents to locations served by transit in general, but to locations served by transit offering frequent, no-transfer trips to their campus destinations. A property along a direct, frequent bus line could receive an "excellent" accessibility score even if it was several miles from campus. The difference between the control and experimental groups in this regard is examined next.

The most direct measurement of the experiment's accessibility impacts is shown in Table 9 and Table 10. The tables are based on the five preferred properties chosen by a respondent. Among the control group, 55 percent of respondents chose properties with "excellent" access to their home campus; this rose to 65 percent among the experimental group. The effect of the information on the choices of the experimental group was significant with over 99 percent confidence, based on the Pearson chi-square and Kendall's tau-b statistics. Kendall's tau-b statistic can also be viewed as a measure of the strength of association of the two variables (group membership of a respondent and accessibility rating of a property). These range from -1 (perfect negative association) through 0 (no association) to +1 (perfect positive association). Thus the values of the statistic, ranging from 0.10 to 0.13 in Table 9 and Table 10, represent a modest positive correlation; that is, membership in the experimental group was associated with somewhat greater accessibility in residential choices.

**Table 9 Cross-tabulation of Combined Pedestrian and Transit Accessibility to Central Campus and Home Campus for All Units**

| | Access to Central Camput | | | Access to Home Campus | | |
|---|---|---|---|---|---|---|
| | **Control Group** | **Experimental Group** | **Total** | **Control Group** | **Experimental Group** | **Total** |
| Low Count | 60 | 34 | 94 | 60 | 34 | 94 |
| percentage | 10.2% | 5.8% | 8.0% | 10.2% | 5.8% | 8.0% |
| Medium Count | 35 | 30 | 65 | 92 | 79 | 171 |
| percentage | 5.9% | 5.1% | 5.5% | 15.6% | 13.5% | 14.6% |
| High Count | 113 | 98 | 211 | 114 | 93 | 207 |
| percentage | 19.2% | 16.7% | 18.0% | 19.4% | 15.9% | 17.6% |
| Excellent Count | 381 | 424 | 805 | 323 | 380 | 703 |
| percentage | 64.7% | 72.4% | 68.5% | 54.8% | 64.8% | 59.8% |
| TOTAL COUNT | 589 | 586 | 1,175 | 589 | 586 | 1,175 |
| percentage | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| | **Value** | **P-Value** | | **Value** | **P-Value** | |
| Pearson Chi-square | 10.932 | 0.012 | | 14.924 | 0.002 | |
| Kendall's tau-b | 0.085 | 0.002 | | 0.100 | 0.000 | |

**Table 10 Cross-tabulation of Combined Pedestrian and Transit Accessibility to Central Campus and Home Campus for Units More Than 0.5 Mile from Campus**

| | Access to Central Camput | | | Access to Home Campus | | |
|---|---|---|---|---|---|---|
| | Control Group | Experimental Group | Total | Control Group | Experimental Group | Total |
| Low Count | 41 | 18 | 59 | 51 | 23 | 74 |
| percentage | 28.3% | 15.1% | 22.3% | 20.8% | 11.6% | 16.7% |
| Medium Count | 15 | 15 | 30 | 77 | 63 | 140 |
| percentage | 10.3% | 12.6% | 11.4% | 31.4% | 31.8% | 31.6% |
| High Count | 46 | 39 | 85 | 65 | 45 | 110 |
| percentage | 31.7% | 32.8% | 32.2% | 26.5% | 22.7% | 24.8% |
| Excellent Count | 43 | 47 | 90 | 52 | 67 | 119 |
| percentage | 29.7% | 39.5% | 34.1% | 21.2% | 33.8% | 26.9% |
| TOTAL COUNT | 145 | 119 | 264 | 245 | 198 | 443 |
| percentage | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| | **Value** | **P-Value** | | **Value** | **P-Value** | |
| Pearson Chi-square | 7.230 | 0.065 | | 12.678 | 0.005 | |
| Kendall's tau-b | 0.130 | 0.019 | | 0.130 | 0.002 | |

Accessibility is defined here as it was defined in the information system: an "excellent" ranking went to properties within 0.5 mile walking distance of a major destination, or within 0.5 mile of a direct transit line with 15-minute headways or better. Table 9 combines the campus proximity effects and the transit effects of the information experiment. To focus on the transit effects alone, Table 10 eliminates properties within 0.5 mile of one's campus destination from the analysis. The effects remain notable: 21 percent of the properties chosen by the control group had excellent transit access to their home campus, compared with nearly 34 percent of the properties chosen by members of the experimental group. These effects were also evident in relation to Central Campus. These numbers are presented here because Central Campus, which is at the cultural hub of Ann Arbor, is a valued destination for many students, regardless of their home campus.

## Effects on Proximity to Major Destinations (Downtown or the Three Campuses)

In addition to the transit-distance effects described above, participants in the experimental group were more likely to choose units closer to one of the four major destinations for graduate students (defined as Central Campus, North Campus, Medical Campus, and downtown Ann Arbor). Participants in the experimental group preferred properties located 0.3 mile (about 30 percent) closer to a campus or downtown Ann Arbor than the properties preferred by the control group. The difference remained statistically significant at a 95 percent level of confidence, but decreased to 16 to 17 percent when we considered accessibility to the four destinations simultaneously. This result helps explain why participants in the experimental group also appeared to locate in areas with higher transit service frequency than participants in the control group. Areas close to major destinations in Ann Arbor tend have higher transit service frequency than areas farther from those destinations.

What are the effects of a 0.3-mile change in the distance to a destination (from 1.3 miles to 1 mile) for walking and bicycling activity? To examine this, we relied on three recent studies that examine travel mode choice and walking trips in distinct settings: Cervero and Duncan's analysis of San Francisco Bay Area commuters,[42] Rodríguez and Joo's study of commuters to the University of North Carolina in Chapel Hill,[43] and Shay, et al.'s analysis of walking trip frequency by distance to a commercial center in a new urbanist neighborhood.[44] These three studies are useful because they study nonmotorized travel separate from all travel, and they use distance-related independent variables that can be used to simulate changes in mode shares given changes in commuting distance while holding all other variables constant.

