Improving ADA Paratransit Demand Estimation: Regional Modeling

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP REPORT 158

Improving ADA Paratransit Demand Estimation: Regional Modeling

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

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The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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The research that produced this report was performed under TCRP Project B-28A. David Koffman of Nelson\Nygaard Consulting Associates was the Principal Investigator and co-author of the report. Mark Bradley of Mark Bradley Research and Consulting specified and estimated the models, wrote programs to implement the models, and wrote Chapter 3 of the report and the regional model documentation. David Chia of Planners Collaborative participated in the process of selecting candidate transit systems for the modeling. Jeff Livingston of NuStats directed the survey effort.

Staff of Dallas Area Rapid Transit and the Fort Worth Transportation Authority gave generously of their time, providing detailed data about their systems and users, facilitating mailings to potential respondents, and fielding calls from those who chose to opt out of the survey.

FOREWORD

By Dianne S. Schwager
Staff Officer
Transportation Research Board

TCRP Report 158: Improving ADA Paratransit Demand Estimation: Regional Modeling provides a sketch planning model and regional models to (1) improve the ability of metropolitan planning organizations and transit operators to estimate the probable future demand for ADA complementary paratransit service; and (2) predict travel by ADA paratransit-eligible individuals on all modes, not just ADA paratransit. All model parameters and coefficients are contained in this report and a fully implemented version is available on the enclosed CD-ROM. This report will be of interest to regional, state, and federal agencies that oversee, plan, or finance public transportation; public transportation systems that provide ADA complementary paratransit services; and advocates for people with disabilities.

The models presented in *TCRP Report 158* advance the state of the art in understanding travel by people with disabilities, in particular travel via ADA paratransit. The research demonstrates how the travel of people with disabilities can be explicitly treated in regional travel demand models.

Both models developed in this research build on the research presented in *TCRP Report 119: Improving ADA Complementary Paratransit Demand Estimation* and permit more detailed forecasts and deeper understanding of the travel behavior of ADA paratransit-eligible people.

- *A sketch planning model* allows planners to enter a small number of variables by means of a spreadsheet interface and explore how these variables affect predicted trip-making on ADA paratransit and other modes in the Dallas-Fort Worth area.
- *A regional planning model* (actually a system of multiple models) produces forecasts of travel by ADA paratransit-eligible people, with detail about numbers of trips by mode (ADA paratransit, other specialized service, car passenger, car driver, scheduled transit, and walk/wheelchair), by trip purpose, and by destination.

The models presented in this report are based on analysis of a survey of 800 users of ADA paratransit service operated by Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (FWTA), combined with the regional travel demand model of the North Central Texas Council of Governments (NCTCOG) and Census tract data for the same area. The survey obtained detailed information about actual trips made by ADA paratransit riders—not just on ADA paratransit but also on other specialized services, by private car as a passenger or driver, on scheduled transit, and walking or going by wheelchair. The resulting models explain observed ADA paratransit trip-making on the basis of socio-economic data (e.g., income, age distribution, and household size), travel times, and jobs of various types.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

CHAPTER 1

Summary

The Americans with Disabilities Act of 1990 (ADA) created a requirement for ADA-complementary paratransit service for all public transit agencies that provide fixed-route transit service. ADA-complementary paratransit service is intended to complement the fixed-route service and serve individuals who, because of their disabilities, cannot use the fixed-route transit system. In fulfilling their ADA obligations, transit operators have a responsibility to consider current and probable future demand for ADA-complementary paratransit service and to plan and budget to meet all of the expected demand.

The models described in this report are intended to improve the ability of metropolitan planning organizations (MPOs) and transit operators to estimate the probable future demand for ADA-complementary paratransit service. At the same time, the models predict travel by ADA-paratransit-eligible individuals on all modes, not just ADA paratransit.

Previous Work—Phase I

The research project on which this report is based is the second phase of a project that already produced an earlier set of demand estimation tools, described in *TCRP Report 119: Improving ADA Paratransit Demand Estimation.* The tools described in *TCRP Report 119* estimate total ADA paratransit demand for entire transit service areas based on six variables:

1. ADA paratransit service area population
2. Base fare for ADA paratransit
3. Percent of applicants for ADA paratransit eligibility found conditionally eligible
4. Whether or not trip-by-trip eligibility determination based on conditions of eligibility is used
5. Percent of service area population with household incomes below the poverty line
6. The effective window used to determine on-time performance (i.e., the window from the passenger's point of view, including requirements to be ready early and adjustments made in the scheduling process that may not be communicated to passengers)

The *TCRP Report 119* tools were based on statistical analysis of demand at 28 transit systems believed to offer high-quality ADA paratransit service complying with ADA requirements, although the *Report 119* tools might not necessarily meet the expectations of all users. To apply the *TCRP Report 119* tools, a planner needed only six data items, which could be entered into a ready-made spreadsheet that produced total expected ADA paratransit demand for a service area.

Phase II Research

Compared to the *TCRP Report 119* tools, the models developed in this research are intended to permit more detailed forecasts and to deepen understanding of the travel behavior of ADA paratransit-eligible people. Two models were produced:

- A *sketch planning* model, which allows a planner to enter a small number of variables by means of a spreadsheet interface and explore how these variables affect predicted trip-making on ADA paratransit and other modes in the Dallas-Fort Worth area. Although these forecasts are limited to the Dallas-Fort Worth area where data was collected to estimate the models, they allow exploration of hypothetical changes in age profile, income, household size, travel times, on-time performance, and fares within the Dallas-Fort Worth area. The sketch planning model is limited to predictions of travel by people already registered as eligible to use ADA paratransit.
- A *regional planning* model (actually a system of multiple models) that can be adapted to provide forecasts tailored to conditions in other metropolitan areas. This model system also includes the effects of changes in demographic and travel variables on registration (application and determination of eligibility) to use ADA paratransit. Used in conjunction with an existing regional travel demand model, the new model system produces forecasts of travel by ADA paratransit-eligible people, with detail about numbers of trips by mode (ADA paratransit, other specialized service, car passenger, car driver, scheduled transit, and walk/wheelchair), by trip purpose, and by destination.

To apply the regional planning model system to another area, planners will need census-tract-level socioeconomic data, employment data by census tract or travel analysis zone (TAZ), and matrices of zone-to-zone travel times and distances for whatever year a forecast is desired. It would also be necessary to incorporate differences in the characteristics of the ADA paratransit-eligible population. This could be done by collecting new survey data on the local ADA paratransit-eligible population or by adjusting "expansion weights" in the Dallas-Fort Worth sample to match the local ADA-eligible population. The latter could be done with any data that the local operator has on the riders (probably just age distribution), as well as census comparisons of regional demographic distributions with those in Dallas-Fort Worth, such as adjusting the percentage below poverty rate. Without such data, the regional planning model can still be used for exploratory analysis, but is limited to the Dallas-Fort Worth region.

These models advance the state of the art in understanding travel by people with disabilities, in particular by ADA paratransit. The research demonstrates how the travel of people with disabilities can be explicitly treated in regional travel demand models. However, due to data limitations, the models were only calibrated on the basis of total ADA paratransit trip-making. It was not possible to calibrate on the basis of geographic distribution, travel by other modes, or trip purpose distribution. These are significant limitations, but of less practical concern than might be imagined. ADA paratransit services are planned on the basis of total demand within a service area. Because the service is purely demand responsive within the established service area, origins and destinations (and routes of travel) vary from day to day and are not usually a major factor in planning. By law, trip purpose cannot be a factor in service delivery.

Both models are based on analysis of a survey of 800 users of ADA paratransit service operated by Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (FWTA), combined with the regional travel demand model of the North Central Texas Council of Governments (NCTCOG) and census-tract data for the same area. The survey obtained detailed information about actual trips made by ADA paratransit riders not just on ADA paratransit but also on other specialized services, by private car as a passenger or driver, on scheduled transit, and walking or going by wheelchair. For each trip, respondents provided trip purpose, mode of travel, trip duration, and exact point of origin and destination. The NCTCOG model provided data about travel times between zones in the region, as well as the number of jobs of various types in each zone, which serve as an indicator of the activities available in each zone that would attract trips.

The resulting models explain observed ADA paratransit trip-making on the basis of socioeconomic data for each census tract (e.g., income, age distribution, and household size), travel times between analysis zones, and jobs of various types in each zone.

In keeping with the intent of the ADA law and regulations, the forecasts of ADA paratransit ridership correspond to service that complies with requirements for level of service. The methods are also designed to exclude demand for services that exceed requirements for ADA-complementary paratransit. Of particular importance, demand is predicted only for service by ADA-eligible individuals, for trips within 3/4 of a mile of fixed-route service, based on reservations taken at least 1 day in advance. Demand is predicted for service that is not capacity constrained by significant numbers of denials, unreliable service, or excessive telephone wait times to reach a reservationist.

Evidence about Planning and Policy Issues

The models and the survey data provide limited evidence about planning and policy issues connected with ADA paratransit, including several questions about demand for ADA paratransit raised by *TCRP Report 119*.

Aging of the Population

It is widely anticipated that increasing numbers of older people will lead to growing demand for ADA paratransit. A recent report for the American Public Transportation Association estimated that, compared to levels in 2010, the demand for ADA paratransit by people age 65 and older will grow by 32% in the next 10 years and by 76% in the next 20 years. By comparison, the census population projections used in the report indicate that total population in urbanized areas will grow by just 17% in 10 years and 39% in 20 years. That analysis implied that the ADA paratransit demand would grow much faster than the population because of increasing numbers of older people.

However, *TCRP Report 119* did not find any connection between ADA paratransit demand and the size of the older population in a transit area. Several measures of the size of the older population were tested in the analyses for *TCRP Report 119* and none of them were found to be statistically significant. Instead, ADA paratransit demand was found to be proportional to the total population of an area after adjusting for differences in fares, poverty rates, and eligibility screening processes.

The model of registration rate and the models of tour generation and mode choice include age variables. To test what effect the models predict for an older population, the model system was run with a 10% increase in the fraction of the population over age 60. Also the proportion of ADA paratransit registrants age 60 and older was assumed to increase by 10%. The results of this test were

ADA paratransit trips per registered person:	−3.9%
Number of registered persons:	+1.8%
Total ADA paratransit trips:	−2.2%

Trips per person registered for ADA paratransit would decline, which corresponds with the experience of ADA paratransit operators that older people travel less than younger people, while the number of registered people would increase, which corresponds to the fact that older people are more likely to have disabilities than younger people. The drop in trips per registered person is much larger than the increase in registered persons, so a 10% increase in the senior population would create a 2.2% reduction in total ADA paratransit trips.

Effect of Incomes and Poverty

TCRP Report 119 found that transit systems serving areas with higher poverty rates had much lower demand per capita than transit system service areas with lower poverty rates, all else being equal. This finding surprised some observers, given that people with lower incomes have fewer travel options and so would tend to be more dependent on ADA paratransit. The report theorized that the apparent effect of poverty rate on ADA paratransit reflects differences among communities rather than differences among individuals. For example, if communities with high poverty rates have fewer activities available, fewer shopping opportunities, and fewer services in general than other communities, then high poverty rates would be expected to depress demand for all types of travel, including ADA paratransit.

The model of registration rate and the models of tour generation and mode choice include income variables. To test what effect the models predict for a population with a reduced poverty rate, the model system was run with a 10% *decrease* in the fraction of the households below the poverty rate and with a 10% *increase* in median income in each census tract. Also the proportion of poverty-level ADA paratransit registrants was assumed to decrease by 10%. The results of this test were

ADA paratransit trips per registered person:	+4.1%
Number of registered persons:	–5.8%
Total ADA paratransit trips:	–1.8%

Trips per registered person would increase, which reflects the fact that the models predict more trips overall with higher incomes as well as more trips by ADA paratransit. However, the number of registered persons would decline more, since the registration rate model found that poverty rate and registration rate are correlated, while higher median incomes go with lower registration rates. Overall, the models predict that higher incomes would reduce ADA paratransit travel slightly. Most of the predicted effect comes from a decreased registration rate, which is consistent with the well-established two-way connection between lower incomes and higher rates of disability.[1]

This finding of more ADA paratransit travel with reduced poverty rate is based on an assumption that incomes would rise within the Dallas-Fort Worth area, so it is not directly comparable to the finding of *TCRP Report 119* about differences among communities. Also, it does not take into account the possibility that a general community-wide rise in incomes would result in changes in available activities and services in the community.

Household Size

The effect of household size has not previously been a topic of discussion in connection with ADA paratransit demand, but household size is commonly included in regional travel models. Household size might be expected to decline in the future with a higher percentage

[1] Elwan, Ann, 1999. "Poverty and Disability: A Survey of the Literature, SP Discussion Paper No.9932," World Bank.

of older people, including many women who have outlived their spouses and more women raising children alone. People who live alone may make more trips because they cannot delegate activities to others. On the other hand, people with disabilities who live with others may make more trips because they have someone to assist them, accompany them, or provide rides for them. But while they might make more trips overall, they might make fewer trips using ADA paratransit. In general, the smaller the household, the fewer the opportunities for getting rides.

The model of registration rate and the models of tour generation and mode choice include variables related to household size. For convenience, the effect of larger rather than smaller households was tested. The model system was run with a 10% *decrease* in the fraction of single-person households and with a 10% *increase* in average household size in each census tract. Also the proportion of ADA paratransit registrants in single-person households was assumed to decrease by 10%. The results of this test were

ADA paratransit trips per registered person:	+1.0%
Number of registered persons:	–5.3%
Total ADA paratransit trips:	–4.4%

The results are opposite in direction from the result for an aging population, but with a much larger drop in registered persons and a much smaller increase in trips per registered person, leading to a significant drop in ADA paratransit trips.

Sensitivity to Fares

TCRP Report 119 found a fare elasticity of demand for ADA paratransit of –0.77, meaning that a 10% difference in fares corresponds to a 7.7% difference in demand in the opposite direction. In other words, if one system has 10% higher fares than a second system, it will have 7.7% lower demand on average, all else being equal. Given that the analysis was based on comparison of ADA paratransit in different areas, that is all the results imply. They do not say whether such a strong effect applies to fare changes within one ADA paratransit system. In fact, other analysis of fares and ridership in ADA paratransit systems has produced evidence that the actual fare elasticity of ADA paratransit demand is much lower. An analysis of ADA paratransit in Los Angeles, cited in *TCRP Report 119,*[2] found a fare elasticity of 0.43, which is close to values seen in general public bus service.[3] Also, since ADA paratransit riders tend to have low incomes, it is possible that lower income riders are more sensitive to fares than higher income riders.

Evidence from the model development supports a fare elasticity for ADA paratransit in the neighborhood of –0.41 for riders with household incomes under $15,000 per year and in the neighborhood of –0.23 for riders with household incomes of $15,000 per year or more. (Note, however, that even the higher income group still has few members with incomes over $35,000 per year.) Each of these groups constituted about half of the sample in the survey of ADA paratransit riders. This finding is based on analysis of a “Stated Preference” survey, in which ADA paratransit riders were presented with various service scenarios requiring tradeoffs between ADA paratransit fares and travel times, combined with the results of the travel model showing how travel times affect demand.

[2] HLB Decision Economics, 2004. “Demand Forecasting Model for LA Access ADA paratransit,” Access Services Inc.
[3] “The Demand for Public Transit: A Practical Guide,” Transport Research Laboratory, Report TRL 593, 2004, quoted at http://www.vtpi.org/tdm/tdm11.htm.

Sensitivity to Travel Time

Travel times on ADA paratransit are typically much longer than times for similar trips by private car. ADA regulations[4] prohibit "substantial numbers of trips with excessive trip lengths" but do not specify what is excessive. The FTA has interpreted the regulations to require that ADA paratransit travel times should be comparable to travel times by fixed-route transit. Common sense suggests that ADA paratransit users, like anyone else, will be influenced in their choices by travel times.

To investigate this issue, the model system was run with modified ADA paratransit travel times. These tests indicated that elasticity with respect to ADA paratransit travel is –0.5 for ADA paratransit trips, –1.1 for ADA paratransit passenger-miles, and –0.1 for total trip-making by ADA-eligible people. In other words, a 10% increase in ADA paratransit travel times would result in

- A 5% reduction in ADA paratransit trips
- An 11% reduction in ADA paratransit passenger-miles
- A 1% reduction in trips by all modes by ADA-eligible people

Most of the decrease in ADA paratransit trips would be made up by a corresponding increase in trips by other modes (mode shift), but not all of them—there would be a 1% decrease in total trips made by ADA-eligible persons. The elasticity for total trip-making is quite small, but still quite a bit higher than trip "suppression" elasticities estimated for the general population, which are typically much smaller than –0.1. Conversely, the mode-specific elasticity of –0.5 is toward the low end of values typically estimated for the general population, based on the experience of the research team.

These results are consistent with the fact that ADA paratransit users tend to have fewer travel options than the general population. Because they have few options, ADA paratransit riders would reduce their use of ADA paratransit in response to an increase in ADA paratransit travel time by less than the general population reduces its automobile or transit use in response to a similar increase in travel times on those modes. But the same lack of options means that fewer foregone ADA paratransit trips can be made up by trips on other modes than would be the case for transit riders or drivers. To some extent, relatively low sensitivity to ADA paratransit travel time could also reflect the fact that travel on ADA paratransit is less predictable than automobile or transit travel time, because the operator may group any given trip with a different set of other trips from one occasion to the next.

The research also provided some evidence on the value that ADA paratransit users place on travel time. Based on the Stated Preference tradeoff analysis, a change in ADA paratransit travel by one multiple of car travel time (e.g., from twice automobile travel time to 3 times automobile travel time or vice versa) is valued the same as a fare change of $1.73 by people making less than $15,000 per year, and the same as a fare change of $2.96 by people making $15,000 or more. If a car trip takes an average of 30 minutes, these results imply a "value of time" of about $3.50 per hour for the lower income group and about $5.50 per hour for the higher income group.