For walking, Cervero and Duncan's results suggest that a decrease of 0.3 mile from the mean commuting distance is related to an increase of 5.6 percent in the share of walking trips, from 12.5 percent to 18.1 percent of all trips.[45] Rodríguez and Joo's results suggest that a similar decrease in distance, from the mean distance in their sample of 2.5 miles, is related to an increase of 8.3 percent in the share of walking trips (from 17.2 percent to 25.5 percent). Average distances in our study are significantly shorter than what Cervero and Duncan, and Rodríguez and Joo observed;[46] for this reason, expected changes based on their results are likely to underestimate the effect for our sample. Shay, et al.'s results suggest that a decrease of 0.3 mile (from 1.3 to 1.0 mile) in the distance to commercial areas increased walking trip frequency by 57 percent.[47] The effects for bicycling are less pronounced because bicycling is less sensitive than walking to travel distance. Cervero and Duncan's results suggest that a 0.3 mile decrease from the mean commuting distance is related to an increase of 0.14 percent in the share of bicycling trips (from 1.5 percent to 1.64 percent),[48] while the results of Rodríguez and Joo suggest an increase of 2.3 percent in the share of bicycling trips (from 17.2 percent to 19.5 percent) when commuting distance decreased 0.3 mile from 4.05 miles.[49]

As discussed in the methods section, it is possible that the *means* of the distribution of each outcome variable are the same even though the *distributions* differ significantly. This would occur if, for example, some individuals reacted favorably to the experiment and located closer to transit while others reacted negatively to it and explicitly located farther away from transit or major destinations. We used Kolmogorov-Smirnov tests for equality of distributions to compare the distribution of outcome variables for the control and experimental groups. In every case, except for the measure of nonmotorized access to the closest destination for the top five properties (p=0.05), the null hypothesis that the distributions are equal could not be rejected. Figure 16 shows the only case in which the distribution of the outcome variable differed between the experimental and control groups. Participants in the experimental group located closer to the major proximate destination than the control group, and fewer located at distances beyond 2.5 miles of this major center.

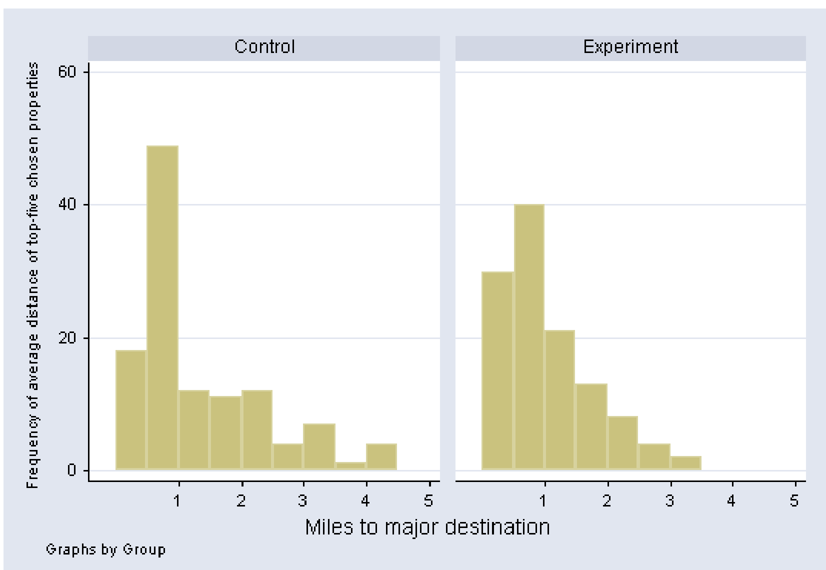


**Figure 16 Frequency Distribution of Average Distance to Major Destination for Top Five Properties Chosen by Control and Experimental Groups**

## ANALYSIS OF SUBPOPULATIONS WITHIN THE EXPERIMENTAL GROUP

Our fourth hypothesis was that subgroups within the experimental group might have been more or less susceptible to acting on the information provided. To examine this hypothesis, we tested interactions between survey variables and participants' housing selections using two types of tests, as discussed above: ANOVA for continuous outcome variables, and ordered logistic regression for outcomes involving percentages. The survey variables were grouped into the same categories presented previously in Table 5:

- **Sociodemographic characteristics (survey section IV)**: age (Q1), sex (Q2), yearly income (Q12), monthly rent (survey section III, Q2), and affordability.
- **Current travel patterns (survey section III, Q10-14)**: percent of UM and non-UM trips by multiple transportation modes.
- **Locational preferences (survey section II, Q1, 2)**: closeness to destinations and to transit among top three reasons to choose a residence, and two composite variables summarizing participants' preferences regarding preferred property attributes, explained below.

Table 11 summarizes the results of including interaction terms between the survey variables shown and the information treatment (only results for statistically significant interactions are shown). These various tests, described in more detail below, reveal two significant findings. First, the higher the age of the participant in the experimental group, the more likely he or she is to locate closer to transit routes. Second, frequent UM transit users make use of the accessibility information offered to them by locating closer to major destinations and in areas that are well-served by transit.

**Table 11 Differences in Location Choices According to Age and UM Transit Use for Participants from the Experimental Group**

| | Age x Experimental Group | | % UM Trips by Bus x Experimental Group | |
|---|---|---|---|---|
| **Outcome** | **Coeff** | **p-value** | **Coeff** | **p-value** |
| *Access to transit* | | | | |
| Average network distance to transit from top three | -0.03 | 0.01 | — | — |
| Average network distance to transit from top five | -0.02 | 0.01 | — | — |
| Average crow-fly distance to transit from top three | -0.02 | 0.03 | -0.24 | 0.08 |
| Average crow-fly distance to transit from top five | -0.01 | 0.03 | — | — |

**Table 11 Differences in Location Choices According to Age and UM Transit Use for Participants from the Experimental Group (Continued)**

| | Age x Experimental Group | | % UM Trips by Bus x Experimental Group | |
|---|---|---|---|---|
| **Outcome** | **Coeff** | **p-value** | **Coeff** | **p-value** |
| % of three most preferred within 1/4 mile of transit route† | — | — | 2.78 | 0.08 |
| % of five most preferred properties within 1/4 mile of transit route† | 0.12 | 0.01 | — | — |
| *Service frequency* | | | | |
| Total buses per hour within 1/4 mile of top three | — | — | 1.82 | 0.04 |
| Total buses per hour within 1/4 mile of top five | — | — | 1.97 | 0.01 |
| *Destination diversity* | | | | |
| Sum of # of routes within 1/4 mile of top three | — | — | — | — |
| Sum of # of routes within 1/4 mile of top five | — | — | — | — |
| *Pedestrian accessibility* | | | | |
| Average network distance to closest destination from top three | — | — | -1.06 | 0.06 |
| Average network distance to closest destination from top five | — | — | -1.03 | 0.04 |
| Average sum of network distance to main destinations from top three | — | — | -4.66 | 0.05 |
| Average sum of network distance to main destinations from top five | — | — | -4.50 | 0.03 |
| † Ordered logistic model used. For the measurement units of each outcome variable, please see Table 7. Only results statistically significant at a 90 percent confidence level are shown. | | | | |

## Sociodemographics

One pattern emerged from the analysis of the sociodemographic data from respondents. We found no differences with respect to the impact of information on location patterns by sex, yearly income, monthly rent or mortgage, and affordability, but age was an important variable. The results suggested that as individuals got older, they were more likely to locate closer to transit routes if offered information about them. Although the mean distance between the selected housing units and a bus stop did not differ between the full experimental and control groups, *older* individuals in the experimental group tended to locate closer to transit than both the younger individuals in the experimental group and members of any age within the control group. Looking at the mean network distance between their preferred housing units and a transit stop, for every additional year of age, participants in the experimental group located between 0.02 and 0.03 mile closer to transit (8.2 percent closer) than younger persons and those in the control group. The coefficient for the bus service frequency outcome also suggests that information for older participants is related to locating in areas with higher transit service frequency. For every additional year of age, participants in the experimental group chose properties that were 4 percent more likely on average to be within 0.25 mile of a transit stop. Thus, for a ten-year difference in age of participants, the older participants would be 40 percent more likely to select properties within 0.25 mile of a transit stop than younger participants, holding everything else equal.