Importance of Pick-up and Drop-off Time

ADA paratransit systems typically take reservations based on the rider's desired pick-up time or desired appointment time. The ADA regulations note only a prohibition on "substantial

[4] 49 CFR 37.131, "Service criteria for complementary ADA paratransit."

numbers of significantly untimely pick-ups," but in later interpretations FTA has been clear that timely drop-offs are also an important part of on-time performance.[5] In the Stated Preference analysis that was part of the ADA paratransit user survey, half of respondents were asked to make tradeoffs involving late pick-ups and half were asked to make similar tradeoffs involving late drop-offs. The analysis found that a change of 5% in the frequency of late pick-ups was valued the same as a $1.06 fare change, but a change of 5% in the frequency of late drop-offs was valued the same as a $1.41 fare change. In other words punctuality for drop-offs was considered 35% more important than punctuality for the pick-up. In practice, of course, both pick-up and drop-off punctuality are important for each trip.

Telephone Hold Time

TCRP Report 119 attempted to measure the effect on ADA paratransit demand of telephone hold times when making reservations. A survey of practitioners conducted for that research ranked "ability to get through on the phone to reserve a ride" very highly as a factor that influenced demand. However, 9 of 28 systems studied did not have a measure of average hold time available. Analysis using the 19 systems with a measure of average hold time found that longer hold times appear to depress demand, but the result was not statistically significant.

In the ADA paratransit user survey for this research, the Stated Preference analysis asked respondents to make tradeoffs between the time "you may have to wait on hold for when you call to reserve a trip" and other service variables. The analysis found no significant impact for choices involving hold times of "up to 1 minute," "up to 3 minutes," and "up to 5 minutes." If correct, this result would imply that variations in hold time within this range are relatively unimportant compared to other variables in the analysis, namely fare, travel time, and lateness for pick-up or drop-off. Alternatively, the result could indicate problems with the way the question was stated, or it could mean that these statements of measured hold time are very different from customers' subjective sense of hold time. In other words, the difference between hold times of up to 3 minutes and hold times of up to 5 minutes may feel much greater than it sounds in a survey question.

Pedestrian Access to Activities

A reasonable speculation is that people with disabilities who live close enough to shops and services that they can walk or go to them by wheelchair will be less dependent on ADA paratransit. Ideally, this would be tested by taking into account the quality of pedestrian access in the form of safe sidewalks accessible to people with disabilities, crosswalks, clear pedestrian signals, sufficient crossing time at intersections, benches for resting, reduced traffic speed, and traffic islands. Aspects of accessibility for people with disabilities include accessible bus stops, curb ramps at intersection corners, audible pedestrian signals at street crossings, sidewalks that are clear of constructed obstacles such as telephone poles in the path of travel, and sidewalks that are in good repair. Comprehensive data about the quality of pedestrian infrastructure by zone was not available, but it was possible to test the effect on ADA paratransit registration rates of a high density of service and retail activities in a census tract. A very significant result was found: a 10% increase in access to activities reduces ADA paratransit registration rate by approximately 9%.

[5] Disability Rights Education and Defense Fund, June 2010. "On-Time Performance in ADA Paratransit," *Topic Guides on ADA Transportation, available at* http://www.dredf.org/ADAtg/index.shtml.

Further Research and Development

This is the first attempt to develop a disaggregate regional model of travel by ADA paratransit-eligible individuals, so numerous unanswered questions and opportunities for further development remain.

Disaggregate model of registration. In this research, the rate at which people apply for and obtain ADA paratransit eligibility was modeled using aggregate data for census tracts. The alternative would be to construct a disaggregate model using data from a large sample of individuals like the ones gathered in a regional household travel survey. It would be necessary to reliably determine which individuals in the overall sample have actually been certified as eligible for ADA paratransit. In a disaggregate model it would be possible to include the increase in mobility and accessibility that ADA paratransit would provide for the individual. This could be measured by the difference in the overall expected utility from the trip generation, distribution, and mode choice models with, versus without, ADA paratransit as an alternative. People expected to achieve the greatest benefit from ADA paratransit would be expected to be more likely to apply for it.

The effect of automobile ownership on registration. Automobile ownership and availability were not included in the tract-level registration rate model, because this variable is endogenous to many travel demand model systems. That is, it is predicted rather than used as an input, because, for many households, ownership decisions depend on relative accessibility by various modes. In further research along this line, it may be worthwhile to include automobile ownership as an exogenous factor, because it is unlikely that the level of ADA paratransit service would significantly affect automobile availability levels among the eligible population.

Differences among regions that affect registration. A comparison among regions might be able to determine the effects of

- The process used by the provider in determining eligibility (e.g., whether a simple paper application is used or all applicants are subject to functional testing); and
- The level of awareness of the service (the degree of activity/sophistication of social service agencies/advocacy groups in the region may be an indicator).

The effect of ADA paratransit service variables. The effects of ADA paratransit travel time, fares, service reliability, and telephone hold times could be further explored using additional Stated Preference research, time series modeling, or disaggregate modeling in a region where there is significant variation in these variables.

The effect of alternatives to ADA paratransit. Good alternatives to ADA paratransit would be expected to reduce demand or increase overall mobility. Two alternatives of vital importance whose effect could not be modeled in this research were

- Specialized services provided by Medicaid, adult day health care, programs for people with developmental disabilities, and so forth. Availability of these services varies among regions. In principle they vary among ADA paratransit riders within a region due to differences in eligibility (especially for Medicaid) and in some cases location. However, it was not practical to measure these differences.
- Fixed-route transit service. The attractiveness of fixed-route transit service for those ADA paratransit riders capable of using it for some trips depends on proximity to service, fare, frequency of service, transfers required, and accessibility features. Modeling the attractiveness of fixed-route transit service for such riders would require having zone-to-zone travel data for these variables and such data were not available in the data maintained by NCTCOG for

the study area. This information is available in many large regional travel models. In regions whose models have this information, it would be possible to test how the availability of convenient fixed-route service affects ADA paratransit demand. Regarding accessibility features, both transit operators, DART and FWTA, operate 100% wheelchair-accessible fleets, so there was no opportunity to test differences. Ideally, the availability of accessible pathways to transit stops would also be measured.

Weekend trips and time of day. Currently, the model only predicts weekday ADA paratransit trips, and not weekend trips. Modeling weekend trips would require collection of additional survey data. Also, trip departure time choice for ADA paratransit users was not modeled.

Model estimation in another region. It would be desirable to estimate a similar or more refined model in another region. Aside from the possibility of modeling the effect of transit level of service, weekend trips, and departure time choice, this would help test the transferability of the results found in Dallas-Fort Worth. Estimating a similar model in another region would require a travel survey of ADA paratransit customers. There may be opportunities to conduct such a survey by extending the sample used in a regional household travel survey of the general population.

Model testing in another region. Short of estimating a new model, the model developed in this research can be applied using census data and travel network data in another region. This process would test whether the model makes reasonable predictions beyond the region in which it was estimated.

Calibration using geographic and trip purpose distribution and travel by all modes. In a new model for another region, it would be desirable to calibrate results on the basis of observed geographic and trip purpose patterns and on the basis of observed use of modes other than ADA paratransit. From a policy perspective, it would be especially useful to confirm the validity of forecasts of travel by fixed-route transit. A premise of the ADA and of much work in ADA paratransit planning is that many ADA paratransit customers could use fixed-route transit for many of their trips. It would also be important to confirm the validity of forecasts of travel as a passenger in a private car, given that such travel is by far the most common mode of travel by ADA paratransit-eligible people.

Refinement of travel survey methods. In most respects, the research determined that ADA paratransit riders can be surveyed with methods similar to those used for traditional household travel surveys. However, respondents to this travel survey appear to have over-reported their use of ADA paratransit. It appears that respondents who travel infrequently may have made it a point to schedule the trips they needed to make on their assigned survey days. This effect occurred despite use of standard travel survey methods, including controlled choice of assigned survey days. The resulting over-reporting was adjusted for by using a calibration procedure, but there was no way to test or adjust for the possibility that travel by other modes could have been correspondingly under-reported. Respondents in a typical general population travel survey have much less opportunity or incentive to make such adjustments to their usual travel patterns. However, the respondents in this survey travel much less frequently and non-discretionary travel such as for work or school makes up a much smaller part of their overall travel. Testing ways to control for or prevent over-reporting of ADA paratransit trips would be useful.

CHAPTER 2

Description of the Research

This chapter explains the rationale for developing disaggregate models of ADA paratransit travel and how the typical travel demand model structure was adapted for the case of ADA paratransit. There is also a review of the steps carried out by the research team, including selecting sites for collecting data and the actual data collection process.

Regional Travel Demand Models

This project created a model of the type used by MPOs in the regional household travel models with which MPOs project travel trends, including use of major highways and transit. The new model (actually a series of models) can be combined with existing regional travel models to add ADA paratransit to the mix of modes treated by those regional models.

Regional travel models traditionally have been based on aggregate data for travel analysis zones (TAZs). More recently, disaggregate travel demand models have been developed that model choices by individuals at the behavioral level that they actually occur. A typical model of household travel demand treats travel behavior as a series of separate but interrelated decisions:

- Frequency choice (usually called "trip generation"): the choice of how many trips to make for different purposes;
- Destination choice (usually called "trip distribution"): the choice of where to travel to;
- Mode choice: the choice of which travel mode (drive-alone, transit, carpool) to use; and
- Route choice (usually called "trip assignment"): the choice of which route of travel to take.

A disaggregate travel demand model attempts to explain these individual decisions in terms of individual or household characteristics (e.g., income, gender, and employment status), the available opportunities (e.g., work and shopping) at various possible destinations, and the cost or travel time associated with possible trips depending on the mode of travel.

This research created a disaggregate model of the decisions of individual ADA paratransit users to make particular trips and of their decisions to make them by ADA paratransit or by some other mode. These choices are similar to those modeled in typical regional travel demand models, although ADA paratransit users have a different set of modes available to them. Also, choice of route of travel, which is part of a typical travel demand model, is not relevant to travel by ADA paratransit, because the system operator determines the route after the individual has chosen to make a trip.

The alternative to a disaggregate model is an *aggregate model,* which is one that treats only the combined results of travel decisions by thousands of people (e.g., total trips in an area). The model developed in the first phase of this research was an aggregate model that compared total ADA paratransit demand in 28 transit systems and attempted to explain the observed differences in terms of regional measures such as population and poverty level, as well as ADA paratransit system policies such as fares and on-time performance.

There are two primary advantages of the disaggregate approach, relative to an aggregate model. First, the disaggregate approach may avoid the problem of *spurious results.* The more aggregated the data is, the more likely one is to find broad correlations between variables and the more difficult it is to attribute behavioral effects to any particular variable. For example, the first phase of this research found that high levels of poverty in a region correlate with lower ADA paratransit ridership. This effect was statistically very significant but it says nothing about how the incomes of ADA paratransit riders (as opposed to the community as a whole) affect their use of ADA paratransit. It could still be the case that lower income riders choose ADA paratransit instead of private automobile more than higher income riders. With disaggregate data, we can relate the ADA paratransit trip rates of individual persons or households to (1) their household incomes as well as the availability of an automobile within the household; (2) the accessibility to important destinations by automobile versus other modes (e.g., parking convenience, parking costs, and walking distance between stores); and (3) land use mixes (the proximity of different types of destinations). By using a large number of observed cases subject to different levels of these variables, we can overcome problems of correlation and sort out their relative effects on behavior.

A second important advantage of the disaggregate approach is that it can overcome *aggregation bias.* This type of bias arises from the fact that most models that represent discrete choices at the individual level (e.g., logit models and gravity models) are nonlinear, and thus the probability share and model sensitivity at the aggregate average value is not necessarily equal to the average of the probabilities and sensitivity across all individual values. This is shown in Figure 2-1 and is true both for the predicted choice shares and the predicted elasticities. This means that if the data used to estimate and/or apply demand models are aggregated to too coarse a level, the predicted demand is subject to inaccuracies.

As an example of aggregation bias, suppose that households with no automobiles have few alternatives to using transit, so their mode choice is not very sensitive to transit service levels. Also suppose that households with a car for every driver are very unlikely to use transit, so their mode choice is also insensitive to transit service levels. The intermediate households who own cars but do not have a car for every driver are the ones where transit and automobile are most competitive, and thus most sensitive to transit service changes. A model that uses aggregate average car ownership levels within a zone or a region would assign everyone an intermediate level of car ownership and thus would over-predict the sensitivity of mode choice to transit service levels. Similar logic could apply to predicting how ADA paratransit service quality affects the choice to use ADA paratransit instead of another mode.

Aggregate regression models such as the one created in the first phase of this research (*TCRP Report 119*) can be subject to this same underlying behavioral inaccuracy. Such models are estimated using single average values for variables distributed across the population, and there is no guarantee that the predicted effects of changing those variables will be the same as what we would predict from more detailed models that segment the population into more homogenous categories.

12 Improving ADA Paratransit Demand Estimation: Regional Modeling

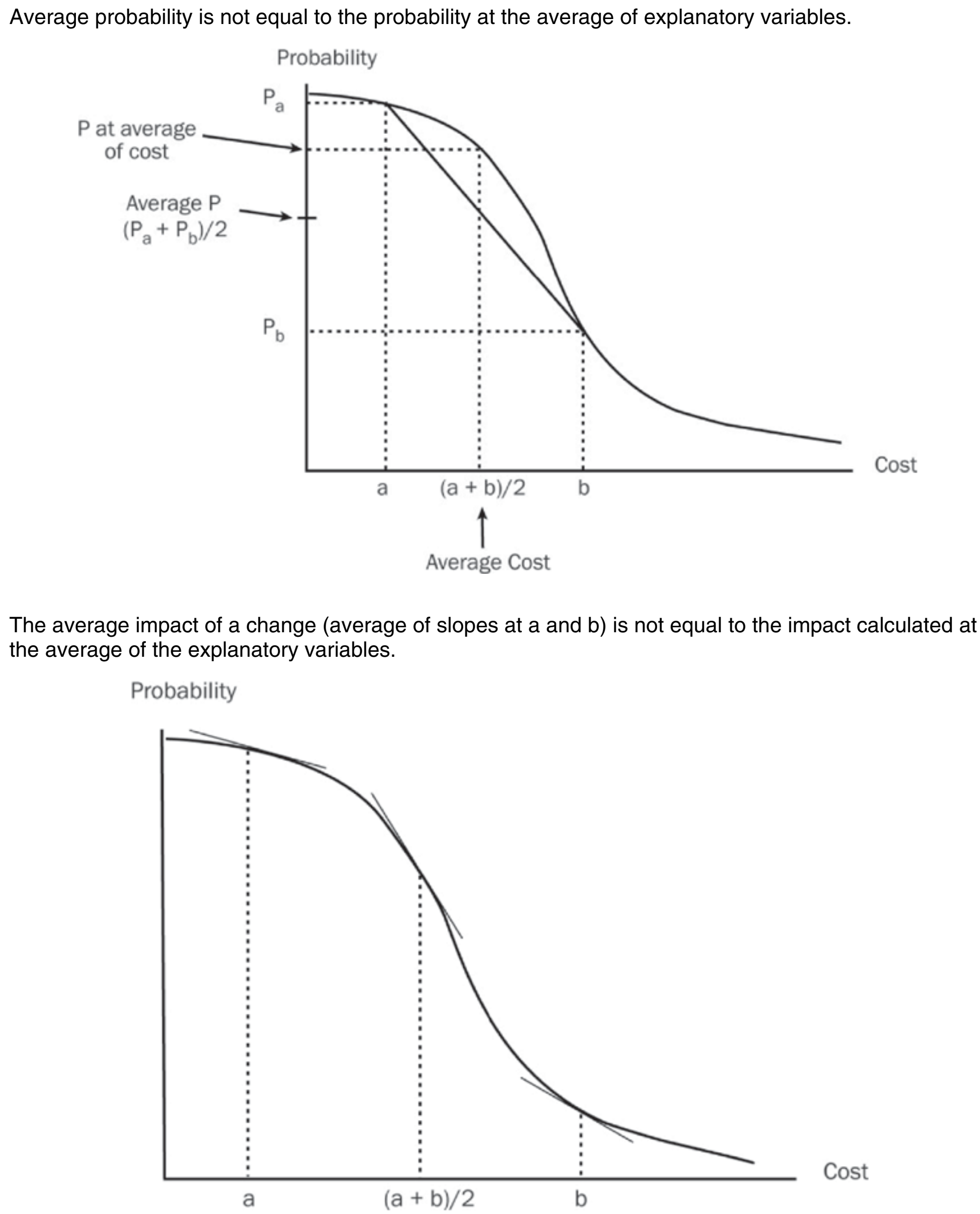

Figure 2-1. Aggregation bias with nonlinear logit models.

Adapting Travel Demand Models for ADA Paratransit

For modeling ADA paratransit demand, the basic four-step approach has been expanded to account for issues unique to this mode of travel and to incorporate state-of-the-art methods in regional travel demand modeling. Aside from the details of implementation, the model still treats four key decisions that determine the number of trips by ADA paratransit that any given individual makes, but not the same ones used in a traditional four-step model and not in the usual sequence. The decisions are

1. The decision to apply/register for ADA service eligibility. This step is necessary, because a person with a disability has to apply for and be certified as meeting ADA eligibility criteria before ADA paratransit becomes a possible travel choice.
2. Tour generation: The decision to leave home to make one or more connected trips for some purposes.

3. Mode choice: The decision to make that series of trips by ADA paratransit or an alternative mode, or some combination of modes.
4. Destination choice: The decision to visit a specific destination.

The ordering of the steps implies that each of these decisions is conditional on making the decision above it. However, we cannot treat the decisions as purely sequential, because each decision may also depend somewhat on the decisions below it as well. The decision to apply for ADA eligibility will depend on the number of trips a person makes and the propensity to make those trips by ADA paratransit. This is comparable to the decision to get a license to drive an automobile. For example, people in New York City are less likely to have driving licenses, not because they are less able to drive, but because driving is less attractive there, so they are less likely to make the effort. In the case of ADA paratransit, the decision to apply for ADA eligibility (Step 1 above) depends to some extent on whether or not there are particular types of trips that a person wishes to make using the system (Steps 2 through 4 above). Another example is the fact that some people may have no feasible alternative to ADA paratransit for some trips, so the decision to make a trip at all may depend on the availability of ADA paratransit service. This inter-relationship is probably even stronger than it is for most other types of travelers who are able to use a wider variety of modes.

In disaggregate travel demand modeling, the most effective way of modeling interrelated decisions is to use the expected utility, or "logsum" (the logarithm of the sum of the modeled utilities), across all available alternatives in the lower level model (i.e., a model of one of the lower decisions in the list above) as an explanatory variable in the upper model (i.e., a model of one of the upper decisions in the list above). This essentially leads to a system of simultaneous nested models which are internally consistent. This type of linkage is described further below, as part of a discussion of variables that should be considered in each of the four models above.

The choice to model mode choice before destination choice departs from the usual practice in travel demand models in the United States, though it is not unusual in Europe. It is entirely possible that ADA paratransit users' choice of destination depends more on the modes available than that mode depends on the destination. Also, in the case of ADA paratransit, the travel time by ADA paratransit to a specific destination is not generally known in advance. Therefore, it is not critical to model mode choice after destination choice. Moreover, NCTCOG's model has very limited data on transit travel times. In the mode choice model, a logsum of the type just described is used to represent overall ability to reach destinations of interest by each mode.

The next four sections describe modeling methods for each of the four decisions. Each component of the complete model system is described in detail in Chapter 3.

The Decision to Apply/Register for ADA Paratransit Eligibility

Initially, it had been hoped to estimate a disaggregate model of ADA paratransit registration that would predict the probability of any individual applying and registering for ADA paratransit. However, that would have required a very large survey of the general population, not just limited to ADA paratransit users, that obtained the variables related to ADA paratransit eligibility as well as whether any household members were actually registered for ADA paratransit. Such survey data was not available and could not be obtained for a reasonable cost.

In the future, it may be possible to obtain the data for such a model by adding a small number of questions to a general-purpose regional household travel survey. Respondents would need to be asked if any household members had any condition that limited their ability to travel, and then questions would need to be asked about the nature of the condition and whether the individual was registered for ADA paratransit. Ideally, the travel diary portion of the survey would include ADA paratransit among the modes that respondents could report on.

For this research, a model was estimated to predict the fraction of people in each census tract who apply for and obtain ADA eligibility. One set of variables of interest are those related to disability:

- Age
- Gender
- Employment status (unemployment as an indicator of disability)
- Income (provides access to healthier lifestyle, better health care)
- Household size (people not living alone may tend to be healthier)

These are not necessarily causes of disability, and certainly have nothing to do with whether an individual meets the ADA eligibility criteria; but they may have a statistical relationship to ADA eligibility that will be useful for modeling purposes. Other variables are related to the probability that eligible individuals will actually apply for eligibility and be accepted:

- Household size (as an indicator of the availability of help from other family members)
- Location within the ADA paratransit service area
- Proximity to locations that can be reached by walking or wheelchair (reducing the need for ADA paratransit)

In a disaggregate model, it would also be desirable to include the increase in mobility and accessibility that ADA paratransit would provide for the individual. This could be measured by the difference in the overall expected utility from the trip generation, distribution, and mode choice models with and without ADA paratransit as an alternative.

Other variables could affect application rates among different regions, but could not be measured within one study region. These include

- The process used by the provider in determining eligibility (e.g., whether a simple paper application is used, or all applicants are subject to functional testing)
- The level of awareness of the service (the degree of activity/sophistication of social service agencies/advocacy groups in the region may be an indicator)

Tour Generation: The Decision to Make a Series of Trips

The key variables are those that influence the propensity of a person to carry out various types of out-of-home activities. Depending on the type of activity (the trip purpose), variables may include

- Age. Most activities generally decrease with age.
- Income. People with higher incomes typically travel more for all purposes.
- Employment status/student status. These determine the need for commute or school trips.
- Gender. Females and males often have somewhat different participation rates for specific out-of-home activity purposes, particularly in older households.
- Type of impairment/disability: People with certain disabilities may be more likely to travel for certain purposes (e.g., people with mental impairments to adult daycare).
- Household size. In general, people who live alone may make more trips because they cannot delegate activities to others, but people with disabilities who live with others may make more trips because they have someone to assist them, accompany them, or provide rides for them.
- Car availability.
- Accessibility to activities. People living in areas where it is possible to reach more activities of interest in a reasonable time are likely to travel more. (“Accessibility” here is used in the broad sense generally used in travel behavior theory, namely access to destinations, taking account of travel times, availability of travel options, etc.)

- Regional effects. Climate and lifestyles may vary somewhat across regions in ways that affect travel. However, in a model estimated for one region, there is no way to measure these effects.

Trip generation was modeled at the level of tours (i.e., tour generation) consisting of a sequence of chained trips from home to various destinations and back to home. Within each tour, additional steps modeled the number of intermediate stops that would be made.

Mode Choice: The Decision to Travel by ADA Paratransit or an Alternative Mode

Depending on the principal purpose for leaving home, the key factors in mode choice fall into two categories: (1) variables directly related to ADA paratransit service and (2) variables related to alternatives to using ADA paratransit. In principle, ADA paratransit service variables should be of major importance. These could include

- Service reliability
- Advance reservation requirements (how far ahead a trip can be reserved)
- Availability of most convenient requested time
- Conditional eligibility trip screening
- Fare
- Travel time (will typically be somewhat longer than travel time by private car, but somewhat shorter than the scheduled time on fixed-route transit)
- Denial rates (not relevant in this study, because the scope was limited to ADA-compliant services)
- Availability of a program to coach riders on how to use the system

In practice, with results from only two very similar ADA paratransit services, and with no data about ADA paratransit travel times, it was not possible to estimate these effects from travel data. As a next-best alternative a Stated Preference analysis was used to provide limited evidence for the effect of some ADA paratransit service variables. The process of gathering Stated Preference data is described in the Data Collection section and the analysis is described in Chapter 3.

Variables related to alternatives to using ADA paratransit—that can be modeled—include

- Automobile ownership and availability. Ability to drive would be important, but few ADA paratransit users are able to drive.
- Household size (may mean that a companion driver is available).
- Cars per driver in the household (for households with a car).
- Income (determines which options are affordable and may also influence availability of specialized services).
- Age (influences ability to drive and walk and may influence availability of other specialized services).
- Disability type/need for mobility aids (also influences the ability to use alternative modes and services).
- Trip purpose has a bearing on mode choice and is easily included in the model. For example, recreation and social trips may be less commonly made by ADA paratransit than other trip types, and some work and school trips may tend to be made using specialized services operated by school districts or by agencies that provide supported work.

Ideally, a mode choice model would incorporate the effect of differences in the cost (to the rider) and time required for a trip by ADA paratransit compared to the same trip by other modes. However, the cost for every ADA paratransit trip is essentially the same in the Dallas-Fort Worth region, and travel time for an ADA paratransit trip is not known before a reservation is made. Instead, a summary measure of accessibility to all potential destinations by each mode was used; this is another example of the type of logsum described earlier.

Mode choice is first modeled for tours. Then after intermediate stops are added to tours, a separate model treats whether subsidiary modes would be used (e.g., getting a ride home in a car after taking an ADA paratransit trip or else walking, going by wheelchair, or getting a ride to transit).

Additional variables that may be important but could not be modeled include

- Availability of specialized services provided by Medicaid, adult day healthcare, and programs for those who have developmental disabilities. This varies among regions, but is the same for all ADA paratransit users in the Dallas-Fort Worth region. However, some of this effect is captured by trip purpose as noted above.
- Fixed-route transit convenience, fare, frequencies, transfers required, wheelchair lifts, etc. NCTCOG's model included very limited transit data, and both DART and FWTA operate 100% wheelchair-accessible fleets.

In particular, planners would find it useful to understand the potential impacts of

- Establishing more convenient fixed-route transit service to major ADA paratransit trip generators and attractors,
- Improvements in accessible pathways to fixed-route stops and stations,
- Offering fixed-route fare incentives for ADA-eligible riders or persons with disabilities in general,
- Reducing walking distance for riders with disabilities by shifting to a flex-route design in certain corridors.

Trip Distribution: The Decision to Visit a Specific Destination

Destination choice models typically include two types of variables: (1) impedance variables and (2) attraction variables. Impedance variables (e.g., travel time and cost) measure the separation between zones and typically have negative effects. Attraction variables (e.g., retail employment) measure the attractive power of a zone as a destination and have positive values. Given that transit travel times were not available and ADA paratransit travel time is not known in advance, automobile travel time was used as an impedance measure.

The 2007 zonal data provided by NCTCOG has six possible attraction variables:

- The number of resident households
- The number of retail jobs
- The number of service jobs
- The number of "basic" jobs (non-retail, non-service jobs, such as industry, production, and wholesale)
- The number of jobs at shopping malls
- The number of jobs at hospitals

The number of jobs in a zone is considered a measure of the overall level of activity in the zone that should attract trips. For example, numerous jobs at hospitals in a zone indicate the presence of major medical facilities that would attract large numbers of medical trips. The first four variables are typical attraction variables used in travel models, although some regions have finer breakdowns of employment than just the three categories (basic, retail, service). The last two, however, are not typical, but fortunately NCTCOG includes hospitals and shopping malls as "special generators" in their models, so the model includes separate zonal data. Because these are common destinations for ADA paratransit, both of these variables were tested.

Site Selection

Locations were needed to develop the models with good-quality ADA paratransit and an adequate travel model system. For each location, the process required conducting a travel diary survey of ADA paratransit users and using an existing regional travel demand modeling system. After consideration of more than 40 candidate locations, DART and the Fort Worth Transportation Authority (FWTA) were chosen. Each candidate location was evaluated based on the following criteria:

- The ADA paratransit system in operation there was believed to be operating without capacity constraints and generally employing best practices in operations and eligibility screening.
- The ADA paratransit operator maintained a list of registered users and would allow the list to be used to survey those riders.
- The local MPO had an existing regional model system that was typical (or better than average) in terms of the specification of input and output data. For this study, it was important that the system include an automobile ownership model that predicts car ownership distribution by combination of income group, household size, and number of workers in the household.
- The local MPO was willing to provide access to their model data and a modest level of guidance in using it.
- One or more members of the study team had worked with the MPO and with their data and were familiar with their models.

Other locations declined to participate, were unable to provide rider information due to confidentiality concerns, had inadequate travel models, were believed to have possible ADA service quality issues, or were unfamiliar to the study team so that information was lacking to make an assessment.

DART and FWTA met the criteria and agreed to participate in the study. Having two systems in the same metropolitan area raised some concerns, but also had significant advantages, because both are within the jurisdiction of the same MPO with the same travel model. The MPO, the NCTCOG, agreed to participate. The agency's travel model was already known to the study team. Also, despite being in the same metro area, Dallas and Fort Worth have the positive feature of being significantly different with respect to demographics and ADA paratransit system characteristics. Compared to Dallas, Fort Worth has about one-fourth the population, less density of fixed-route transit service, a higher poverty rate, and a higher percentage of older women. Looking at ADA paratransit service, Fort Worth makes less use of conditional eligibility and uses a 30-minute on-time window (compared to 20 minutes in Dallas); both charge $2.75 per trip. As it turned out, it was not possible to make detailed use of these differences in service characteristics.

DART's ADA paratransit system is known just as DART ADA paratransit, while FWTA's is known as Mobility-Impaired Transportation Service (MITS).

Data Collection

The principal source of data for model estimation was a travel diary survey of 800 ADA paratransit users, including 400 DART users and 400 MITS users. The travel diary survey was similar in concept to surveys conducted by MPOs for estimating urban travel demand models. These surveys typically ask for details of all trips made by all household members during one or two specific days. A typical sample size for regional travel surveys is 3,000 to 6,000 households. The number of ADA paratransit trips reported in such a survey tends to be quite small and not adequate to estimate separate models for those trips. In fact, ADA paratransit is rarely given its own mode category—it is often relegated to the "other" category to be written in by the occasional respondent. Because of these limitations, a special-purpose ADA paratransit travel survey was needed for this research.

This survey was used for estimating all of the model components, except the model of ADA paratransit registration. Because data was needed only from people who had already applied for and obtained eligibility to use ADA paratransit, the survey could be conducted using a well-defined sampling universe (all ADA paratransit registrants of the participating transit operators) whose contact information was already in the databases held by the transit operators. Compared to the process for a typical regional household travel survey, this process had several advantages:

- It was only necessary to collect data from the ADA-eligible person(s) in a household, rather than from every household member.
- Because people with disabilities tend to make fewer trips than the average person, the travel diary period could be extended beyond a single day without adding significant respondent burden.
- It was possible to use the ADA paratransit operators' registration data to contact respondents, greatly increasing response rate compared to a survey using a typical random sample.
- By combining the registration lists with the operators' databases of actual trips, it was possible to stratify the sample according to trip frequency and age group and to calibrate the results of the travel diary reporting using actual total trip-making.

The ADA paratransit travel survey was conducted from September 2009 through June 2010 by a professional research firm experienced in this type of data collection. DART and FWTA provided the contact information of ADA paratransit customers who could be asked to participate in the survey. The study was divided into two survey efforts. First, a pilot survey was conducted from September 2009 to December 2009 that yielded complete demographic and travel behavior characteristics for 17 ADA paratransit users. The purpose of the pilot survey was to test the survey methodology, evaluate respondent materials and comprehension, and gauge participation rates. The full survey was fielded subsequent to the pilot survey, from January 2010 to June 2010. As an incentive, respondents were told that, for participating in the study, they would be entered into a random drawing for a cash prize of $200. The $200 honorarium was awarded to five respondents selected at random at the conclusion of data collection after all data had been processed.

The procedures for the survey were similar to standard procedures for conducting a travel survey and included the following 10 stages, which are described in more detail below:

1. Sample Selection
2. Opt-Out Mailing
3. Recruitment Telephone Interview
4. Respondent Packet Mailing
5. Reminder Call
6. Data Retrieval Telephone Interview
7. Reminder Postcard
8. Processing
9. Real-Time Geocoding
10. Data Edit Checks and Cleaning

Sample Selection

The sample consisted of a stratified selection of DART and FWTA customers. The sample was limited to adult (age 16 and older) ADA-eligible riders (excluding personal care attendants or companions) who had either ridden the ADA paratransit service in the preceding 12 months or (in Fort Worth only) become eligible in that same time period. DART and FWTA provided lists of eligible customers, including date of eligibility certification, date of birth (for calculating age), and the number of trips taken in the preceding 12, 6, and 3 months.

The sample was stratified by age and trip frequency using four trip frequency categories and four age categories. The purpose of this stratification was to ensure adequate coverage of all ages, including both frequent and infrequent users. An initial stratification used in the pretest produced numerous respondents who did not travel at all during the 2 days assigned for recording their travel. In response, the stratification was modified as described here and summarized in Table 2-1.

The first table in Table 2-1 shows the actual distribution of the client bases used for drawing the sample (7,220 DART records and 4,584 FWTA MITS records) across the age and frequency categories. This excludes people who had not ridden or registered in the past 12 months, records with missing age data or age under 16, missing telephone numbers, or people who were already included in the pilot survey. The second table shows the target distribution for the survey, which was used for drawing the sample to be contacted. The row and column totals in bold were set to achieve the desired totals in each age group overall and each frequency group overall. Compared to the pretest sample, these targets increased the sample of frequent users in the sample (to avoid too many respondents who would have no travel to report) and also increased the number of

Table 2-1. Sampling targets.

Actual Distribution of ADA Paratransit Registrants

	Trip Frequency (trips in last 3 and 12 months)				
Age	6+ trips per month in the last 3 months	1-5 trips per month in the last 3 months	No trips in the last 3 months, but trips in the last 12 months	No trips in the last 12 months, but registered in the last 12 months	Total
Dallas					
16-44	10.3%	5.8%	5.4%		21.5%
45-64	12.6%	15.4%	11.5%		39.5%
65-79	5.3%	12.2%	9.2%		26.7%
80+	2.1%	5.5%	4.6%		12.2%
Total	30.4%	38.9%	30.8%		100.0%
Fort Worth					
16-44	6.7%	3.9%	3.1%	2.0%	15.7%
45-64	10.6%	13.1%	10.1%	7.4%	41.2%
65-79	5.4%	9.9%	7.1%	5.9%	28.3%
80+	1.9%	5.7%	4.2%	3.2%	14.9%
Total	24.5%	32.6%	24.4%	18.5%	100.0%

Target Survey Sample Distribution

	Trip Frequency (trips in last 3 and 12 months)				
Age	6+ trips per month in the last 3 months	1-5 trips per month in the last 3 months	No trips in the last 3 months, but trips in the last 12 months	No trips in the last 12 months, but registered in the last 12 months	Total
Dallas					
16-44	21.39%	5.45%	3.15%		***30%***
45-64	22.08%	12.18%	5.74%		***40%***
65-79	7.94%	8.18%	3.88%		***20%***
80+	3.59%	4.19%	2.22%		***10%***
Total	***55.0%***	***30.0%***	***15.0%***		
Fort Worth					
16-44	21.49%	5.74%	1.02%	1.74%	***30%***
45-64	21.51%	12.29%	2.08%	4.12%	***40%***
65-79	8.77%	7.42%	1.17%	2.64%	***20%***
80+	3.24%	4.54%	0.73%	1.49%	***10%***
Total	***55%***	***30%***	***5%***	***10%***	

younger persons in the sample—both because their behavior may be different from the older age groups and because younger people tend to be more difficult to contact during the survey process.

In summary, the sample stratification and weighting was done in order to obtain a useful sample for modeling as efficiently as possible. It is desirable to include some respondents who make no trips or very few trips in the sample in order to model travel frequency, but for modeling mode choice and destination choice, it is more efficient to survey people who will make a fair number of trips, including trips by ADA paratransit and by other modes, during the 2-day survey period. When modeling the data, the observations were re-weighted to be representative of the full population of possible (certified) ADA paratransit users.

The fractions in the cells in the second table were calculated using iterative proportional fitting (IPF), starting with the actual cell percentages in the first table, and making the smallest possible adjustments which would match both the row targets and column targets in the second table. By dividing the cell percentages in the second table above by those in the first table, weights were calculated to use in drawing a probability sample for the survey that would match the cell targets.

Based on the results of the pretest, the sample provided to the survey company included 5,304 records to allow for those who would opt out, not be contacted, or decline to participate at any stage.