## Current Travel Habits

We also find consistent evidence suggesting that, when accessibility information is offered to them, frequent UM transit users make even more use of the information than did older members of the experimental group. People who self-reported as UM transit users chose housing units that were closer to one of the four major destinations in the area, to transit stops, and to AATA bus routes that offered higher service frequency. Specifically, as the percentage of UM trips by bus increases by one, participants in the experimental group chose properties that were:

- located near a bus route with 0.4 more buses per hour (an 11.4 percent increase in frequency, evaluated at the mean frequency)
- 9.4 percent more likely, on average, to be within 0.25 mile of a transit stop
- 0.37 mile closer to the one of the four major destinations (29 percent closer, evaluated at the mean distance to the closest major destination) and
- 1.6 miles closer to all major destinations considered simultaneously (20.3 percent evaluated at the mean distance to all destinations).

We found no differences in the use of information for location choices by regular auto drivers or by AATA transit users. As a result, we conclude that habitual UM transit riders are more open to using information to choose locations that support nonauto travel modes. UM transit riders may represent a middle ground between regular AATA bus riders and car drivers who would be unlikely to use a bus under any circumstances. Under these circumstances, UM transit ridership may indicate a greater propensity to be convinced of the benefits of a transit-accessible location.

## Locational Preferences

To examine how preferences for certain property attributes can interact with the provision of accessibility information, we examined the attitudes summarized in Table 12 using an exploratory factor analysis. Such an approach allows us to reduce participants' ratings of their attributes to a lower number of variables or factors. A factor is a latent variable that is not observed by us, but for which we have related indicators.[50] Once the factors were extracted through the factor analysis procedure, factor scores were used to compare the interactions with the information experiment. For the purposes of this exploratory factor analysis, all variables were treated as continuous.

Two criteria (scree test and Eigenvalue >1.0)[51] indicated the relative suitability of two factors for rotation. On the basis of these results, the entire sample was factor-analyzed, and two factors were rotated to a promax (oblique) solution. All items loaded 0.35 or more on at least one factor, except the bottom four questions (Table 12). A positive loading indicates that the higher the rating provided, the more important the item in determining the factor. A negative loading indicates that the higher the loading, the less important the item in determining that factor. The two factors account for 87 percent of the variance of the 15 questions examined. The stability of the scale for each factor is demonstrated through Cronbach's alpha. Typically, a scale is considered reliable if its Cronbach's alpha is 0.70 or higher. The factors have an average Cronbach's alpha score of 0.63 (range = 0.60 - 0.66), indicating moderate reliability.

### Table 12 Factor Analysis of Preferences for Property Attributes

| Attribute | Factor 1* | Factor 2* |
|---|---|---|
| *Accessibility (Cronbach's a = 0.60)* | | |
| Size of the housing unit | -0.506 | |
| On-site parking | -0.485 | |
| Close to campus | 0.497 | |
| Close to work | 0.526 | |
| Shops and services nearby | 0.378 | |
| *Local public services and neighborhood attribtes (Cronbach's α =0.66)* | | |
| Safety and security | | 0.441 |

**Table 12 Factor Analysis of Preferences for Property Attributes (Continued)**

| Attribute | Factor 1* | Factor 2* |
|---|---|---|
| Quiet inside the housing unit | | 0.509 |
| Good schools for children | | 0.456 |
| Lively neighborhood | | 0.407 |
| Neighborhood amenities (parks, streetscape, etc) | | 0.560 |
| Nice neighbors | | 0.568 |
| Public transportation nearby | | |
| Single-family house (as opposed to apartment, condo, or townhouse) | | |
| Amenities (for example, pool, gym) | | |
| Attractive building (exterior and interior) | | |
| *Eigenvalue* | 2.161 | 1.49 |
| * Note: Only loadings > 0.35 are shown | | |

The first factor, which we interpret as the importance of accessibility to destinations, is determined by positive loadings for variables such as proximity to destinations such as campus, work, and shops and services. The first factor is also determined by negative loadings for housing unit size and on-site parking. The latter is expected if properties capitalize the value of accessibility; therefore, properties located in highly accessible places will be smaller in size and less likely to have parking than comparably priced units that are less accessible. Our interpretation of this first factor is consistent with Alonso's bid rent theory.[52]

We interpreted the second factor as the importance of local public services and neighborhood attributes. This is broadly consistent with Tiebout's theory that people vote with their feet and choose to live in neighborhoods with local public goods that meet their expectations and requirements.[53] This factor contains variables such as safety and security, low noise levels, school quality, neighborhood amenities such as parks, and nice neighbors. We interpret this factor as the importance of local public services and neighborhood amenities in choosing a property.

Scores for each of the two factors are used to examine if individuals within the experimental group with high or low factor scores might have been more or less susceptible to acting on the information provided.[54] We found no statistically significant differences between the outcome variables for individuals in the experimental group with high factor scores and everyone else. We also found no statistically significant difference when we examined interactions between the experiment and (1) individuals who ranked closeness to destinations among their top three reasons to choose a residence, and (2) individuals who ranked transit nearby among the top three reasons to choose a residence.

### Transit Convenience and Exposure

We did not find any differences in location patterns for the interaction between transit exposure and belonging to the experimental group, or for the interaction between the degree to which the participant considered transit inconvenient and belonging to the experimental group.

### Ease of Using the Search Tool

Finally, we examined interactions between participants' self-reported ease of using the search tool and belonging to the experimental group. We found no differences in the use of information for location choices by the degree to which the tool was deemed easy to use.