Opt-Out Mailing

In order to address privacy concerns, DART and MITS customers were contacted via mail to inform them of the upcoming study and to invite them to opt out of the study if they so chose. Respondents were able to opt out by calling, emailing, or mailing their respective transit agencies. Those users choosing to opt out of the study were removed from the sample list used for data collection. Only 176 people chose to opt out within the 2 weeks allowed for this. An additional handful requested to opt out after data collection had begun and they were also removed from the sample list.

Recruitment

The selected sample of ADA paratransit users were contacted by telephone. The purpose of the survey was explained, and respondents were assured that none of the information they would provide would be given to DART or FWTA. They were told participants would be entered in a drawing for a $200 honorarium. They were then asked if they would participate. For those respondents who agreed to participate in the study, a demographic interview was conducted to obtain data about the household and their members, including household size, number of vehicles, household income, dwelling type, age, gender, education level, driver's license status, employment status, student status, and address. At the end of the recruitment interview, the respondent was assigned 2 travel days and arrangements were confirmed to call back and retrieve information about travel on these days. In total, 1,455 respondents were recruited and agreed to complete a 48-hour travel diary.

Respondent Packet Mailing

Travel diaries and Stated Preference materials were mailed to each respondent who had agreed to participate. The travel diary was an 18-page booklet with space for respondents to record information about locations visited, time of travel, mode used, traveling companions, and activ-

Diary Instructions

Use this diary to record information about **ALL** the **PLACES** you visit on your assigned travel days. Record one **PLACE** per page.

Answer all of the questions on each page for each place.

What is a **PLACE?**

A **PLACE** is any location where you do something. You may stay there for a long time (like at work or school) or just a few minutes (like at a drive-thru window).

✓ **IF YOU DRIVE**, include places where you drop off or pick up passengers or buy fuel.

✓ **IF YOU ARE A PASSENGER**, only include places where you got in or out of a vehicle, but do not include stops to let other people on or off.

Keep your completed Travel Diary by the phone. We'll call you to collect the information, or you can call us toll-free at 1-877-261-4621. If you are unable to complete the diary, please have a caregiver or other adult complete the diary for you. **Thank you!**

Confidentiality:
This survey is conducted in accordance with strict privacy provisions. All information, whether related to personal identity or travel and activities, will remain completely confidential. The information will not be published, sold, distributed, or otherwise made available to any third party.

Questions? Call the toll-free Survey Hotline:
1-877-261-4621

1

EXAMPLE PLACE

A **What is this PLACE?** ☐ My home ☒ Another place *(provide address below)*

What is the NAME and ADDRESS of this PLACE?

Sunny Farms Supermarket
Name of place (if any)

901 Main St.
Street address OR nearest cross-streets

Anytown TX 99999
City State Zip

B **What TIME did you ARRIVE?** ***(Please record exact time)***

11 : 35 ☒ am ☐ pm

C **HOW did you travel there? *(Check one* MODE*)***

☐ Walk
☐ Wheelchair/Electric Scooter (not on a vehicle)
☐ Auto/Van/Truck - Driver
☒ Auto/Van/Truck - Passenger
☐ Transit (DART or The T)
☐ Other: ____
☐ DART Paratransit
☐ MITS Paratransit
☐ Other Specialized Transit or Shuttle Service
☐ Taxi
☐ School Bus

D1 **How many people traveled with you? (DON'T *include yourself)*** 1

D2 **Of those, how many were household members?** 1

E **What ACTIVITIES did you do there? *(Write code from* LIST 1 *on flap)***

Main activity (code): 11
Other activity (code): 14

F **What TIME did you LEAVE?** ***(Please record exact time)***

12 : 52 ☐ am ☒ pm → **Next PLACE**
☐ Did not leave → **Go to DAY 2 - PAGE 10**

2

Figure 2-2. Travel diary pages.

ity performed (purpose of the trip). Pages 2 and 3 from the diary, including instructions and a sample page for recording trip data, are shown in Figure 2-2.

The Stated Preference materials consisted of a 4-page booklet, "ADA Paratransit Choices," which presented five scenarios in which respondents were asked to make tradeoffs among service variables, including fare, travel time, reliability, telephone hold time, and advance reservations period. There were eight versions of the "ADA Paratransit Choices" booklet, each with a different set of scenarios. Figure 2-3 shows a sample. Table 2-2 shows the choices in each of the eight versions. The service variables measured were

- Fare: the fare for a one-way ADA paratransit trip;
- Travel time: multiple of automobile travel time that an ADA paratransit trip can take;
- Late: number of trips out of 20 in which the pick-up or drop-off might be late (half of respondents received choices based on pick-up time and half received choices based on drop-off time);
- Reservations: how many days in advance reservations can be made (by law, reservations must be accepted up to close of business 1 day in advance); and
- Hold time: how many minutes customer may wait on hold to reserve a trip.

Choice 4 For a trip like the one you described, which option below would you prefer: _____A _____B

Option A	Option B
You can reserve your trip **up to 1 day in advance**	You can reserve your trip **up to 2 weeks in advance**
You may have to wait on hold for **up to 1 minute** when you call to reserve a trip	You may have to wait on hold for **up to 5 minutes** when you call to reserve a trip

Choice 5 And finally, for a trip like the one you described, which option below would you prefer: _____A _____B

Option A	Option B
You may have to wait on hold for **up to 5 minutes** when you call to reserve a trip	You may have to wait on hold for **up to 3 minutes** when you call to reserve a trip
Including stops, your ride might take up to **2 times as long** as making the same trip by car	Including stops, your ride might take up to **3 times as long** as making the same trip by car

That was the last question. Thank you!

MITS A

Paratransit Choices

Now, we want to ask you about some different possibilities for paratransit services. We will ask you these questions using the example of a recent trip you made using MITS paratransit.

Please look at your travel diary information and write down the details of the last trip you made from your home to another location using MITS.

If you didn't make any trips from home using paratransit on the two days you recorded, please think about the last trip you did make on MITS, and fill in the details below.

If you have never used MITS, you may skip these questions.

Details of your most recent trip using MITS:

____
Destination place name

____
Reason for making the trip

Day of week: M Tu W Th F Sa Su

Time of day left home: ______ : ______ ☐ am ☐ pm

Please turn the page to answer the questions inside…

Now, suppose that you were making that same trip, and you had the choice of using two different paratransit services that are **identical** to each other in every way, except that one of the services is **better** than the other in one way, but **worse** than the other one in another way. We'll give you five choices like this. In each case, on balance, which of the two options would you prefer?

We will collect your answers to these questions when we collect the travel diary information. If you feel unable to answer these questions now, you may choose to wait and answer them at the time that the interviewer calls you back.

Please note: The service changes in these questions are completely imaginary. and for our research only. MITS is NOT actually considering these changes.

Choice 1 For a trip like the one you described, which option below would you prefer: _____A _____B

Option A	Option B
Including stops, your ride might take up to **2 times as long** as making the same trip by car	Including stops, your ride might take up to **3 times as long** as making the same trip by car
The fare for a one way trip is **$2.00**	The fare for a one way trip is **$1.00**

Choice 2 For a trip like the one you described, which option below would you prefer: _____A _____B

Option A	Option B
The fare for a one way trip is **$3.00**	The fare for a one way trip is **$2.00**
You may be dropped off late, after your appointment time, **1 time out of 20.**	You may be dropped off late, after your appointment time, **1 time out of 5.**

Choice 3 And now, for a trip like the one you described, which option below would you prefer: _____A _____B

Option A	Option B
You may be dropped off late, after your appointment time, **1 time out of 10**	You may be dropped off late, after your appointment time, **1 time out of 20**
You can reserve your trip **up to 2 weeks in advance**	You can reserve your trip **up to 4 days in advance**

Please answer the final two questions on the back…

Figure 2-3. Stated preference materials.

Table 2-2. Stated preference choice sets.

Set 1		
Choice 1	A	B
Travel time	2	3
Fare	200	100
Choice 2	A	B
Fare	300	200
Late	1 in 10	3 in 10
Choice 3	A	B
Late	2 in 10	1 in 10
Reservations	14	4
Choice 4	A	B
Reservations	1	14
Hold time	1	5
Choice 5	A	B
Hold time	5	3
Travel time	2.5	3

Set 2		
Choice 1	A	B
Travel time	3	2
Late	2 in 10	3 in 10
Choice 2	A	B
Late	3 in 10	1 in 10
Hold time	3	5
Choice 3	A	B
Hold time	1	3
Fare	300	100
Choice 4	A	B
Fare	100	300
Reservations	1	14
Choice 5	A	B
Reservations	4	1
Travel time	2.5	2

Set 3		
Choice 1	A	B
Travel time	2	3
Hold time	3	1
Choice 2	A	B
Hold time	1	3
Reservations	1	4
Choice 3	A	B
Reservations	14	4
Fare	300	100
Choice 4	A	B
Late	2 in 10	1 in 10
Fare	100	200
Choice 5	A	B
Late	2 in 10	1 in 10
Travel time	2	2.5

Set 4		
Choice 1	A	B
Travel time	3	2
Reservations	14	1
Choice 2	A	B
Reservations	1	4
Late	1 in 10	3 in 10
Choice 3	A	B
Late	1 in 10	3 in 10
Hold time	5	1
Choice 4	A	B
Hold time	5	3
Fare	100	200
Choice 5	A	B
Fare	300	100
Travel time	2.5	3

Set 5		
Choice 1	A	B
Late	2 in 10	3 in 10
Fare	300	100
Choice 2	A	B
Fare	200	300
Travel time	2.5	2
Choice 3	A	B
Travel time	3	2
Hold time	1	5
Choice 4	A	B
Hold time	5	1
Reservations	14	4
Choice 5	A	B
Reservations	1	14
Late	2 in 10	3 in 10

Set 6		
Choice 1	A	B
Hold time	1	5
Late	2 in 10	1 in 10
Choice 2	A	B
Late	3 in 10	1 in 10
Travel time	2.5	3
Choice 3	A	B
Travel time	2	3
Reservations	4	14
Choice 4	A	B
Reservations	14	1
Fare	300	200
Choice 5	A	B
Fare	100	300
Hold time	5	1

Set 7		
Choice 1	A	B
Reservations	14	1
Hold time	5	3
Choice 2	A	B
Hold time	1	5
Travel time	2.5	2
Choice 3	A	B
Travel time	2	3
Late	3 in 10	1 in 10
Choice 4	A	B
Fare	100	300
Late	3 in 10	1 in 10
Choice 5	A	B
Fare	200	300
Reservations	1	4

Set 8		
Choice 1	A	B
Late	3 in 10	1 in 10
Reservations	14	1
Choice 2	A	B
Reservations	1	14
Travel time	2.5	3
Choice 3	A	B
Travel time	3	2
Fare	100	300
Choice 4	A	B
Fare	300	200
Hold time	1	5
Choice 5	A	B
Hold time	3	1
Late	2 in 10	3 in 10

Reminder Call

The night prior to the assigned travel day, reminder calls were made to the respondent. This reminder call served three key purposes:

- To confirm that the respondent received the packet and to answer any questions respondents might have about using the diary to track their travel;
- To schedule an appointment for the retrieval interview; and
- To increase the likelihood that the household would follow through with recording their travel by reiterating the importance of the study and the household's commitment to participate.

For those instances where an answering machine was reached, the interviewers left brief messages that referenced a toll-free number for respondents to call if they had questions.

Data Retrieval Telephone Interview

The day after the assigned travel period or at the appointed time, telephone calls were made to retrieve the travel data recorded by each respondent in his/her travel diary. The interviews were guided using Computer-Aided Telephone Interviewing (CATI) programs of the retrieval interview form. The average retrieval interview length was 20.31 minutes. The retrieval rate was 55 percent. This was calculated by dividing the completed retrieval calls (807) by the number of recruited households (1,455).

Processing

Data processing took place throughout the survey, beginning with the release of the sample for recruitment, processing recruitment data for the respondent mailing, appending the retrieval data to the master data tables, and performing quality control on the data. A master control file tracked the progress of each respondent through the various survey stages with codes to allow for immediate identification of problem cases that were not progressing according to schedule, as well as for confirmation that cleared cases moved along as appropriate.

Real-Time Geocoding

All trip-ends and habitual addresses were geocoded during the retrieval telephone interview. The geocoding software was designed to provide interviewers with study-area details (e.g., road names and landmark references). Interviewers used this additional detail to confirm respondent-reported locations in real time. Once the interview was completed, full address information, with matching x-y coordinates, for 100% of the locations was immediately available.

Data Edit Checks and Cleaning

Routine and customized data quality checks and data cleaning were performed on master data files. Routine checks included such items as

- Data range checks (was there data outside the expected range?);
- Checks for intra-household travel inconsistencies;
- Checks for missing data (this was done by a combination of queries and direct data viewing of the internal delivery files, and minimized processing problems);
- Checks for proper data skips;
- Checks to ensure that deliverable files included the data items on the matrix and that variables were properly named; and
- Checks for high frequency of item non-responses (checked throughout data collection).

Data cleaning and preliminary data analysis reduced the number of usable, completed travel surveys to exactly 800.

Characteristics of the Survey Sample

Because of stratification, the survey is not representative without weighting (which was done for the model estimation described in the next chapter). Chapter 4 presents weighted tabulations. The highlights below represent characteristics of the sample used for the research.

Survey Response Characteristics

1. The sample was split almost exactly 50/50 between Dallas and Fort Worth: 406 from Dallas DART and 394 from Ft. Worth MITS.
2. Only about 6% refused to answer each of the Stated Preference questions.
3. 88% said they were willing to participate in future surveys.

Demographics of the Sample

4. There were more African-American (49%) than White (41%) respondents; 12% identified as Hispanic or Latino.
5. Very few people live in nursing homes or assisted living. (This was deliberate as part of survey administration procedures. Initially, some attempts were made to interview nursing home residents, but response rates were very low, and nursing home staff were generally not cooperative.)
6. Regarding household characteristics: 41% lived alone and 30% lived with one other person; 52% lived in a single-family unit and 44% lived in a duplex; 61% had an annual household income under $15,000; 52% lived in a household with no vehicle.

7. 15% were employed and 1% were students; 54% described themselves as "disabled/on disability status" and 22% described themselves as retired.
8. 67% of the respondents were female, 68% were age 50 or older, and 29% were age 65 or older. This apparently low representation of older people matches the target set in the sample stratification and was corrected in the weighting procedure.
9. 58% of respondents had a physical/motor impairment, 13% had a visual/sensory impairment, 11% had a mental/cognitive impairment, and most of the others had some combination of impairments. It is likely that the sample is somewhat biased toward physical/motor because they have the easiest time completing the survey. 74% schedule their own trips, which may also be a bit biased compared to all users. Also, only 8% gave their answers through a proxy.

Travel Characteristics

10. About 37% of respondents stayed home all day on Day 1, and about 43% stayed home on Day 2. Only 22% stayed home on both days. That is lower than had been feared. There is some non-response/survey fatigue bias on Day 2 compared to Day 1, which is typical. This was adjusted for in the model estimation process.
11. The most common reasons for not traveling on the diary day were "homebound elderly or disabled" or "no plans to travel that day." Most people who used the first reason did so on both days, whereas most people who used the second (no plans to travel that day), made trips on the other day.
12. 34% had a valid driver's license.
13. Only 6% had another specialized transit service available.
14. There were 2,681 person-trips, or about 1.7 per person-day. Of those, 27% were DART ADA paratransit trips, 22% MITS ADA paratransit, 25% automobile passenger, 8% scheduled transit, 7% walk, 5% wheelchair/scooter, 4% car driver, and only 2% other modes. 22% of trips used wheelchair or scooter in combination with other modes.
15. For almost half of the trips by auto/truck/van passenger, there was no other household member in the vehicle, meaning that the persons often get a ride with somebody else from outside the HH (household).
16. About 38% of reported ADA paratransit trips on both systems were subscription and 59% were scheduled for that trip. Most scheduled trips were scheduled 1 or 2 days in advance, although some were scheduled to 7 days (DART) and 14 days (MITS) in advance.
17. All trip-ends were successfully geocoded.

CHAPTER 3

The ADA Paratransit Demand Models

This chapter describes the component models that make up the full modeling systems, how these components are related to each other, the results of the model estimation process, how the models were calibrated, and the results of sensitivity tests.

Overview of the Model Components

The model system is made up of aggregate components and disaggregate components:

- The aggregate components include a model that predicts the number of registered users of the ADA paratransit system living in each census tract and traffic analysis zone (TAZ) within the region. Further steps transform the output of this model into a "synthesized population" in each TAZ needed to run the disaggregate components. In addition there is an aggregate calculation of the ADA paratransit service level (expressed as "generalized travel time" compared to driving a private car) that applies to the entire region.
- The disaggregate components are a series of models that can be applied to the detailed survey data (or a synthesized population) to predict the number, purpose, mode, and destination of trips made during a representative weekday for a registered user of the ADA paratransit system.

The model system can be run in two modes, a "regional mode" and a "sketch mode."

- The **regional mode** can use detailed demographic data (e.g., at the census tract level) from a region other than the Dallas-Fort Worth region that was treated in the research.
- The **sketch mode** uses demographic data from the Dallas-Fort Worth region, but allows a user to assume changes in region-wide demographic statistics and ADA paratransit service characteristics and see how these changes affect predicted travel.

Most of the aggregate model components are only run in the regional mode.

The disaggregate components can be used to predict the characteristics of all trips made on a typical weekday by the given sample of ADA-eligible users and are the components used in the "sketch mode" of running the model. However, those results are specific to the particular ADA-eligible population in the Dallas-Fort Worth region and to the specific residence locations of our survey sample within that region. Further models and analysis were required to transform the model system into a model of ADA paratransit demand that can be applied to other regions. Two main approaches could have been followed:

1. Synthesize a population of ADA-registered persons within each TAZ of a region.
2. Use our survey sample of ADA-registered persons, and re-expand it for each TAZ of a region to represent an ADA-eligible population within each TAZ

Although the first approach is more typical in applied travel demand modeling, the second approach seems more accurate for this study context. There are at least two important reasons for this. First, there are no available data sources, such as the census, that can tell us what the detailed characteristics of the ADA-registered population are. Our own survey sample is likely the best source of detailed data that exists for this purpose, so we should try to use that information to the greatest extent possible. Second, our models contain a few variables, such as disability type, that are not available from standard data sources. (The census definitions of disability are unlikely to be useful for this purpose.) Therefore the second approach has been used.