## ANALYSIS OF SUBPOPULATIONS WITHIN THE FULL SET OF PARTICIPANTS

The final component examined in our analysis was the differences in preferred housing properties among subgroups of individuals, irrespective of whether they were in the control or experimental groups. Understanding these effects is important because they can shed light on the personal characteristics that make people more likely to walk or use transit in general (outside the context of an experiment such as ours). Some of the key findings from this analysis are that older participants were likely to prefer properties farther from both transit stops and major destinations; that women were more likely to choose accessible locations than men; and that as households spent a higher proportion of their monthly income on housing, they were more likely to choose accessible units. In terms of attitudes, we found that individuals who value local public services and neighborhood amenities chose properties that were farther away from transit than individuals for whom these factors were not important. Participants who stated that they found transit inconvenient to use were more likely to choose housing units closer to major destinations, suggesting that perhaps they wanted the option of walking or biking to those destinations.

## Sociodemographics

Results from this analysis, which looked at the full set of participants (the control and experimental groups combined), suggest that as age increases, individuals are likely to prefer housing units located farther away from both transit stops and major destinations. For every additional year of age, participants located between 0.02 and 0.03 mile away from transit and between 0.04 and 0.05 mile farther away from the closest major destination. This result is the opposite of the results described on page 54, which found that older participants in the experimental group were likely to live *closer* to a transit stop. One can conclude that, in general, older participants chose to locate in less accessible housing units, but that this effect was countered by the information treatment. It is likely that older individuals in our sample are wealthier than younger individuals, which may result in higher demand for larger lots, more bathrooms, or more built area, all qualities more likely to be found in units farther from major destinations.

We also found differences by gender and the percent of income a household spent on its housing. In terms of gender, we found that females chose properties located closer to transit, with higher service frequency, and with more routes served than did males (see Table 13). Women also located closer to major destinations. As the ratio between monthly rent or mortgage payments and monthly income increased (making the current housing less affordable), residents were more likely to locate in areas in which transit provided higher service frequency and route diversity (Table 14). We found no differences in location patterns by yearly income or monthly rent or mortgage payments.

**Table 13 Differences in Location Choices According to *Age and Sex* (Experimental and Control Groups Combined)**

| | Age | | Sex (Female) | |
|---|---|---|---|---|
| **Outcome** | **Coeff** | **p-value** | **Coeff** | **p-value** |
| *Access to transit* | | | | |
| Average network distance to transit from top three | 0.03 | 0.00 | — | — |
| Average network distance to transit from top five | 0.02 | 0.01 | — | — |
| Average crow-fly distance to transit from top three | 0.02 | 0.02 | — | — |
| Average crow-fly distance to transit from top five | 0.01 | 0.06 | — | — |
| % of three most preferred within 1/4 mile of transit route† | -0.24 | 0.00 | 0.88 | 0.03 |
| % of five most preferred properties within 1/4 mile of transit route† | -0.15 | 0.01 | 0.78 | 0.03 |

### Table 13 Differences in Location Choices According to *Age and Sex* (Experimental and Control Groups Combined) (Continued)

| | Age | | Sex (Female) | |
|---|---|---|---|---|
| **Outcome** | **Coeff** | **p-value** | **Coeff** | **p-value** |
| *Service frequency* | | | | |
| Total buses per hour within 1/4 mile of top three | -0.08 | 0.06 | 0.57 | 0.03 |
| Total buses per hour within 1/4 mile of top five | — | — | 0.42 | 0.07 |
| *Destination diversity* | | | | |
| Sum of # of routes within 1/4 mile of top three | — | — | — | — |
| Sum of # of routes within 1/4 mile of top five | — | — | 1.29 | 0.07 |
| *Pedestrian accessibility* | | | | |
| Average network distance to closest destination from top three | 0.05 | 0.07 | -0.36 | 0.04 |
| Average network distance to closest destination from top five | 0.04 | 0.10 | -0.29 | 0.07 |
| Average sum of network distance to main destinations from top three | 0.21 | 0.08 | -1.39 | 0.06 |
| Average sum of network distance to main destinations from top five | — | — | -1.12 | 0.09 |
| † Ordered logistic model used. For the measurement units of each outcome variable, see Table 7. Only statistically significant results are shown. | | | | |

### Table 14 Differences in Location Choices According to *Affordability of Current Housing* (Experimental and Control Groups Combined)

| | (Un)affordability of current home location | |
|---|---|---|
| **Outcome** | **Coeff.** | **p-value** |
| *Access to transit* | | |
| Average network distance to transit from top three | — | — |
| Average network distance to transit from top five | — | — |
| Average crow-fly distance to transit from top three | — | — |
| Average crow-fly distance to transit from top five | — | — |
| % of three most preferred within 1/4 mile of transit route† | — | — |
| % of five most preferred properties within 1/4 mile of transit route† | — | — |
| *Service frequency* | | |

**Table 14 Differences in Location Choices According to *Affordability of Current Housing* (Experimental and Control Groups Combined) (Continued)**

| | (Un)affordability of current home location | |
|---|---|---|
| **Outcome** | **Coeff.** | **p-value** |
| Total buses per hour within 1/4 mile of top three | — | — |
| Total buses per hour within 1/4 mile of top five | 0.16 | 0.08 |
| *Destination diversity* | | |
| Sum of # of routes within 1/4 mile of top three | 0.73 | 0.03 |
| Sum of # of routes within 1/4 mile of top five | 0.62 | 0.03 |
| *Pedestrian accessibility* | | |
| Average network distance to closest destination from top three | — | — |
| Average network distance to closest destination from top five | — | — |
| Average sum of network distance to main destinations from top three | — | — |
| Average sum of network distance to main destinations from top five | — | — |
| † Ordered logistic model used. For the measurement units of each outcome variable, see Table 7. Only statistically significant results at a 90 percent confidence level are shown. | | |

## Current Travel Habits

We did not find any differences in the residential choices made by participants according to the mode they use to commute to the university or to other destinations. This contrasts with the results in Table 11, where current UM transit commuters in the experimental group were more likely to select properties closer to transit, with better transit service frequency, and closer to major destinations.

## Locational Preferences

We found no statistically significant difference when we examined the full set of respondents compared to individuals who ranked closeness to destinations among their top three reasons to choose a residence, individuals who ranked transit nearby among the top three reasons to choose a residence, and individuals who had high factor score values for accessibility. However, we found differences for individuals with high scores for the factor interpreted as the value of local public services and neighborhood amenities. As shown in Table 15, individuals for whom such local attributes are important (and who thus have a high score) chose properties that were farther away from transit than did individuals for whom these factors were not important. The size of the effect for this variable is about twice the effect of the provision of information.

**Table 15 Differences in Location Choices According to Preferences for Neighborhood Attributes and Transit Inconvenience (Experimental and Control Groups Combined)**

| | Local public services/ neighborhood attributes factor | | Degree of transit inconvenience | |
|---|---|---|---|---|
| **Outcome** | **Coeff** | **p-value** | **Coeff** | **p-value** |
| *Access to transit* | | | | |
| Average network distance to transit from top three | 0.07 | 0.06 | — | — |
| Average network distance to transit from top five | — | — | — | — |
| Average crow-fly distance to transit from top three | 0.06 | 0.08 | — | — |
| Average crow-fly distance to transit from top five | 0.03 | 0.10 | — | — |
| % of three most preferred within 1/4 mile of transit route† | — | — | — | — |
| % of all five properties within 1/4 mile of transit route† | — | — | — | — |
| *Service frequency* | | | | |
| Total buses per hour within 1/4 mile of top three | — | — | — | — |
| Total buses per hour within 1/4 mile of top five | — | — | — | — |
| *Destination diversity* | | | | |
| Sum of # of routes within 1/4 mile of top three | — | — | 0.65 | 0.07 |
| Sum of # of routes within 1/4 mile of top five | — | — | 0.53 | 0.09 |
| *Pedestrian accessibility* | | | | |
| Average network distance to closest destination from top three | — | — | -0.18 | 0.09 |
| Average network distance to closest destination from top five | — | — | -0.12 | 0.08 |
| Average sum of network distance to main destinations from top three | — | — | -0.75 | 0.02 |
| Average sum of network distance to main destinations from top five | — | — | -0.51 | 0.07 |

† Ordered logistic model used. For the measurement units of each outcome variable, see Table 7. Only statistically significant results at a 90 percent confidence level are shown.

### Transit Convenience and Exposure

Variables for current and prior transit exposure were unrelated to the outcome characteristics of residential properties selected. However, the variable asking people if they consider transit inconvenient showed that the higher the perceived inconvenience, the lower the distance between participants' preferred housing units and major destinations (Table 12). In other words, participants who view transit as inconvenient did not penalize it by locating further away from transit stops. Instead, they chose residences that supported bicycle and pedestrian travel. The effect identified here reinforces the effect of information on location decisions identified in Table 8.

### Ease of Using the Search Tool

We found no relationship between the locations of the preferred units that participants selected and their evaluation of how easy it was to use the search tool. Because results are not statistically significant, no table is shown.

### Summary

We found effects of the information experiment on the location patterns with respect to the four major destinations, and an effect on proximity to high-quality transit. We also found that older participants in the experimental group, as well as frequent UM transit users, used the information to locate closer to transit routes and to major destinations, respectively. We explored location patterns, irrespective of whether participants were in the control or experimental groups, and found that older participants were likely to live farther from both transit stops and major destinations; that women were more likely to choose accessible locations than men; that as households spent a higher proportion of their monthly income on housing they were more likely to choose accessible units; that individuals who value local public services and neighborhood amenities chose properties that were farther away from transit than individuals for whom these factors were not important; and that participants who found transit inconvenient to use were more likely to choose housing units closer to major destinations.

## LIMITATIONS OF THE RESEARCH

Although the results of the experiment seem to show that providing housing seekers with information about transit accessibility led participants to choose more transit-accessible units, like most research, our experiment has limitations that constrain our ability to generalize our findings. The first limitation is our reliance on stated preferences in a laboratory simulation, rather than using revealed preferences. Although this is a common limitation of experimental research, other studies in the transportation arena have used laboratory setting and simulations to examine participants' reactions to information in a travel context.[55] Furthermore, although our study relied on actual properties available in the real estate market, participants in reality were not searching for a new location but were asked to simulate that such relocation was required. However, Earnhardt compared revealed and stated preference data in examining housing choices and concluded that actual and stated decisions follow similar decision processes with respect to attributes such as the square footage of a property, its age, and the income of the decision maker.[56]

A second limitation is that the laboratory simulation forced individuals to make decisions within a short-term horizon and with limited information. When considering housing location decisions, individuals not only may ponder their choices for a longer time, but also are likely to visit each location. Such visits would provide decision makers with detailed information about accessibility to destinations over and beyond what was provided to the control group in our simulation.[57] However, in a real-world setting, linked transportation-housing unit data would stimulate relocators to choose a more accessible set of units to visit, thus increasing the likelihood that their final choice would also have good accessibility.

A third limitation is that experimental research design can limit one's ability to predict effects that can be translated to the broader population or to other subpopulations.[58] Our reliance on a university population underscores this concern. The context of our study, a university town, with, for example, few prominent destinations and limited parking availability, may be such that alternative travel modes are viewed as viable travel modes relative to the automobile. As a result, participants in such a context may react more favorably to the bundled information than the general population. Further research should examine if our results hold in a broader population.

A fourth limitation relevant to social scientists is that the causal mechanism through which information influenced decisions in this experiment is not clear. For example, the experiment reduced information search and processing costs, but we cannot identify the effect of each. By contrast, a strength of our research design is that it overcomes sample selection bias and provides an unambiguous indication of causality, a rarity in transportation and planning research.

A fifth limitation is our reliance on the rental market. Individuals may make different choices when making rental housing decisions than when purchasing a house. The degree to which our results translate to home purchasers is a matter for future empirical analysis.

A final limitation is our reliance on a limited set of outcome measures. Participants may have used the information to modify their search and decision process in ways that our outcome variables do not measure.

# CONCLUSION

As researchers and policy makers search for ways to broaden Americans' use of alternatives to solo driving, they have begun to explore the use of new information technologies. The hope is that these might enable or even encourage travelers to make more use of transit, biking, and walking. This report investigated one such innovative approach to information provision, using a Web-based housing database to provide people with detailed, integrated information about the transit, biking, and walking options for each available rental unit. This chapter concludes the report by drawing together the key policy implications that flow from the research findings, as well as recommendations for future research on the topic.

## POLICY IMPLICATIONS

Our main finding is that providing housing seekers with information about their travel options from each housing unit has the potential to encourage residence in accessible locations, which may increase travel by transit, biking, and walking. A key factor determining whether people use a particular mode of travel is the likely convenience. Travel time (and its components: access and egress time, waiting time, and in-vehicle time) is a key element of perceived convenience. People are more likely to use the bus if they live near a bus line with frequent service to their major destination, and are more likely to walk or bike if they live a short distance from their destinations. Our research found that providing housing seekers with information about the ease of using transit or walking or biking led to increased probability that some of them would choose a housing unit where those modes would be relatively convenient. These conclusions are expanded on below.

*Providing housing seekers with information about their walking and biking options from each unit has the potential to encourage people to choose housing units that are closer to their major destinations than they would otherwise select.*

Results from the study simulation suggest that disseminating bundled accessibility and housing information resulted in the selection of preferred locations that were closer to major destinations, as compared to the selections of individuals without access to the information. The distance difference to the closest major destination between the experiment and control group ranged from 27 to 30 percent. Although we cannot know with certainty that travel behavior differences would necessarily ensue from the effects identified in our experiment, the higher accessibility to destinations by the experimental group suggests likely travel behavior effects that deserve additional exploration.