The "aggregate model components" are shown in Table 3-1 and introduced briefly below. Following that, the disaggregate components are introduced before discussing the detailed results for each model.

Aggregate Components

The ADA paratransit registration rate model: This model predicts the percentage of the adult (age 18+) population within a census tract who are registered as eligible to use ADA paratransit service and have either made an ADA paratransit trip or else registered within the

Table 3-1. Model system components.

Aggregate components (run for each census tract or TAZ)			
Model	Choice level	Predicts	Key input variables
ADA paratransit registration rate model	Census tract (could also be applied at other spatial levels)	Percent of people that register to use ADA paratransit	Tract age distribution Tract income distribution Tract household size and type distribution
ADA-ADA paratransit registered population synthesis	Census tract (could also be applied at other spatial levels)	Expansion factors for the survey sample specific for each census tract	Tract income distribution Tract age distribution Tract household size and type distribution Corresponding regional distributions
Allocation of ADA-registered population to zones	TAZ	Residence TAZ for each survey record within each tract	Zonal population Tract population More detailed inputs
Generalized ADA paratransit service levels	All zone-to-zone pairs	Generalized travel time by ADA paratransit (based on Stated Preference data)	ADA paratransit travel time (relative to driving own car) ADA paratransit fare ADA paratransit punctuality (at pick-up or drop-off point)
Disaggregate components (run for each person in synthesized population)			
Model	Choice level	Predicts	Key input variables
Tour generation model	Person-day	Number and main purpose of home-based tours made in the day	Household characteristics Person characteristics Residence zone accessibility measures
Tour main mode choice model	Tour	Main mode used for the tour	Household characteristics Person characteristics Residence zone accessibility Tour main purpose
Intermediate stop generation model	Tour	Number and purpose of intermediate stops made during tour	Tour main purpose Tour main mode Number of tours made in day
Trip mode choice model	Trip	Mode used for each trip in a tour	Tour main mode Position of trip in the tour
Trip destination choice model	Trip	Destination zone for each trip in a tour	Trip purpose Trip mode and tour mode Trip origin zone Automobile travel time and distance between all zone pairs Zonal attraction variables

previous 12 months. (Those characteristics describe the sampling universe for our survey sample.) It was estimated by tabulating the number of actual registered users in the Dallas (DART) and Fort Worth (MITS) databases to the census-tract level and regressing that against tract-level data from the 2000 census, using data on the age, income, household size, and household type distributions within each tract. The output of this model is used in the ADA paratransit registered population synthesis procedure described below, giving the size of the population to be synthesized within each census tract.

ADA paratransit registered population synthesis: This procedure re-expands the survey sample, which was originally expanded to represent the entire region, but is now expanded to represent each census tract separately. With this procedure, a new sample expansion factor is generated for each sample member for each census tract, so that the sample is now representative of each tract. This is done using iterative proportional fitting (IPF) based on the characteristics of each sample member and on the population distribution of each tract relative to the region as a whole. The ADA paratransit registration rate model determines how many registered users there are in each census tract—thus the total size of the registered population that is synthesized in each tract.

Allocation of ADA-registered population to zones: Using the best available estimate of the fraction of the population within each census tract living in each TAZ within the tract, synthetic households in each tract are randomly allocated to specific TAZs, assuming that the spatial distribution of the ADA-eligible population across zones in the tract is the same as the spatial distribution of the general population.

Generalized ADA paratransit service levels: The user of the model system can set assumptions regarding the travel time via ADA paratransit relative to driving one's own car, the fare for ADA paratransit trips, and the punctuality of ADA paratransit in terms of the frequency of delays at the pick-up or drop-off point. Using tradeoff analysis from the Stated Preference data collected as part of our survey, these inputs are translated into a "generalized travel time" via ADA paratransit for each origin-destination zone pair in the region, and that generalized time is used as input to the disaggregate model components described below.

Disaggregate Components

The tour generation model: This model predicts the number of home-based tours that a particular person makes during the day, and, for each purpose, predicts the main purpose for making the tour. A small percentage of tours have multiple out-of-home stops with different activity purposes, so a "tour main purpose" is designated, as described in more detail below. The likelihood of making tours for various purposes is modeled as a function of household characteristics (e.g., size, income, and number of vehicles), person characteristics (e.g., age, gender, and type of disability), as well as measures of residence zone accessibility. In total, there were roughly 1,030 home-based tours recorded by the survey respondents during approximately 1,600 travel diary person-days, or an average of 0.63 tours per person-day.

The tour main mode choice model: For each tour generated by the generation model, the main mode choice model predicts the primary mode used to make that tour as a choice of the following alternatives: car drive-alone, car shared-ride, ADA paratransit, scheduled public transit, other special transit, and walk/wheelchair. A small percentage of tours use more than one mode (e.g., ADA paratransit in one direction and car passenger in the other direction), so a "tour main mode" is designated as described in more detail below. The likelihood of choosing each mode is modeled as a function of the household, person, and residence zone characteristics modeled above for tour generation; of mode "accessibility" (a measure of overall ability to reach activities by each mode); and of the tour main purpose.

The intermediate stop generation model: As part of the 1,030 home-based tours in the data, there were approximately 300 "extra" stops made in addition to the stop at the primary tour destination. This small number of stops was deemed important enough to include in the model system, but not large enough to estimate a detailed model with all household and person characteristics. Therefore, a relatively simple model was estimated to predict the number and purpose of any extra stops made during each tour as a function of only the tour main purpose, the tour main mode, and the number of tours predicted to be made during the day. The tour mode is important because some modes, particularly the private automobile, can be used more flexibly than others, and therefore are more amenable to making multiple stops during a single tour.

The trip mode choice model: Out of roughly 2,400 person-trips that are part of the survey data, there are only about 200 trips where the trip mode is not the same as the main tour mode. Again, this is important enough to represent in the model system, but there were not enough cases to estimate a detailed model. A simple classification model was created to predict the mode for each trip as a function of the tour main mode and the position of the trip in the tour (from home, back to home, or non-home-based).

Trip destination choice model: Knowing the number and purposes of all stops made on a tour, and the mode used to reach each stop, the final model predicts the destination zone for each trip. This is modeled primarily as a function of the time to reach each possible destination zone via the trip mode, as well as the attractions (jobs of various types and households) within each zone. The trip destination model is applied beginning at home (the origin of the first trip in the tour) and predicting the destination of each trip from the current destination. The destination of the last trip does not need to be predicted, because the tour returns to the home zone by definition.

The placement of trip destination choice at the "bottom" of the decision hierarchy is somewhat different than the approach used in traditional four-step models and tour-based models. However, it is an approach often adopted in the United Kingdom and some other countries. In this study, the decision was made because of the distinct characteristics of the ADA-eligible population. Relative to the general population, this population tends to have less of a choice among competing modes of transportation, so that the choice of where to go is constrained by the availability of a mode to get there more often than the choice of travel mode is constrained by where one wants to go. Clearly, across any group of people, there will be instances of both types of constraints, and the choices of mode and destination are highly interdependent. On balance, however, conditioning the choice of destination on which mode is used was judged to be more behaviorally representative for this population context.

Details of the Aggregate Models

The ADA Paratransit Registration Rate Model

This model predicts the percentage of the adult (age 18+) population within a census tract who are registered as eligible to use ADA paratransit service and have either made an ADA paratransit trip or else registered within the previous 12 months. (Those characteristics describe the sampling universe for our survey sample.)

The dependent variable for the model was determined by first geocoding the addresses of all the DART and MITS clients who were in the sampling universe for the travel diary survey (including those who had made one or more trips in the preceding 12 months or had become eligible and registered within the preceding 12-month period but had made no trips in that time) and locating them by census tract. In total, this included 14,929 ADA-registered people spread across 746 different tracts in the Dallas-Fort Worth area. That is an average of 20 persons

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per census tract, with about 90 of those tracts having only one registered person, and 9 tracts having over 100 registered persons. One extreme case is a tract in the Fort Worth area that has 555 registered persons, almost 30% of the adults in that census tract. This is likely to be a tract that contains a number of assisted living or other type of senior residential facilities.

Using 2000 census-tract-level data for the population by age group, the fraction of adults registered to use ADA paratransit in each tract was calculated as the total number of registered people in our database divided by the census value for population age 18 or older in the tract. This value was regressed against various census-tract characteristics. Models were tested using the fraction and the log of the fraction as the dependent variable, with the log-linear models giving the best fit and most reasonable results. Also, models were estimated using all 936 census tracts in the region, using only the tracts with at least one person registered (723 tracts), and using only the tracts with at least two persons registered (642 tracts). The models using all tracts were rejected because: (1) most of these tracts are completely outside the DART and FWTA scheduled transit service areas, and thus not strictly eligible for ADA paratransit service; and (2) to implement a log-linear model, one must assign an arbitrarily low value to use as a substitute for the log of 0, and the model results can be sensitive to that assumption. The model based only on the 642 tracts with at least two persons registered was selected as the best model, and the results are shown in Table 9. It is most important to have a model that predicts well for tracts that have many registered users, because the tracts with very few users will not contribute much to the overall forecast model system results.

The model in Table 3-2 is a simple least-squares linear regression model (with a logged dependent variable). The R-squared for the model, adjusted for degrees of freedom, is 0.723, which is quite high for a regression model with over 642 observations and only 14 parameters.

Each variable in the model is discussed below. Most of the variables are based on 2000 census data for the distribution of population and households in each tract.

Age group: In general, an older population will mean more likely ADA paratransit users. This was found for the age groups 40–59 and 60–74 relative to younger age groups. However, we could not find any effect for the fraction of the population age 75+.

Table 3-2. Census tract ADA paratransit registration rate model.

Dependent variable	LN(Fraction of adult population registered)	
Tract observations used*	642	
R-squared (adjusted)	.723	
Variable	Coeff.	*T*-stat
Residual constant	-6.611	-12.2
Fraction of population age 40-59	1.400	2.2
Fraction of population age 60-74	2.054	2.5
Fraction of population below poverty level	1.898	4.8
Median income in tract in 1999 ($K)	-0.0059	-3.1
Fraction of HH 1 person single females	1.907	2.3
Fraction of HH 2+ person single female head	2.907	5.5
Fraction of HH non-family	-5.430	-4.4
Average household size	-0.099	-1.0
Fraction of HH within DART service area	1.618	15.9
Fraction of HH within FWTA service area	2.138	13.3
Tract is in MITS service area	0.378	2.2
Average walk mode accessibility measure	-0.117	-3.3
Outlier tract with very high registration rate	2.855	4.8

* Tracts with 2+ people registered

Income: Two income variables were found to be significant. The first is that the registration rate increases with the fraction of the population with incomes below the poverty level. It also decreases with the median income in the tract, which captures much of the variation above the poverty level.

Household size and composition: Two types of households in particular are associated with higher registration rates in tracts where these types of households are most prevalent. The first is females living alone in one-person households. The second is households of two or more people where the head of household is a single female. (This could be a single mother with children, or a single woman living with other adults.) On the other hand, for reasons not obvious, a higher fraction of non-family households is associated with lower registration rates. (These may be student areas and other areas with a high proportion of young adults sharing rental housing, which tend to attract younger, mobile residents.) In addition to these variables, the registration rate decreases slightly as the average household size increases, perhaps indicating more neighborhoods where many households have children present.

Scheduled transit service areas: Two variables were used, representing the fraction of households in each census tract within the DART and FWTA service areas. There are an average of 6 TAZs in each census tract, and each zone has been designated by NCTCOG as being in the DART or FWTA service area if the zone centroid is within 20 minutes walking time (1 mile) of a transit stop. If a TAZ is designated to be in the service area, then all people living in that zone are designated to be in the service area for the purposes of this calculation. The results show that these two variables are very highly significant. These variables do much of the job in explaining which tracts have very low registration rates (because much of the tract is not near any scheduled transit stops).

DART versus MITS area: After all other variables are accounted for, it appears that the MITS area has a slightly higher registration rate than the DART ADA paratransit service area, but the difference is not large compared to other variables in the model.

Walk mode accessibility: Using the TAZ-specific accessibility measures described above and in Table 3-1 (Model System Components), population-weighted accessibility measures were computed for each tract as a weighted average across all TAZs in the tract. One would expect the need for ADA paratransit service to be somewhat lower in an area with high walking accessibility to retail and service establishments. The results in Table 3-2 show the expected result, with somewhat lower registration rates where walk accessibility is highest.

Sensitivity to outliers: As mentioned above, there is one tract with very high ADA paratransit registration—over 30% of adults. To give some idea of the model's sensitivity to outlier cases, the model was estimated, isolating the effect of this one tract (as in Table 3-2), or else not isolating it so that it would contribute to all other estimates. It was found that the other estimates do not change very substantially when the "outlier" dummy variable is dropped, so the model even manages to explain the very high registration rate in that tract reasonably well.

Results of the ADA registration rate model: The actual total number of in-scope registered persons is 7,134 in tracts in the DART service area and 4,426 in tracts in the MITS service area. Applying the regression model to the same data from which it was estimated gives predicted values of 7,193 registered persons in all DART tracts and 4,465 registered persons in all MITS tracts, both within 1% of the actual figures.

The ADA registration rate model was run a number of times, each time increasing one of the input variables by 10% for every census tract in the region. This shows the sensitivity of the predicted registration rate to region-wide demographic shifts. The sensitivity test results shown in Table 3-3 are very similar for the DART and MITS regions. The elasticity (percent change in

Table 3-3. Elasticities for ADA registration rate.

(Based On Model Application)

Variable	Elasticity	
	DART	MITS
Fraction of population age 40-59	0.34	0.32
Fraction of population age 60-74	0.18	0.18
Fraction below poverty level	0.36	0.41
Median income level	-0.23	-0.21
Fraction single female 1 person HH	0.28	0.28
Fraction single female 2+ person HH	0.60	0.58
Fraction non-family HH	-0.31	-0.29
Average household size	-0.28	-0.28
Average walk mode accessibility	-0.94	-0.90

the prediction divided by the percent change in the input variable) is in the range of 0.2 to 0.4 for most of the variables tested. The walk mode accessibility variable has the largest elasticity, although it is not intuitively clear what changes in land use or pedestrian infrastructure would be needed to cause a 10% shift in that accessibility measure.

ADA Paratransit Registered Population Synthesis

The disaggregate models are designed to use as input a sample of individual households and people within each TAZ. A common practice in travel demand modeling is to use the Public Use Microsamples (PUMS) available from the census. In order to apply the ADA paratransit demand models, a similar sample of households with ADA-ADA paratransit-eligible individuals is needed. Given that no such sample is actually available, a "synthetic population" is created within each census tract and TAZ using the following procedure.

1. For each tract, using census data, compare the regional population distribution to the tract-specific population distribution along three dimensions:
   - Age group: e.g., 18–39, 40–54, 55–64, 65–74 and 75+
   - Income group: e.g., \$0–15,000, \$15–30,000, \$30–60,000, and \$60,000+
   - Household type: e.g., 1 person male, 1 person female, 2+ person single female, 2+ person non-family, 2+ person family with children, 2+ person other
2. Using the full weighted representative survey sample, estimate the marginal and joint distributions across the three dimensions above for the 15,000 or so registered ADA users in the region.
3. For each tract in the region, estimate new marginal distributions for the ADA-registered population in that tract using a pivot-type procedure based on the total adult population characteristics in the specific tract relative to the entire region:

$$\begin{array}{l}\text{Marginal fraction for} \\ \text{ADA-eligible in tract}\end{array} = \begin{array}{l}(\text{Marginal fraction for ADA-eligible in total region}) \times \\ (\text{Marginal fraction for full adult population in tract}) / \\ (\text{Marginal fraction for full adult population in region})\end{array}$$

4. For each tract in the region, using the joint distribution for the weighted survey sample from Step 2 as a starting point, apply iterative proportional fitting (IPF) to the expansion factors in the survey sample to calculate new, tract-specific expansion factors for each observation so that the distributions for the weighted sample in the tract match the adjusted marginal fractions from Step 3.
5. Using the best available estimate of the fraction of the population within each census tract living in each TAZ in the tract, randomly allocate each synthetic household in each tract to a

specific TAZ. This assumes that the spatial distribution of the ADA-eligible population across zones in the tract is the same as the spatial distribution of the general population. This may not always be correct, but, unless there is more accurate local data available about the spatial distribution of the ADA-registered population, this is the best that can be done. (Such data is available in Dallas/Fort Worth, but the objective is to create a method that can be applied even in regions with less detailed data.)

In theory, if the data were available, the process described above could be applied at a level smaller than a census tract, such as a block group or even a single census block or TAZ. For future applications it may be worth investigating if this same method could be applied using block group data, perhaps from the most recent years of the ACS survey. Note that if it were possible to apply Steps 1 through 4 above at a TAZ level instead of a tract level, then Step 5 would not be necessary.

It is also worth mentioning that the above procedure will generally produce a synthetic sample that has more persons than the actual ADA-eligible population, with average expansion factors less than 1.0. As an alternative, it would be possible to sample just the estimated number of ADA-registered people within each tract, so that every case has an expansion factor of exactly 1.0, following the sampling procedure typically used for activity-based models. However, such a sampling method introduces extra stochastic simulation error that is not introduced with the re-expansion procedure above. Also, it would be difficult to incorporate the information provided by the current sample expansion factors. In the re-expansion procedure outlined above, the information from the original expansion factors that adjust for survey oversampling is maintained throughout the process.

Generalized ADA Paratransit Service Levels

The model incorporates sensitivity to ADA paratransit service variables, such as fare and punctuality, by means of factors that translate changes in the level of service variables into equivalent changes in travel time. Because travel time is a variable already included in the demand models, this method allows the model system to be sensitive to ADA paratransit fare and reliability as well. The resulting modified travel time is referred to as "generalized ADA paratransit travel time."

The procedure is necessary because all of the surveyed ADA paratransit users in the Dallas-Fort Worth area are offered virtually the same ADA paratransit service in terms of fares, reliability, reservation system, and so on, so it is not possible to impute the influence of those variables on demand from the travel diary data alone.