Although most real estate information is provided by private organizations, our results suggest that public organizations (for example, transit agencies) should consider facilitating transit route and schedule information so that it could be easily combined with existing real estate data. If the effects identified in this experiment are replicated for other groups in diverse contexts, then local, state, and federal agencies may take steps to motivate or ensure that real estate information providers include transit and accessibility information in their listings. The emerging popularity of using free mapping software for real estate searches suggests that transit agencies may more readily combine their information to existing real estate information tools than before.

*Providing housing seekers with information about their transit options from each unit can increase the proportion of individuals seeking housing near high-quality transit.*

Respondents in the experimental group selected locations with excellent accessibility at a rate about 10 percentage points higher than those in the control group. Participants in the experimental group chose units that were nearly 0.25 mile closer to high-quality (that is, direct and frequent) transit than their control-group counterparts.

*Certain population subgroups are especially likely to react to information about their transit options from each unit considered by choosing more transit-friendly locations than they would otherwise select.*

The simulation study results suggest that if certain subgroups of the population receive bundled housing and accessibility information, they will select housing units closer to transit than they otherwise would have. In this study, older individuals and those who are habitual users of UM's transit system were more likely to pick housing units close to a transit stop when provided with the transit information. This result suggests that efforts to market transit options to people in the process of choosing a new home may be most successful if targeted at certain populations, rather than all groups.

Overall, the changes in accessibility to destinations due to the information experiment underscore the importance of identifying planning opportunities to improve accessibility so that those who value such improvements will act accordingly. The desire for decreased distances to major destinations is supportive of policies that encourage the mixture of land uses and development and redevelopment that efficiently uses existing, highly accessible city spaces. Little is gained, however, if high-accessibility areas are not identified as such by the public. Our results also support the need to communicate the availability of high-accessibility spaces to people at the time they move.

## RECOMMENDATIONS FOR FUTURE RESEARCH

Additional research will help to confirm how widely applicable those results are, and also if people actually *do* increase their use of alternative travel modes over time as a result of the linked housing and accessibility information. Further research can determine the degree to which our simulation findings will occur when individuals are making actual choices in the marketplace and if the results can be generalized to other populations. The following are several promising study designs.

*Repeat the study design with populations other than graduate students.*

Graduate students at a national research institution like the University of Michigan provided a good, easily accessible sample of the larger population for this initial research, since they come from diverse regions of the country and the world, and thus have diverse prior experiences with their travel options and habits. At the same time, graduate students are unlike the larger population because they are relatively young (most are in their twenties), well-educated, low-income, and have flexible daily schedules. The UM students tested had a surprisingly high rate of past familiarity with transit use, although comparisons to other populations are hard to make because of lack of data. The effects of providing linked accessibility and housing data should be tested on other populations as well, to determine if the results from this study could be generalized to other segments of the population.

In selecting test populations, researchers may want to identify population subgroups that could be effectively targeted with this kind of information at the time they relocate. One possible target group might be retirees or empty nesters who are moving out of the houses in which they raised families to smaller housing units, as some retirees may be interested in housing that provides them with the health benefits of walking or biking for transportation, or may be interested in living where they are not dependent on driving in case health problems make that difficult.

*Repeat the study design in locations with less omnipresent bus access.*

Ann Arbor has a relatively dense network of bus service, so a high proportion of the units in the database were within a short walk of a bus stop. It would be useful to repeat the experiment, perhaps even with graduate students, in a study area where there is a larger proportion of clearly transit-*inaccessible* units. This will ensure higher contrast among units with and without transit access.

*Investigate market demand for including transit information in prevailing housing information outlets.*

Although the effects of providing bundled transit and housing information are encouraging, most real estate information is provided by private organizations. Further research should identify ways in which private organizations can more widely incorporate accessibility and transit information into their real estate information. Real estate information occasionally includes access to rail transit, but less so to bus transit. Can private organizations be compelled to include this bundled information based on existing (latent) demand for it?

*Design a study that relies on observed behavior rather than stated preference.*

This study looked at participants' stated preferences about what housing units they thought they would rent, but survey research shows that stated preferences surveys are not universally good predictors of actual behavior. A similar study could divide a population of people actually relocating into control and experimental groups, with the experimental group receiving the additional accessibility information. It would then be possible to survey participants six months or so after they had chosen housing in the area to determine any differences in where the two groups chose to live, and any differences between the two groups in their rates of biking, walking, or taking transit. This would further identify possible biases inherent in our current research design.

*Design a study to examine various mechanisms to deliver bundled housing and transit information.*

Although our study focused on a Web-based experiment, it is likely that our results translate more broadly to the availability of transit information, irrespective of the way it is made available to individuals selecting housing locations. Future research may determine whether low-technology approaches like printed maps and real estate agents who highlight accessibility-related attributes of properties may achieve similar outcomes to the Web-based approach examined in this study.

## Concluding Thoughts

The study's findings are relevant not only for policymakers, as discussed above, but also contribute a new angle to the ongoing debates within the transportation research community about the strength and nature of the transportation/land-use relationship. Some observers assert a strong relationship, with households guided by the tradeoff between transportation accessibility and housing cost in their locational decisions; others find in the current auto-dominated transportation environment a weakened relationship, under which nonaccessibility factors dominate. Our findings suggest a third option: the relationship between transportation and land use is neither inherently weak nor inherently strong, but can be either nurtured or thwarted by policy. Appropriate interventions can increase the capacity of transportation accessibility to guide locational decisions, thus strengthening the transportation/land-use relationship. As this research suggests, integrated transportation and housing information, offered at the time of a residential locational decision, could be one of these interventions.

Our research looked at just one type of policy designed to do this, but the positive results suggest that planners and decision makers need to consider tools and techniques that will help people—especially those with some willingness to try alternative modes—to more easily identify high-accessibility housing.

# APPENDIX A
# PARTICIPANT RECRUITMENT E-MAIL

We sent to students across campus an e-mail with the subject "$20 Cash Incentive for 1 hr On-Campus Simulation Exercise." The text of the e-mail was as follows:

The Taubman College of Architecture and Urban Planning (TCAUP) at the University of Michigan is conducting a study of how people use information when they search for housing. As part of this study, we have developed a housing search tool that helps graduate students find housing opportunities in Ann Arbor.

All graduate students except TCAUP students are eligible to participate in this study. The study involves participating in this simulation exercise during 30 minutes and a web-based survey of your experience and attitudes related to housing choices and travel during 10 minutes. The simulation and survey duration in total will be less than 60 minutes. All participants will receive $20 cash incentive for completing the exercise and survey.