The factors for converting level of service variables into equivalent travel are derived from a separate Stated Preference (SP) experiment that was included in the travel survey. Each respondent was given five tradeoff questions requiring a choice between various scenarios, each involving randomized combinations of fare, travel time, late pick-up or drop-off, reservations policy, and time on hold to make a reservation. Further detail is provided in the survey report. Analysis of the respondents' choices yields the coefficients shown in Table 3-4.

Fare: The effect of fare was estimated separately for the lowest income group (<$15,000/year) and all others. Each group was about 50% of the sample. For both groups, fare has a significant coefficient with the expected negative sign, meaning that a higher fare reduced the probability of choosing the associated scenario. Also, as expected, the coefficient is larger (more negative) for the lower income group than the higher income group. In the "Equivalent Fare" column of Table 3-9, the equivalent of a dollar fare for the lower income group is set at $1.00. For the higher income group, a dollar of fare only has an equivalent utility value of about $.58 cents, which is

Table 3-4. Stated preference estimation results.

Variable	Coefficient	T-statistic	Equivalent Fare	Equivalent % Travel Time
Fare($) - lowest income segment	-0.288	-4.5	$ 1.00	58 %
Fare($) - higher income segment	-0.168	-2.2	$ 0.58	34 %
Travel time- multiple of car time	-0.497	-8.0	$ 1.73	100 %
Late pick-up- times out of 20 trips	-0.305	-6.5	$ 1.06	61 %
Late drop-off- times out of 20 trips	-0.406	-9.7	$ 1.41	82 %
Days in advance reservations are allowed	-0.0599	-6.8	Not used	Not used
Time may wait on hold (min)	0.0258	1.0	Not used	Not used

calculated by dividing the fare coefficient of –0.168 for this group by the fare coefficient of –0.288 for the lower income group. The result is shown in the Equivalent Fare column. Another way to say this is that the higher income group values a dollar difference in fare 42% less than the lower income group.

Travel time: The travel time coefficient is very significant. Each multiple of car time has a value of about $1.73 for the lower income group (the time coefficient divided by the low-income fare coefficient). In other words, if the travel time for a trip that takes 3 times as long as by car were reduced to a time only 2 times as long as by car, these respondents would be willing to pay an extra $1.73 in fare. If the average car travel time were, say, 30 minutes, then this would imply a value of time (VOT) of about $3.50 per hour, which seems reasonable for this low-income population. For the higher income group (which is still mostly in an income range less than $35,000 per year), the VOT would be about $5.50 per hour.

In the Equivalent % Travel Time column of Table 3-4, the value for travel time is set arbitrarily as 100%. Then the coefficients for other variables are used to calculate equivalent percentages of travel time. For example, for the higher income group, the fare coefficient of –0.168 is 34% of the travel time coefficient of –0.497. This is interpreted as meaning that $1.00 of fare has an equivalent utility value of a change in travel time of 34% of the travel time by car for the same trip. For example, a $1.00 fare increase would be equivalent to increasing ADA paratransit travel time from twice the travel time by car to 2.34 times as long as the travel time by car. Note that actual ADA paratransit travel times relative to private car travel times in Dallas-Fort Worth are not known, so this result is used only to represent the effect of other variables in terms of equivalent changes in travel time.

Reliability: Late pick-up and drop-off times: This variable also has the expected negative sign and is very significant. To reduce the chance of a very late pick-up by 5% (1 in 20 trips), the person would be willing to pay about $1.06 more in fare. The variable was even more important when presented in terms of drop-off time at the destination instead of pick-up time at the origin. In that case, reducing the chance of a late drop-off by 5% is valued at $1.73 in fare. Each of these is also shown in terms of equivalent change in travel time. For example, to reduce the chance of a late drop-off by 5%, respondents would be willing to have an increase in travel time from twice as long as the same trip by car to 2.82 times as long as the same trip by car.

Days in advance reservations are allowed: This variable also has a negative and significant effect. In this case, however, we had expected a positive effect from being able to reserve earlier. A possible explanation is that people interpreted this variable as the number of days in advance required to reserve a trip, instead of the number of days allowed. If people suspect that trips will fill up ahead of time, then they may interpret those two concepts to mean more or less the same thing. Given that requiring a reservation more than 1 day in advance is not permitted under ADA regulations, this result has no application in the model.

Time may have to wait on hold on the telephone: This variable also has an unexpected sign, with a slight positive coefficient for more minutes spent waiting on hold. In this case, however, the result is not significantly different from zero, so we can assume that the effect of this variable is negligible compared to the other ones, and omit this variable from model application. This does not mean that hold time is actually unimportant, but the Stated Preference procedure was not able to gauge its importance.

Predicted sensitivity to service variables: To see how fares, travel time, and on-time service affect travel demand in the model, the model system was run to test the sensitivity to ADA paratransit travel time, which is a variable already included in the choice models (described in the next section). The resulting elasticities with respect to changes in ADA paratransit travel time are

The number of ADA paratransit passenger trips = –0.5
The number of ADA paratransit passenger-miles = –1.1
The total number of trips made by ADA-eligible persons = –0.1

This means that if ADA paratransit travel time increased by 10%, the number of passenger trips would decrease by 5%, and the ADA paratransit trips would become shorter, on average, so the number of passenger-miles would decrease by 11%. Most of the decrease in ADA paratransit trips would be made up by a corresponding increase in trips by other modes (mode shift), but not all of them—there would be a 1% decrease in total trips made by ADA-eligible persons (trip frequency shift). This elasticity for total trip-making is quite small, but still quite a bit higher than trip "suppression" elasticities estimated for the general population, which are typically much smaller than –0.1. Conversely, the mode-specific elasticity of –0.5 is toward the low end (in absolute value) of the range of values typically estimated for the general population, based on the experience of the research team. On average, the ADA-eligible population tends to have fewer mode options than the general population, which would explain the results of relatively less mode switching and more trip suppression.

In the model, the effects of changes in ADA paratransit fare and ADA paratransit reliability are incorporated by making the equivalent percentage change in ADA paratransit travel time, as taken from the right-hand column of Table 3-4 above. The results of changing these variables in the model system base scenario are shown in Table 3-5.

The first row shows the same sensitivity to travel time change as described above. The next two rows show the predicted effects of a $1.00 fare change for the income segments above and below $15,000 per year. At the existing fare level in Dallas and Fort Worth of $2.75, this would be a fare elasticity of –0.41 for the lowest income group and –0.23 for the higher income groups. These are in the same general range as fare elasticities typically estimated for scheduled transit riders.

The model is quite sensitive to punctuality, where, following the Stated Preference results, a change in punctuality of 5% (1 in 20 trips) has more effect on demand than a $1.00 change in fare.

Table 3-5. Predicted trip changes for service variables.

Change in Variable	Change in ADA Paratransit Trips	Change in Trips by All Modes
10% increase in travel time	5% decrease	1% decrease
$1 fare increase: lowest income segment	12% decrease	2% decrease
$1 fare increase: higher income segment	7% decrease	1% decrease
5% (1 in 20) more trips are late	14% decrease	2% decrease

Details of the Disaggregate Models

Disaggregate Model Input Data

Three main types of data were used to estimate the disaggregate models:

1. **Travel survey data:** Full trip diary data for 2 days for each of 800 respondents
2. **Zonal attraction data:** For each of 5,386 designated TAZs in the NCTCOG region, the following variables were used:
   - The number of resident households
   - The number of resident people
   - The number of service jobs
   - The number of retail jobs
   - The number of other jobs (called "basic" employment)
   - The number of hospital/medical center jobs (an important subset of service jobs)
3. **Zone-to-zone travel time and cost matrix data:** For each origin-destination zone pair, NCTCOG provided network matrices of the best path values of
   - AM peak period automobile travel times
   - PM peak period automobile travel times
   - Off-peak period automobile travel times
   - AM peak period transit variables (fare, in-vehicle time, wait time, walk time)
   - Off-peak period transit variables (fare, in-vehicle time, wait time, walk time)

The times are from network "skim" matrices based on the shortest path through a congested network loaded with a number of trips appropriate to the specific time period. The automobile skims used are for single-occupant vehicles, not including use of any carpool-only lanes.

Using this data, we also created composite accessibility variables for travel from each TAZ. These variables give a measure of ability to reach activities of interest by each mode. The accessibility variables are specified as

$$\text{Accessibility} = \text{LN}(\text{sum across destinations } [\text{Attraction variable}/\text{EXP}(\text{impedance variable})])$$

This is essentially the expected value (logsum) from a simple destination choice model, which is a formulation often used in travel demand modeling and is consistent with discrete choice theory. The specific attraction and impedance variables are different for each mode. Table 3-6 shows the measures created for this study and the corresponding definition of the attraction and impedance variables. ADA paratransit accessibility (not shown in the figure) is calculated using the same equations as the automobile accessibility variable, but substituting ADA paratransit "generalized time" for the automobile travel time. ADA paratransit generalized time is initialized to be the same as automobile time, but then adjusted according to the user input changes for ADA paratransit travel time, ADA paratransit fare level, and ADA paratransit fare, using the Stated Preference analysis results. ADA paratransit accessibility is used in the tour generation

Table 3-6. Zone accessibility measures.

Accessibility measure	Attraction variable	Impedance variable
Off-peak automobile	Service + retail jobs	(Off-peak outbound automobile time + off-peak return automobile time) / 40 minutes
Peak auto	Total jobs	(AM peak outbound automobile time + PM peak return automobile time) / 40 minutes
Walk	Service + retail jobs	(Off-peak outbound automobile distance + off-peak return automobile distance) / 2 miles
Off-peak transit	Service + retail jobs	(Off-peak transit in-vehicle time + 2.0* Off-peak out-of-vehicle time) / 80 minutes
Peak transit	Total jobs	(AM peak transit in-vehicle time + 2.0* AM peak out-of-vehicle time) / 80 minutes

and tour mode choice models, while the generalized ADA paratransit time is used in the model of destination choice for ADA paratransit trips.

Many regions have attraction employment variables split into more categories than the list above, including government employment, office employment, food service employment, and entertainment employment. An advantage of using the few categories available from NCTCOG, however, is that the model will be applicable in most other regions, because almost all regions have a split of jobs into at least the three categories of service, retail, and other. Many regions may not have hospitals and medical centers coded as a separate employment category, but could generate such data from available data sources if needed for this model.

Scheduled Transit Service Data

Ideally, the model would use transit times and fares for transit trips. As mentioned above, NCTCOG did provide origin-destination (O-D) matrices for scheduled transit times and fares, for both peak and off-peak periods. However, when using this data together with the survey records, it was found that the NCTCOG matrices only have transit connections for 4 of the 57 O-D zone pairs for which transit trips were actually reported in the survey data. We checked carefully for possible problems in our geocoding of the trip-ends to the NCTCOG zone system and did not find errors. We also input various reported transit trip origin and destination addresses into the Dallas and Fort Worth online transit route information systems and found that there are actually valid transit connections for those address pairs. So, the problem in this case appears to be incomplete coverage of transit connections in the NCTCOG transit matrices.

This is a typical occurrence in travel modeling, where some transit trip observations need to be rejected from the models because there are no network time and cost data for the O-D zone pair of the observed trip. In this case, however, the problem affects most of the scheduled transit trip observations, for which we have very few to begin with. As a result, we have estimated the models described below without making extensive use of the NCTCOG transit time and cost matrices, but in a way that still allows us to keep the scheduled transit mode alternative in the models. In terms of applicability of the model, there is some attraction to this approach, because it will make the resulting model system much easier to use, especially for smaller regions and ADA paratransit agencies that do not have access to scheduled transit network matrix data. Because the 29 scheduled transit tours in the survey are only 2.9% of all tours reported and there are over 22 times as many ADA paratransit tours as scheduled transit tours, the inability to use detailed scheduled transit travel time and cost data has little effect on the overall results.

The Tour Generation Model

This model predicts how many home-based tours (a chain of two or more trips starting and ending at home) a person will make during a day, as well as the main purpose of each of those tours (the activity purpose at the main tour destination). The following purposes were distinguished in the data:

- Dialysis
- Other medical purpose
- Work/work-related
- School/school-related
- Adult daycare
- Shopping
- Other errands
- Personal business
- Eat a meal

- Civic/religious
- Recreation
- Social visit

In cases where more than one destination was visited during a tour, the primary destination and purpose was defined as the one with the highest priority activity purpose, with the assumed priority order as above—medical the highest and social visit the lowest. In cases where the same activity purpose was carried out at two different destinations within a tour, the primary tour destination was selected as the one with the longest duration of stay at that location.

A "nested logit discrete choice model" was used to represent the choice to make a tour during the travel day for any of the different purposes or else stay at home. (Saying the model is "nested" is a technical matter not always clearly related to behavioral issues. Nesting is a way of representing that certain alternatives are more closely related than others in statistical terms.)

If the person makes one tour, then there is a choice to make another tour during the day or to stay at home and not make any more tours and so on. In cases where a person makes another tour, the model also predicts the primary purpose of the tour. It is specified as a nested model across nine different alternatives, as shown below:

Level 1:

Alternative 1: Make another tour
Alternative 2: Stay home for the rest of the day

Level 2: Eight alternatives nested under Alternative 1 above:

1A. Dialysis/other medical tour
1B. Work tour
1C. School tour
1D. Adult daycare tour
1E. Shopping/restaurant tour
1F. Recreation tour
1G. Social visit tour
1H. Personal business/other errand/civic/religious tour

Each of the nine alternatives (1A-1G and 2) has explanatory variables related to the likelihood of choosing that alternative. The "base" alternative was specified as 1H, personal business/errands/civic and religious, so the variables for the other tour purposes represent the likelihood of making a tour for that purpose relative to personal business.

The model results are shown in Table 3-7. A wide variety of different variables was tested, and, after discussion of initial results, a selection was made based on statistical and behavioral considerations of which variables to keep in the model.

In Table 3-7, for each purpose and each explanatory variable, two numbers are shown:

1. A coefficient, which represents the strength of the relationship; the higher the coefficient, the more the variable increases the likelihood of making a tour for this purpose. A negative coefficient means that the variable makes it less likely that a person will make a tour for this purpose.
2. A T-statistic, which is related to the statistical probability that the estimated relationship is real, i.e., that the coefficient is actually different from zero. T-statistics of 1.8 or greater are generally interpreted as meaning that a coefficient is significantly different from 0, although the significance is related to sample size as well, and it is sometimes valid to maintain variables that are somewhat less significant but have a reasonable outcome based on experience with other travel behavior models.

Table 3-7. Tour generation model results.

Model name	Tgen2bw	
# Observations	2612	
Final log-likelihood	-2664.0	
Rho squared w.r.t. 0	0.536	
Rho squared w.r.t. constants only	0.229	
Nesting of tour purposes under stay-at-home alternative	Coeff= 0.727	t-stat= 5.2

	Choice	medical tour	work tour	school tour	adult daycare tour	shopping / meal tour	recreation tour	social visit tour	personal business tour	stay at home
	Chosen unweighted	340	159	44	68	204	69	20	125	1583
	Chosen weighted	331	97	31	49	221	88	28	128	1640
Variable	**Unweighted % of observ.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**
Age 16 to 39	20.4%	-0.701 -2.9					1.179 4.2	1.012 1.9		-1.232 -3.4
Age 65 to 74	24.2%	0.346 1.5								1.172 3.9
Age 75 and up	13.7%	0.564 1.9			0.963 1.5	0.528 1.8	1.124 2.9	1.187 2.4		0.937 3.2
Female	66.0%				-0.748 -2.2	0.486 2.7		1.396 2.5		
Sensory impairment	23.7%				0.966 2.4					
Physical impairment	72.3%	0.980 4.8	0.331 1.0			0.348 1.7				
Mental impairment	22.7%				2.068 5.3			-1.476 -1.7		
Income under $15,000	59.6%	-0.426 -2.8			1.669 4.3			-0.503 -1.1		
Single-person HH	38.2%	-0.760 -4.5			-2.722 -2.3	0.696 3.5				
No cars in HH	53.5%				-2.994 -4.0	-0.469 -2.7	-0.331 -1.3			
Full-time worker	10.3%	0.819 1.9	7.568 8.0				1.819 4.6			
Part-time worker	8.0%		6.715 7.4							
Full-time student	5.6%			4.107 7.5						
Part-time student	4.1%			4.160 7.5						
Proxy answers	8.1%									0.511 1.7
Second diary day	48.7%									0.360 2.5
Already made 1 tour	36.0%									3.781 4.3
Already made 2 tours	3.2%									4.323 4.6
Already made 3 tours	0.2%									6.212 2.8
Home zone accessibility	100.0%				0.569 2.6	0.569 2.6	0.569 2.6	0.569 2.6	0.569 2.6	
DART area	51.3%			1.145 2.0	-0.652 -1.8					
Residual constant	100.0	7.609 2.6	2.669 0.9	3.503 1.2	-1.435 -2.7	-0.207 -0.9	-0.934 -3.8	-2.885 -5.1		8.836 3.1

Weighting of observations: In order to gain efficiency in data collection and heterogeneity in the sample, the survey sample was drawn using a stratified approach, oversampling frequent ADA paratransit users and younger age groups. In a tour frequency model, the choice probability of making a tour is not independent of the probability of being in the sample, particularly given that we oversampled more frequent travelers. To adjust for this, we used weighted logit estimation, weighting each observation using the expansion factors described earlier, so that the overall weighted sample is representative of the full ADA-eligible population. The weighting factors were also normalized to have an average value of 1.0 in the estimation data so that the total weighted number of observations is the same as the unweighted total (2,612 observations). The top rows of Table 3-7 show both the unweighted and weighted frequency with which each choice alternative is observed in the estimation data. The use of weighting reduces the choice frequency for the types of tours made most regularly (e.g., work, school, and adult daycare) and increases the frequency for the types of discretionary tours made on a less regular basis (e.g., shopping, recreation, and social visits). As one would expect, the weighting also increases the frequency of the stay-at-home alternative.

Age group: Dummy variables were included for the age groups 16–39, 55–64, 65–74 and 75+. A dummy variable is 1 if the person is in the category (i.e., in a certain age group) and 0 otherwise. The model results show the impact of being in each category (age group). The column to the left shows, for instance, that the 16–39 age categories comprises 20.4% of the unweighted sample. Persons age 40–54 were designated as the "base" age group, and all other age group effects are interpreted relative to that base category. For people in the base age group, all of the dummy variables are zero. (In a logit model, the effects of variables must all be relative to the effects of some other category, so a "base" category always needs to be specified where the effect is constrained to 0.) The base age group is not shown in Table 3-7 (nor is the 55–64 age group, because no significant effects were found for that age category relative to the base group). The results show that, all else being equal, those in the youngest age group are less likely to remain at home, less likely to make medical tours, and more likely to make recreation and social visit tours. (Positive coefficients indicate that a variable is associated with an increase in the probability of an alternative being chosen, and negative coefficients just the opposite.) Relative to the other age groups, those in the oldest two age groups are more likely to stay at home instead of traveling, as one might expect. They are also more likely to make tours for medical purposes. Those in the oldest age group are also somewhat more likely to travel for medical purposes, adult daycare, and various discretionary purposes.

Gender: After other variables are accounted for, there are few differences related to gender. The base case (dummy variable = 0) is male and is not shown. Females make somewhat fewer tours than males for the adult daycare, but somewhat more tours for shopping and social visits.

Type of impairment: Respondents were asked if they were subject to sensory/visual impairment, physical/motor impairment, or mental/cognitive impairment, or any combination of those. A respondent could have any number of impairments, so for each impairment the base case is not having that impairment. These variables are self-reported and not objective categorizations and may not be useful in a forecasting model for the general population. However, they may be useful for research purposes for explaining behavior. The results show that those with physical impairments are more likely to travel for medical, work, and shopping purposes, while those with sensory/visual impairment are more likely to go to adult daycare. Those with mental impairments are most likely to attend adult daycare and somewhat less likely to make social visit tours.

Income level: Only one income group was tested, under $15,000/year, the lowest survey category, which includes a full 60% of the sample. The base case is income over $15,000 per year, including 40% of the sample. None of the higher income groups have large enough samples to estimate income effects reliably. Compared to those with higher incomes, those with the lowest incomes are more likely to attend adult daycare, but less likely to travel for social visits and medical purposes.

Household size: It was hypothesized that those living alone may have different behavior from those living with others, who make up the base case. The results show that those in single-person households are somewhat less likely to travel for medical and adult daycare tours, but somewhat more likely to travel for shopping (perhaps because they do not have others to do the shopping for them).

Car ownership: Those in households with no cars are somewhat less likely to make adult daycare tours, shopping/meal tours, and recreation tours. Another variable specified as the number of cars per licensed driver in the household was also tested, but did not show any significant effects. Overall, car ownership has less influence in the trip generation model than it does in the mode choice model (reported below).

Employment status: Not surprisingly, full-time workers and part-time workers are much more likely to make work tours than non-employed people (the base case) are. Full-time workers are also more likely to make medical and recreation tours.

Student status: As one would expect, full-time and part-time students are the most likely to make school tours. No other significant result was found related to student status.

Proxy responses: Those whose diary information was reported by proxy (another person) have a positive coefficient for staying at home. This suggests that there is some under-reporting bias of travel related to proxy responses. It is also possible that proxy answers occurred most often for those with severe mental incapacity, and these individuals do actually travel less than others. In any event, the effect is fairly small, only applies to 8% of the survey sample, and can be adjusted for in model application.

Second diary day: Relative to the first diary day (the base case), respondents were more likely to choose the "stay-at-home" alternative for the second diary day data. As the diary days were selected randomly, this indicates an effect of respondent fatigue where people were less likely to record or report their travel on the second day relative to the first. In any case, we can estimate this effect and adjust for it when applying the models.

Numbers of tours already made: As one would expect, the more tours that somebody has already made in the day, the more likely they are to stay at home for the rest of the day. Note that only a very small percentage of the sample made more than one tour in a day.

Residence zone accessibility level: The intent of this variable is to test whether having more places available to go to increases trip-making for some purposes. An average of the off-peak automobile accessibility measure described in Table 3-6 and the weighted ADA paratransit-specific accessibility was used to represent this effect, given that most trips by registered users are made either as private automobile passengers or ADA paratransit passengers. The number of service and retail jobs is used to represent the level of attraction; for example, retail jobs indicate the presence of retail activities that would attract shopping trips. ("Accessibility" here refers not to accommodation for people with disabilities but to the ability of travelers in one zone to reach potential destinations in other zones.) In the model results, a significant positive effect of this accessibility was found on the likelihood of making tours for discretionary purposes (all purposes except medical, school, and work). When estimated separately for each purpose, the effects were similar, but not significant, so the variable was estimated jointly across the purposes. No effect was found for medical, school, or work purposes. These tours tend to be non-discretionary, so their frequency will not be greatly influenced by accessibility.

Service area: About 51% of the observations are from those living in the DART (Dallas) service area and the other 49% are from the MITS (Fort Worth) service area. After accounting for all other variables, there are only minor differences between the residents of the two areas, with those in the DART area somewhat more likely to make school tours and somewhat less likely to make adult daycare tours than those in the Fort Worth area (the base case).

Residual constants: The alternative-specific constants are residual to the other variables and have no behavioral interpretation in themselves—their values depend on what other variables are included in the model specification.

Nesting parameter: The nesting of the eight tour purpose alternatives versus the stay-at-home alternative has a logsum coefficient of 0.727 and is significantly different from both 0 and 1, indicating that this is a statistically correct nesting structure.

In summary, this model suggests which variables contribute most to the level of mobility of the ADA-eligible population. It appears, as might be expected, that the frequency of travel decreases somewhat with age and increases somewhat with automobile ownership, but that different types of people are likely to travel for different purposes.

The Tour Mode Choice Model

The tour mode choice model is the choice among six main modes:

- ADA paratransit
- Other specialized transit/shuttles
- Regular scheduled transit
- Car shared-ride
- Car drive-alone
- Walk/wheelchair/scooter

In cases where more than one of these modes was used on a tour (a small minority of the observed tours), the main tour mode was specified as the highest priority mode in the above hierarchy, where ADA paratransit is the highest and walk is the lowest.

The mode choice results reported in Table 3-8 are generally what one would expect, with very significant car ownership effects and some differentiation by tour purpose (included as dummy variables).

Weighting of observations: As in the trip generation model, our sample was non-representative because we had oversampled on frequent ADA paratransit users, so weighted estimation was used to adjust for that fact. Looking at the unweighted versus weighted mode shares at the top of the table, we see the main difference in the ADA paratransit choices (666 unweighted versus 510 weighted) and private car choices (251 unweighted versus 403 weighted), while the weighted choices for the other mode alternatives increase only slightly.

Mode availability: All modes were set available for all tours, with one exception: automobile drive-alone is only available if the respondent has a license and the household owns one or more cars. This was the case for only 178 of the 1,022 observed tours.

Mode nesting structure: We tested various mode nesting structures, which indicate how certain choices are more closely related than others. A structure that proved reasonable and statistically significant was to group the modes into three nests as follows:

1. Road-based, flexible route and schedule: (1a) Car shared-ride, (1b) Car drive-alone, (1c) ADA paratransit, (1d) other specialized transit

Table 3-8. Tour mode choice model results.

Model name	mode2bw
# Observations	1022
Final log- likelihood	-971.1
Rho squared w.r.t. 0	0.429
Rho squared w.r.t. constants only	0.179
Nesting of scheduled transit and walk in separate nests	Coeff. = 0.646 T-stat = 3.5

	Choice	ADA paratransit	Other special transit	Car shared-ride	Car drive-alone	Scheduled transit	Walk/ wheelchair
	# chosen-unweighted	666	16	226	25	29	60
	# chosen-weighted	510	18	334	69	32	63
Variable	**unweighted % of sample**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**
Mode accessibility logsum	100.0	0.877 2.3	0.877 2.3	0.877 2.3	0.877 2.3	0.877 2.3	0.877 2.3
Age 16-39	22.1						1.780 1.9
Age 40-54	20.8						1.468 1.5
Age 55-64	25.1						2.794 2.6
Female	64.0						-1.674 -2.8
Sensory impairment	26.1	-1.115 -6.0					-0.860 -1.7
Income under $15,000	51.7	-1.558 -2.9		-1.303 -2.4	- 1.263 -2.0		
No cars in HH	49.3			-1.561 -8.4		4.999 1.9	
Cars per driver in HH	50.7				4.245 4.8		
Work tour	15.4	1.960 5.5	2.654 2.3				
School tour	4.3	1.559 2.9	3.439 2.9				
Medical/dialysis tour	23.2	0.162 0.7	2.588 3.8				
Adult daycare tour	6.7	1.348 3.6					
Shopping/meal tour	19.7	-1.494 -5.7					
Recreation tour	6.9	-0.229 -0.7					
Social tour	2.0	-1.008 -2.1					
DART area	52.3	0.268 1.7					
Residual constant	100.0		-6.534	-0.277	-4.327	-8.444	-1.519
			-8.1	-1.0	--4.9	-2.6	-1.0

2. Road-based, fixed route and schedule: (2a) Regular scheduled transit
3. Non-road-based: (3a) Walk/wheelchair

The estimated nesting logsum coefficient of 0.646 is significantly different from both 0 and 1, indicating closer substitution between the four flexible road-based modes than across the three groups. Several other nesting structures were tested during model estimation—for instance nesting ADA paratransit with regular scheduled transit—but none gave statistically acceptable results with logsum coefficients between 0 and 1.

Different types of variables were tested, most of them defined in the same way as for the tour generation model above. The effects of each variable are described below.

Mode-specific accessibility logsum: Because the tour mode choice model is applied before destination choice, we do not know exactly where each tour goes when we predict mode choice. For that reason, we use the accessibility measures defined in Table 3-6 to help explain the choice of mode as a function of overall accessibility by each mode from the residence zone to all possible destinations. The off-peak automobile accessibility logsum was used for all alternatives except for scheduled transit and walk/wheelchair, which used the off-peak transit accessibility and walk accessibility measures, respectively. The resulting coefficient of 0.877 is significantly different from 0, which shows that differences in accessibility between ADA paratransit, walk, transit, and automobile across all destinations influence the choice of tour mode somewhat.

Age group: The only age effects found are that the walk/wheelchair mode is most likely to be chosen in the younger age groups under age 65.

Gender: Females are less likely to choose the slowest mode, walk/wheelchair. Similar trends for gender and age are typically found for the walk mode in regional travel models.

Impairment type: Although variables were tested for all three impairment types, significant effects were found for only one of them—those with sensory/visual impairments are somewhat less likely to choose ADA paratransit or walk/wheelchair (so, by inference, somewhat more likely to travel as car passengers).

Income level: Those in the lowest income category are less likely to travel by ADA paratransit or by private auto. This means that they travel by walk/wheelchair, scheduled transit, or specialized transit/shuttles instead; however, the sample was too limited to estimate coefficients for these modes.

Household size: This variable was tested on various modes, but no significant results were obtained.

Car ownership: Those with no cars in the household (about 50% of the cases) are more likely to choose scheduled transit and less likely to choose car shared-ride. (Also, car drive-alone is not available for those households.) For households that do own cars, a variable was included as the number of cars per licensed driver in the household, capped at a maximum value of 1.0. Those in households with more cars per driver were more likely to choose the car drive-alone mode. Although the model shows no direct effect of car ownership on the likelihood of choosing ADA paratransit, there is a strong indirect effect, because travel by car is the main alternative among the respondents to traveling by ADA paratransit.

Tour primary purpose: Because of the limited number of tours in the data, we did not estimate separate mode choice models for each tour purpose. Instead, we tested dummy variables to look for cases where certain modes are more likely to be used for certain types of tours. The results show that ADA paratransit is more likely to be used for the most regular tour types, including work, school, and adult daycare tours, and less likely to be used for several of the discretionary purposes—shopping, meals, recreation, and social visits. Other specialized transit services are most likely to be chosen for work, school, and medical purposes, corresponding to the types of institutions/facilities most likely to offer those services.

Service area: About 52% of the observations are from those living in the DART (Dallas) service area. After accounting for all other variables, those in the DART service area are slightly more likely to choose ADA paratransit than those living in the MITS service area, but the effect is small.

Residual constants: The alternative-specific constants are residual to the other variables and have no behavioral interpretation in themselves—their values depend on what other variables are included in the model specification.

The Intermediate Stop Generation Model

The intermediate stop model is specified in a similar way as the tour generation model. For each half of a tour (the first half from home to the main tour destination and then the second half from the main tour destination back to home), this model predicts how many intermediate stops are made (if any) and what the purpose of each stop is. The top rows in Table 3-9 show that out of 2,342 choice observations in this model, 2,062 of the choices (unweighted) are to make no intermediate stops, meaning that there are only 280 such stops observed in the survey data.

Most of those stops are for shopping/meals (121) or personal business/errands (78). The weighted data shows an even higher percentage of stops for those discretionary purpose stops.

Apart from the constants, all of the variables in this model are for the "No (more) stops" alternative, with a positive coefficient meaning fewer extra stops per tour and a negative coefficient meaning more extra stops per tour. Only the residual constants are used to determine which purpose each stop is for. The model is specified this way (1) because there are very few observations for most stop purposes, and (2) because of the hierarchical way that the main tour purpose is determined, the tour purpose can limit the possible stop purposes on any tour. For example, medical stops can only be on medical tours—if they were on any other tour, then medical would have been designated as that tour's main purpose. Similarly, work stops can only be found on work tours and medical tours, and so on. So, the tour purpose already goes a long way toward determining the stop purpose.

The explanatory variables in the model shown in Table 3-9 are described below.

Tour main mode: Three tour main modes are used as explanatory variables. As expected, the tour main mode is very important in explaining the number of extra stops on a tour. ADA paratransit tours tend to have fewer extra stops, while private car tours tend to have more. The effect is particularly strong for car drive-alone tours, which are the most flexible in terms of making multiple stops along the tour. These mode-specific differences are why we chose to model extra stop generation after modeling the main tour mode.

Tour main purpose: Five tour main purposes are used as explanatory variables. Because of the time schedules and constraints particular to specific types of tours, tours for some purposes may tend to include more extra stops. The results show that the less discretionary tour purposes (work, school, medical, adult daycare) all tend to include fewer extra stops, while shopping/meal tours include somewhat more stops, on average. These differences, however, are not as large as the mode-specific differences described above.

Table 3-9. Intermediate stop generation model results.

Model name	sgen2bw
# Observations	2342
Final log- likelihood	-1239.2
Rho squared w.r.t. 0	0.707
Rho squared w.r.t. constants only	0.123

	Choice	medical stop	work stop	school stop	adult daycare stop	shopping / meal stop	recreation stop	social visit stop	personal business stop	No (more) stops
	# chosen unweighted	8	4	11	2	121	21	35	78	2062
	# chosen weighted	5	2	12	3	179	20	38	91	1991
Variable	**weighted % of sample**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**	**Coeff. T-stat.**
ADA paratransit tour	44.9%									0.439 1.7
Car drive-alone tour	9.3%									-1.627 -5.8
Car shared-ride tour	35.0%									-0.755 -3.0
Medical/dialysis tour	33.7%									0.496 2.5
Work tour	9.2%									0.667 2.1
School tour	2.7%									5.0 Const
Adult daycare tour	4.8%									0.419 1.2
Shopping/meal tour	25.3%									-0.275 -1.4
Income under $15,000	60.6%									0.333 2.4
Age 40-54	22.5%									-0.323 -2.2
Physical impairment	70.2%									0.707 3.9
Sensory impairment	24.8%									0.543 3.0
Proxy data	6.2%									0.458 1.6
Number of tours in day	100.0%									1.066 5.1
1st half tour	46.7%									1.297 5.4
2nd half tour- No. of trips in 1st half tour	53.3%									0.254 1.6
Already made 1 stop in half tour	11.2%									-0.394 -2.3
Already made 2 stops in half tour	3.6%									0.184 0.7
Already made 3 stops in half tour	1.2%									1.224 2.3
Residual constant	100.0	-1.606 -3.5	-2.748 -3.7	-0.923 -2.9	-2.342 -4.1	0.675 5.2	-1.632 -6.6	-1.016 -5.2		0.557 1.2

Household income: Those in lower income households tend to make fewer extra stops per tour, on average. It is a typical result in travel studies that the number of activities outside the home tends to increase with income.

Age group: Those in the 40–54 age group tend to make more stops per tour than others—this tends to be one of the busiest age groups in general.

Type of impairment: Those with physical and sensory impairments make the fewest extra stops per tour. Complex, multi-stop tours may be more difficult physically for those people to manage.

Proxy data: People whose travel diary data was reported by proxy tend to have fewer extra stops per tour. The person reporting the travel may not know all of the details of the person's tour, or people who need to use proxy reporting may actually make fewer stops. In either case, the effect is moderate and only applies to 6% of respondents.

Number of tours in the day: In activity-based models, it is a common finding that people who make more tours during a day tend to make fewer stops per tour—instead of chaining trips together into a single tour, they tend to split them across multiple tours. The result here shows the same—the more tours generated in the day, the more likely to choose the "no stops" alternative.

Outbound or return tour half: There tend to be fewer extra stops made on the first (outbound) tour half than on the second (return) half. This is also a typical result, as people often go to the main/most important activity of their tour first upon leaving home and then make extra stops on the way home, particularly for longer, scheduled activities such as work and school.

Number of trips made in the first half tour: In general, the more extra stops that somebody has made on the first half tour, the fewer stops they will need to make on the return half. This coefficient is not very large, however, implying that some people make stops on both halves.

Number of extra stops already made in the current half tour: If somebody has already made one extra stop in the current half tour, they are actually more likely to make another stop than somebody who has not made any extra stops yet. This result implies that extra stops can often occur in pairs. However, the coefficients for people who have already made two or three stops in the tour go in the other direction, meaning that it is very rare to make more than two extra stops in a half tour.

Residual constants: In this model, the residual constants partly determine the purpose of any intermediate stops. The constants for all purposes other than shopping/meal and personal business/errand are significantly negative, because those other types of intermediate stops are much less common.

The Trip Mode Choice Model

The trip mode choice model is actually just a simple table that gives the probability of each possible trip mode as a function of (1) the main tour mode and (2) the position of the trip in the tour—from home, back to home, or non-home-based (NHB).