If you are interested in participating in this study, please enter the signup form at http://www.surveymonkey.com/s.asp?u=36112675139. This form is created for the purpose of assigning participants to available exercise sessions. (Filling this form is not part of the study.)

If you have any questions, please contact Jumin Song at zmblue@gmail.com.

Thank you!

Sincerely,

Jumin Song

# APPENDIX B
# INSTRUCTIONS GIVEN TO PARTICIPANTS

This is a study of people's use of information and is completely voluntary. Information on your identity will be kept confidential, and will neither be part of the study nor released to any third party. You will use the housing search tool during the first 30 minutes, at the end of which time you will be asked to provide your top five housing choices from the simulation exercise. Then you will complete a web-based survey of your experience and attitudes related to housing choices and travel.

The property information is provided by the Housing Information Office of The University of Michigan, Ann Arbor. "Off-Campus Housing" refers to any housing that is not University-owned or operated. Neither the University of Michigan nor University Housing guarantees in any manner the service or quality of service offered by listed landlords, management companies, or individuals.

We are able to offer a $20 incentive payment for participants who complete the exercise and the survey. If you stop the exercise before completing, your payment will be prorated. If you would rather not answer individual survey questions, just skip them; this will not affect your payment.

If you have any questions about this study, either before or after you begin participating in it, please contact Professor Jonathan Levine by email at jnthnlvn@umich.edu or by phone at 734-764-1289. Should you have questions regarding your rights as a participant in research, please contact the Behavioral Sciences Institutional Review Board, Kate Keever, 540 East Liberty Street, Suite 202, Ann Arbor, MI 48104, 734-936-0933, irbhsbs@umich.

# APPENDIX C
# PARTICIPANT SURVEY QUESTIONS

### Section I: Housing Choices from the Simulation

1. Please enter your assigned ID.

2. Below please enter the Property Identification Number (PIN) for the five housing units that you identified as most interesting to you from the simulation exercise.

Top choice:
Second choice:
Third choice:
Fourth choice:
Fifth choice:

### Section II: Information about Attitudes

First, we would like to know about the factors that matter to you in choosing a place to live.

1. Imagine that you are searching for housing in the Ann Arbor area. If you were comparing various housing units with similar rents or purchase prices, how important would the following factors be to you?

1 (Unimportant) 2 3 4 (Very important)

a. Size of the housing unit
b. Single-family house (as opposed to apartment, condo, or townhouse)
c. Amenities (e.g., pool, gym)
d. Attractive building (exterior and interior)
e. Smoking permitted
f. Wheelchair accessible
g. Safety and security
h. Quiet inside the housing unit
i. On-site parking

j. Public transportation nearby
k. Close to campus
l. Close to work
m. Shops and services nearby
n. Good schools for children
o. Lively neighborhood
p. Neighborhood amenities (parks, streetscape, etc.)
q. Nice neighbors
r. Other [Please specify]

2. Considering all the factors listed above, which three factors would be most important to you when comparing similarly priced units in the Ann Arbor area?

a. Most important:
b. Second most important:
c. Third most important:

The next set of questions asks for your opinion about some local transportation options.

(Questions 3-6) How do you feel about the following statements? Please choose a number from 1 (strongly disagree) through 5 (strongly agree).

3. Driving to campus is worthwhile, even with the parking difficulties.

4. I know how to use the bus system (or know how to find out).

5. Taking public transit is inconvenient.

6. If the routes, schedules, and travel times of the Ann Arbor Transportation Authority served my needs better, I'd take the bus more.

## Section III: Housing and Travel Information

Next, we have some questions about the place you currently live.

1. What type of housing unit do you live in?

Detached house
Room rented in a single-family house
Duplex or triplex
Rowhouse or townhouse
Apartment or condominium
Mobile home or trailer
Dorm room, fraternity or sorority house

2. What does your household currently pay per month in rent or for a mortgage? Your "household" includes family members or people with whom you live and substantially share income sources, but does not include roommates with whom you may share the rent.

$_________

3. Do you share the rent for your dwelling unit with roommates who are not part of your household?

Yes
No

4. What is the approximate total monthly rent or mortgage payment for the unit you live in, including what any roommates pay?

$_________

Don't know ____

The next questions ask about your travel preferences and habits.

5. Do you have a valid driver's license?

Yes
No

6. When you want to go somewhere in Ann Arbor or surrounding areas, how often do you have access to a car, motorcycle, or other motorized vehicle that you can use to drive yourself?

Always
Sometimes
Never

7. When you want to go somewhere in the Ann Arbor or surrounding areas, how often do you have access to someone who will drive you there?

Always
Sometimes
Never

8. When you want to go somewhere in the Ann Arbor or surrounding areas, how often do you have access to a bicycle?

Always
Sometimes
Never

9. Think about the time you spent on the university campus in the last seven days, not including today. Approximately how many times did you visit the following locations? (Think about your final destination, not where you left your car or transferred on the bus.)

a. North Campus
b. Central Campus
c. Medical Campus
d. Athletic Campus

Now you will be asked a series of questions about your travel in the last seven days, not including today.

When asked about how many "trips" you made, you should count each one-way trip separately. For example, if you biked to and from school one day, you would record that as two bike trips. If you drove yourself to campus, then drove from campus to pick up a friend at her job, and then drove back to your home, you would record that as three trips.

10. In the last seven days, how many times did you use each of the following transportation options to get to or from the university?

# of car trips as a driver
# of car trips as a passenger
# of bicycle trips
# of trips on AATA buses
# of trips on campus buses
# of walk trips

11. Think about your travel in the last seven days, not including today. Apart from your trips to and from the University of Michigan campus, how many trips did you make by car in the Ann Arbor area?

# of trips

12. Think about your travel in the last seven days, not including today. Apart from your trips to and from the University of Michigan campus, how many trips did you make by AATA buses in the Ann Arbor area?

# of trips

13. Think about your travel in the last seven days, not including today. Apart from your trips to and from the University of Michigan campus, how many trips did you make by bicycle in the Ann Arbor area?

# of trips

14. Think about your travel in the last seven days, not including today. Apart from your trips to and from the University of Michigan campus, how many trips did you make by walking in the Ann Arbor area?

# of trips

15. Was there ever a period in your life when you used public transit regularly (i.e., at least one day a week)?

Yes
No

## Section IV: Demographic and Background Information

The following questions will tell us a little bit more about your personal circumstances.

1. What is your age?

____ years

2. What is your gender?

Male
Female

3. Which best describes your race? Check all that apply.

White
African American, Black
Asian
American Indian, Alaskan Native
Native Hawaiian or other Pacific Islander
Hispanic/Latino
Multiracial
Other (please specify)

4. Did you grow up primarily in a:

Large city (over 1 million people)
Medium-size city (200,000 to 999,999 people)
Small-size city (50,000 to 199,999 people)
Town (under 50,000 people)
Village
Rural area

5. Do you live with a spouse or partner?

Yes
No

6. How many children live with you?

# of children

7. Where do you currently live?

Ann Arbor
Ypsilanti
Saline
Dexter
Washtenaw County (outside the four cities listed above)
City of Detroit
Wayne County (outside the City of Detroit)
Livingston County
Oakland County
St. Clair County
Macomb County
Monroe County
Other counties in the state of Michigan
Other (please specify what state)

8. What is the street address where you currently live? Please give either the street number and name OR the nearest intersection.

Street address (e.g., 345 Green Street)

OR

Nearest intersection (e.g., Highland Ave. & Laguna Way): Street 1 (e.g., Highland Ave)
Street 2 (e.g., Laguna Way)

9. Are you currently employed?

Yes, on campus
Yes, off campus
Yes, both on and off campus
No, not employed

10. Where is your primary workplace located?

Ann Arbor
Ypsilanti
Saline
Dexter
Washtenaw County (outside the four cities listed above)
City of Detroit
Wayne County (outside the City of Detroit)
Livingston County
Oakland County
St. Clair County
Macomb County
Monroe County
Other counties in the state of Michigan
Other (please specify what state)

11. What is the address of your primary workplace? Please give either the street number and name OR the nearest intersection.

Street address (e.g., 345 Green Street)

Or

Nearest intersection (e.g., Highland Ave. & Laguna Way): Street 1 (e.g., Highland Ave)
Street 2 (e.g., Laguna Way)

12. Check the category that best describes your total household income, before taxes, in the past 12 months. Include income from employment, financial aid, and family support. Your "household" includes family members or people with whom you live and substantially share income sources, but does not include roommates.

$10,000 or less
$10,001 to $15,000
$15,001 to $20,000
$20,001 to $25,000
$25,001 to $30,000
$30,001 to $40,000
$40,001 to $50,000
$50,001 to $60,000
$60,001 to $70,000
More than $70,000
Don't know

13. How many people live in your housing unit, including all roommates?

____ persons (including myself)

**Section V: The Housing Search Tool Effectiveness**

Finally, we have a few questions about how useful you found the housing search tool.

1. Overall, how easy was the housing search tool to use?

1 (very difficult) 2 3 4 5 (very easy)

2. How easy was it to compare units?

1 (very difficult) 2 3 4 5 (very easy)

3. Did the housing search tool provide the information that you needed to make your decision?

Yes
No

4. If no, what other information would you have wanted the search tool to have provided?

5. May we request your help for the continuation of this study (e.g., an in-depth interview or an additional survey)?

Yes, you can e-mail me at: (e-mail address) ________

# ENDNOTES

## TRANSPORTATION CHALLENGES: ALTERNATIVES TO THE AUTOMOBILE

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35. For example, the outcome variable "% of most preferred within 1/4 mile of transit" had four possible values: 0, 33, 66 or 100%. Treating these outcomes as continuous would be inappropriate; therefore, we decided to use ordered logistic regression instead.
36. Source: Ann Arbor Area Convention & Visitors Bureau, available at http://www.annarbor.org/aboutannarbor/background.asp (Accessed on: 6/23/2005).
37. Source: Ann Arbor Area Convention & Visitors Bureau, available at http://www.annarbor.org/aboutannarbor/um.asp (Accessed on: 6/23/2005).
38. Source: University of Michigan Regents, Parking & Transportation Services, available at http://www.parking.umich.edu/maps/overview.pdf (Accessed on 6/24/2005).

39. We had a test session in which seven testers took part prior to the real simulation exercise and found that 15 and 25 minutes were most reasonable for the control group and the experimental group, respectively. Note that these times are subject to the number of properties and function and speed of a housing search tool for the study.

40. A composite of pedestrian and transit accessibility, available only in the experimental group's version, was measured as follows: (1) Excellent accessibility: walking distance from campus (0.5 mile) or bus route (0.33 mile) with zero transfer and less than or equal to 15 minutes frequency; (2) High accessibility: walking distance to bus route (0.33 mile) with zero transfer and greater than 15 minutes frequency; (3) Medium accessibility: walking distance to bus route with 1 transfer, regardless of frequency; and (4) Low accessibility: none of the above

41. We assumed that the variance of the outcome "distance to transit" was the same for both groups. The type-I error probability was set to 0.05.

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44. Elizabeth Shay, Yingling Fan, Daniel A. Rodríguez, and Asad J. Khattak, "Drive or Walk? Utilitarian Trips Within a Neo-Traditional Neighborhood," *Transportation Research Record,* under review, 2006.

45. Cervero and Duncan (2003) do not report the mean walking or cycling distance. In their study, they considered only trips of less than five miles.

46. Cervero and Duncan, 1487-1483; Rodríguez and Joo, 151-173.

47. Shay 2006.

48. Cervero and Duncan, 1487-1483.

49. Rodríguez and Joo, 151-173.

50. For details, see Roderick P. MacDonald, *Factor Analysis and Related Methods* (Hillsdale, NJ: Erlbaum, 1985).

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52. Alonso 1964.
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54. Scores are point predictions or estimates made based on the loadings shown in Table 12.
55. For example, Kitamura, et al., 1995; Mahmassani and Liu, 91-107.
56. Dietrich H. Earnhardt, "Combining Revealed and Stated Data to Examine Housing Decisions Using Discrete Choice Analysis," *Journal of Urban Economics* 51 (2002):143-169.
57. Consistent with what is available to regular searchers in the University of Michigan off-campus housing Website, our simulation determined if properties were within 1/3 mile of campus.
58. Zellner and Rossi, 1986.

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AATA | Ann Arbor Transportation Authority |
| ANOVA | analysis of variance |
| APTS | Advanced Public Transportation System |
| ATIS | Advanced Traveler Information Systems |
| GIS | Geographic Information Systems |
| IT | information technology |
| PIN | Property Identification Number |
| UM | University of Michigan |

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# PEER REVIEW

San Jose State University, of the California State University system, and the MTI Board of Trustees have agreed upon a peer view process to ensure that the results presented are based upon a professionally acceptable research protocol.

Research projects begin with the approval of a scope of work by the sponsoring entities, with in-process reviews by the MTI Research Director and the project sponsor. Periodic progress reports are provided to the MTI Research Director and the Research Associates Policy Oversight Committee (RAPOC). Review of the draft research product is conducted by the Research Committee of the Board of Trustees and may include invited critiques from other professionals in the subject field. The review is based on the professional propriety of the research methodology.

Funded by
U.S. Department of
Transportation and
California Department
of Transportation

San José State
UNIVERSITY