The survey observations that this model is based on are shown in Table 3-10. In total, there are 1,021 trips from home, 1,021 trips returning back to home, and 315 NHB trips, indicating that most tours are simply one trip out and another trip back with no extra stops. Also note that the large majority of the trips are on the diagonals, with the trip mode the same as the tour mode. The function of the trip mode choice model is to predict those few cases where the trip

Table 3-10. Trip mode choice model: survey data trip observations.

		Trip mode						
Trip type	**Tour mode**	**ADA paratransit**	**Special transit**	**Scheduled transit**	**Car passenger**	**Car driver**	**Walk/ wheelchair**	**Total**
From home	ADA paratransit	630	1	3	24	1	2	661
From home	Special transit		16					16
From home	Scheduled transit			25	1		5	31
From home	Car passenger				219		6	225
From home	Car driver					28		28
From home	Walk/wheelchair						60	60
From home	Total	630	17	28	244	29	73	1021
NHB	ADA paratransit	71	1	1	25		31	129
NHB	Special transit		0	1			7	8
NHB	Scheduled transit			6	1		4	11
NHB	Car passenger				123		1	124
NHB	Car driver					27		27
NHB	Walk/wheelchair						16	16
NHB	Total	71	1	8	149	27	59	315
To home	ADA paratransit	596		5	48		12	661
To home	Special transit		13	1			2	16
To home	Scheduled transit			15			16	31
To home	Car passenger				223		2	225
To home	Car driver					28		28
To home	Walk/wheelchair						60	60
To home	Total	596	13	21	271	28	92	1021

mode is different from the tour mode. Most of those cases are car passenger trips as part of ADA paratransit tours (97 cases) and walk/wheelchair trips that are part of ADA paratransit or scheduled transit tours (70 cases). There are only 34 other cases across all cells.

Choice distribution fractions based on the data in Table 3-10 are shown in Table 3-11. The diagonal nature of the tables (highlighted with bold font) is based on the hierarchy used to define the main tour mode, where ADA paratransit tours can include any other modes, but ADA paratransit trips can only be part of ADA paratransit tours. At the other end of the hierarchy, walk/wheelchair tours can only include walk/wheelchair trips, but walk/wheelchair trips can be part of any tour. Notice that almost all private car tours (as a driver or passenger) include only private car trips and no trips by other modes.

In model application, these fractions will be applied "as is," conditional on tour mode and trip position within the tour.

The Trip Destination Choice Model

Finally, once we have predicted how many trips are made as part of a tour and what mode is used for each trip, we predict the exact destination zone location for each trip. This model is specified to work somewhat differently depending on whether a tour has a single out-of-home destination or multiple destinations.

Single-destination tours: This is the majority of all tours, particularly for ADA paratransit tours. For these tours, the destination choice model is applied just once to predict the location zone of the single out-of-home destination. The model has two main parts:

Table 3-11. Trip mode choice model: choice distribution fractions.

		Trip mode					
Trip type	**Tour mode**	**ADA paratransit**	**Special transit**	**Scheduled transit**	**Car passenger**	**Car driver**	**Walk/ wheelchair**
From home	ADA paratransit	**95.3%**	0.2%	0.5%	3.6%	0.2%	0.3%
From home	Special transit		**100.0%**	0.0%	0.0%	0.0%	0.0%
From home	Scheduled transit			**80.6%**	3.2%	0.0%	16.1%
From home	Car passenger				**97.3%**	0.0%	2.7%
From home	Car driver					**100.0%**	0.0%
From home	Walk/wheelchair						**100.0%**
NHB	ADA paratransit	**55.0%**	0.8%	0.8%	19.4%	0.0%	24.0%
NHB	Special transit		**0.0%**	12.5%	0.0%	0.0%	87.5%
NHB	Scheduled transit			**54.5%**	9.1%	0.0%	36.4%
NHB	Car passenger				**99.2%**	0.0%	0.8%
NHB	Car driver					**100.0%**	0.0%
NHB	Walk/wheelchair						**100.0%**
To home	ADA paratransit	**90.2%**	0.0%	0.8%	7.3%	0.0%	1.8%
To home	Special transit		**81.3%**	6.3%	0.0%	0.0%	12.5%
To home	Scheduled transit			**48.4%**	0.0%	0.0%	51.6%
To home	Car passenger				**99.1%**	0.0%	0.9%
To home	Car driver					**100.0%**	0.0%
To home	Walk/wheelchair						**100.0%**

- The impedance function: An average of the travel time to go from the home location to each possible destination zone and the time to return back home again.
- The attraction function: A composite function of the number of jobs and households in each possible destination zone that attract trips to that zone.

Multiple-destination tours: For this minority of tours, the model is applied once for each out-of-home destination along the trip. The specification is much the same as above for single-destination tours, but with two differences in the impedance function:

- After the first out-of-home destination has been predicted, the impedance function is measured from the previous destination location rather than from the home location.
- Instead of using the average of the time to go to the (next) destination and back again, it uses only the time to go to the (next) destination from the current location, and then a second variable that measures the travel time to go from each possible destination location back to the home location. The use of this second variable prevents the possibility that we would simulate a series of one-way trips that end up a great distance from the home location, which would be unrealistic because the tour eventually needs to end up back at home. (In fact, when we are predicting the last out-of-home destination in the tour, this variable is exactly the travel time for the last trip in the tour that returns to home.)

The destination choice model was estimated using a full sample of all 5,386 possible destination zones for each trip. In the past, a subsample of destinations would typically be used to estimate such a model, but the current logit model estimation software and hardware can estimate a model on a large number of alternatives in just a few minutes, so it is possible to use the full sample, which is more efficient than sampling both in terms of statistics and analyst time.

The model estimation results are summarized in Table 3-12.

Table 3-12. Trip destination choice model results.

Model name	Tdes4
# Observations	1332
Final log- likelihood	-7961.4
Rho squared w.r.t. 0	0.304

Impedance function By trip mode	ADA paratransit	Car drive-alone	Car shared-ride	Other special transit	Regular transit	Walk/ wheelchair
Variable	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.
Automobile time (minutes)	-0.124 -27.4	-0.181 -8.0	-0.172 -20.0	-0.120 -6.8	-0.120 -6.8	
Automobile distance (miles)						-0.570 -10.4
Intra-zonal	0.503 1.4	0.635 0.8	0.908 3.5	-10.0 const	-10.0 Const	2.932 11.5
Automobile time back home (min) (Multi-stop tours only, segmented by tour mode)	-0.103 -8.3	-0.118 -9.3	-0.118 -9.3	-0.177 -3.9	-0.177 -3.9	-.088 -1.3

Attraction size variable function by trip purpose	medical trip	work trip	school trip	adult daycare trip	shopping / meal trip	recreation trip	social visit trip	personal business trip
Variable	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.	Coeff. T-stat.
Service employment	1.0 const*	1.0 const*	1.0 const*	1.0 const*	1.0 const*	1.0 const*	1.0 const*	1.0 const*
Retail employment		0.49 -1.1*			12.45 10.2*	0.81 -0.3		1.94 1.9*
Basic employment		1.87 2.2*						
Hospital/medical center employment	6.45 13.3*							
Households				0.15 -2.2*		0.66 -0.9*	2.90 2.2	0.85 -0.5*

* For size variable functions, the base size variable (Service employment) has coefficient constrained to 1.0 and the t-statistics for the other variables in the function are relative to a coefficient of 1.0.

The impedance function: Separate impedance functions can be used for the six different trip modes. The destinations for car drive-alone and shared-ride trips are the most sensitive to automobile travel time, with coefficients of –0.181 and –0.172, respectively—both with very high t-statistics. The travel time coefficients for ADA paratransit, scheduled transit, and other special transit are all very similar, at around –0.120. The lower ADA paratransit sensitivity to generalized ADA paratransit travel time is an indication that these trips are somewhat longer than private car trips, on average. The walk/wheelchair trip impedance is based on automobile path distance rather than travel time. (NCTCOG does not have a separate walk network with best paths for pedestrians, but such an input could be used with this model system in other regions if it is available.) The coefficient for walk distance is –0.570.

The impedance function uses automobile time, rather than transit in-vehicle and out-of-vehicle time, as the measure for scheduled transit. As discussed earlier, the NCTCOG transit matrices are quite sparse, so using transit times from those matrices would require making many destinations unavailable for transit trips when in reality those destinations are connected by transit. Given (1) the relatively minor role of scheduled transit in the model system, (2) transit matrices can be considerable work to process, and (3) many regions do not have transit matrices at all, this simplification was judged appropriate in the current study context. In the future, if the model system is applied in a region with much higher scheduled transit mode shares and more complete transit data, it would be possible to adjust the models to accommodate them.

Even though the NCTCOG zone system is detailed, with over 5,000 zones in the region, some observed trips in the survey data are intra-zonal, meaning that the origin and destination address are in the same TAZ. In those cases, there is no zone-to-zone travel time information to use in the models, so a separate dummy variable is added for the origin zone alternative to represent the probability of making an intra-zonal trip. As one would expect, this probability is clearly highest for walk/wheelchair trips, but also positive for private car and ADA paratransit trips, indicating that intra-zonal car and ADA paratransit trips do occur. There are no intra-zonal trips observed by scheduled transit or other special transit, so the intra-zonal constant for those modes is constrained to a large negative value.

The final variable in the impedance function is the automobile time back to the home location, applied only for multi-stop tours, as explained earlier. For this variable, the segmentation is by the tour mode, rather than the trip mode, because we do not know for sure that other trips in the tour are made by the same mode as the current trip. For ADA paratransit and automobile tours, which make up the majority of cases, the coefficient for this variable is very accurately estimated and 20 to 35% lower than the main automobile time coefficient for the current trip. For walk tours, the travel time back to home is less significant, but such tours tend not to stray very far from home in the first place.

The attraction function: The size variable function is a specific feature of destination choice models. A “base” size variable is designated—in this case service employment—and the coefficient for that variable is constrained to 1.0, while the estimated coefficients for any other size variables determine their importance relative to the base variable. So, the results at the bottom of Table 3-12 indicate that hospital/medical center employment has an effect that is 6.45 times as large as service employment in attracting medical trips. The largest effect for other purposes is for shopping/meal trips, where retail employment has an effect that is 12.45 times as large as for service employment. (In fact, we combined those two trip purposes because they are both carried out almost exclusively at retail establishments.)

Other noteworthy results are that households are important in attracting social visit trips; basic employment is important in attracting work trips; and recreation trips and personal business/errand trips are attracted by a combination of service jobs, retail jobs, and households.

Model Calibration

Ridership Targets for DART and MITS Forecasts

As a first step in calibrating the models, reported trips in the ADA paratransit travel survey were compared to actual ADA paratransit trips made by ADA-eligible adults, excluding attendants or companions as reported by the two ADA paratransit systems for the time period around the time of the ADA paratransit travel survey. The survey diary days were weekdays, mainly during spring of 2010.

The calculations are shown in Table 3-13. DART provided annual ridership and ridership for the year of survey and also for the period April–June 2010. FWTA provided only annual ridership. The DART ridership figures show 163,219 weekday trips made by ADA-eligible adults in the period. That period included 65 weekdays, for an average of 2,511 trips per spring weekday. Applying the ratio of DART spring weekday ridership to annual ridership to the MITS annual ridership gives an estimate of 1,214 trips per spring weekday for MITS. Dividing the annual trips (row B) by the spring weekday trips (row C) gives a factor of 284.5 to convert to a spring weekday from an annual total. (Note that there are 260 weekdays in a year, so a factor greater than 260 means that spring ridership is somewhat lower than average.)

Table 3-13. Actual and surveyed ADA paratransit ridership.

Based on operator ridership data	DART	MITS
A. Total annual ADA paratransit trips by ADA-eligible persons	718,178*	347,270*
B. Total annual ADA paratransit trips by ADA-eligible adults	714,336*	345,421**
C. Trips per spring weekday by ADA-eligible adults	2,511*	1,214**
D. Factor to convert from annual to spring weekday trips (=B/C)	284.5	284.5
Based on operator client databases	**DART**	**MITS**
E. Full client database – ADA-eligible adults	7,335	4,591
F. Full client databases – trips in last 12 months	654,667	312,792
G. Calculated expected trips per Spring weekday (=F/D)	2,301	1,099
Based on survey sample expanded to full client databases	**DART**	**MITS**
H. Survey expanded sample – ADA-eligible adults	7,282	4,533
I. Survey expanded sample – trips in last 12 months	605,666	284,870
J. Calculated expected trips per spring weekday (=I/D)	2,129	1,001
K. Reported diary trips per spring weekday (expanded)	4,570	2,189
L. Factor – reported / expected trips (=K/J)	2.15	2.18

* Statistics provided by operators, ** assumes same distributions for DART and MITS

Area / frequency category	DART high	DART medium	DART low	MITS high	MITS medium	MITS low	MITS none - new
Survey Expanded sample (H)	2,200	2,811	2,271	1,130	1,466	1,104	833
Avg. trips last 12 months	219.45	30.56	16.28	207.61	26.73	10.04	0
Expected trips per weekday (J)	1,697	302	130	825	138	39	0
Reported diary trips / day (K)	2,436	1,473	661	1,245	596	199	149
Factor reported / expected trips (L)	1.44	4.88	5.09	1.51	4.33	5.11	

The second section of the first table is based on full client databases provided by DART and MITS (excluding anyone who did not make any trips and did not register in the previous 12 months). Each client record contains the count of the number of trips the person made in the previous 12 months. (The total number of clients and trips are in rows E and F.) If we apply the same factor from row D, we obtain the expected number of trips from those clients on a spring weekday (row G). For both DART and MITS, the values in rows F and G are about 10% lower than the values from the total ridership statistics in rows B and C. One possible reason for this is that just as our sample could contain records for people who had recently registered but not (yet) made any trips on the system, there could also be people who had made trips on the system in the prior year but were no longer in the client database because they had moved or otherwise left the system. In any case, the two estimates are reasonably close.

The third section of the first table is similar to the second section, but now based only on the 800 final survey respondents, after expansion to match the full client database. We had oversampled on frequent riders, and the sample expansion adjusts for that, although not perfectly, as the expanded sample trips in the last 12 months (row I) is about 8% below the figure for the full client database (row F). The most striking difference, however, is that the average number of expanded ADA paratransit trips reported per survey diary day is over twice as high as the number that would be expected based on the observed number of trips made in the last 12 months (row K versus J). The reported number of ADA paratransit trips is about 115% too high for both MITS and DART respondents (row L).

The second table in Table 3-13 takes the comparisons in rows H-L and reports them separately for each observed frequency segment used for sample stratification. For the high observed frequency categories, the reported trips are "only" about 50% higher than expected. For the lower observed frequency categories, however, the reported trips are 4 to 5 times higher than expected. This means that those people were much more likely to use ADA paratransit on one or both of the two diary days than they had been in reality over the previous year. Even though people in the lower frequency categories were less likely to report ADA paratransit diary trips than those in the higher frequency categories, this difference was not as strong as would be expected based

Table 3-14. Model calibration constants and results.

	Transit Operator and Frequency Category							
	DART high	DART medium	DART low	DART new	MITS high	MITS medium	MITS low	MITS new
Calibration constant in tour generation model (on Stay Home alternative)	0.0	0.9	1.0	0.8	0.0	0.9	1.0	0.8
Calibration constant in tour mode model (on ADA paratransit alternative)	0.0	-1.8	-2.3	-1.5	0.0	-2.0	-2.5	-1.5
Trips by ADA paratransit – uncalibrated	1,650	1,550	1,050	325	925	850	600	175
Trips by other modes- uncalibrated	1,900	2,350	2,050	475	1,175	1,450	1,300	275
Trips by ADA paratransit – calibrated	1,650	400	175	125	925	175	75	50
Trips by other modes – calibrated	1,900	2,450	2,025	500	1,175	1,500	1,200	300

on previously observed behavior. This is most likely a survey-related bias that needs to be corrected in model calibration. It appears that respondents who travel infrequently may have made it a point to schedule the trips they needed to make on their assigned survey days. The number of trips to calibrate toward is that based on actual aggregate ridership statistics (row C)—roughly 2,500 ADA paratransit trips per weekday on DART, and 1,200 on MITS.

Calibration Procedure

The actual model calibration adds constants to the stay-at-home portion of the tour generation model and the ADA paratransit alternative of the tour mode choice model, using the following procedure:

1. Run the uncalibrated model, and get predictions of ADA paratransit trips, designated as PAR(u), and trips by other modes, designated as OTH(u), within each area and frequency stratum (the columns of the table above).
2. Set target ADA paratransit demand, PAR(t), in each area/stratum.
3. Calibrate the tour generation model so that the total number of trips in each stratum is approximately equal to PAR(t) + OTH(u) (fewer ADA paratransit trips but no change in other modes)
4. Calibrate the tour mode choice model so that the predicted ADA paratransit trips in each stratum is approximately equal to PAR(t) and the trips by other modes is near OTH(u).

The results of the calibration procedure are shown in Table 3-14. The numbers are given approximately, rounded to the nearest 25 trips, because there is some simulation error due to stochastic simulation of choices, so the model system gives somewhat different results if a different random number sequence is used. (Each sample observation is simulated multiple times to reduce the simulation error substantially.) The calibration was done using both the "sketch" version and the full "regional" version, with both methods giving approximately the same aggregate results.

The resulting total calibrated in-scope ADA paratransit trips per day is approximately 2,350 for DART and 1,225 for MITS—both very close to the actual ridership statistics.

Sensitivity Tests

The calibrated model was run using Dallas-Fort Worth data to explore how its predictions vary, given changes in demographic variables. These tests involved factoring the input census-tract numbers that feed into the ADA registration rate model, affecting the size of the predicted registered population, and then making corresponding changes to the survey expansion factors in the ADA population synthesis procedure. Three scenarios were tested:

1. **Higher incomes:** In this scenario, the fraction of households in each census tract with income below the poverty level was decreased by 10%, and the median income in each census tract was increased by 10%. Also, the expansion factor for any sample members in the lowest income category (less than $15K) was decreased by 10% relative to the rest of the sample (The "lowest income" dummy variable is the only income variable that appears in the tour and trip level models, so this is the only distinction that needs to be made to the sample to reflect the effect of income changes.)
2. **Aging of the population:** In this scenario, the fraction of the population in all age groups over age 60 was increased by 10%. Also, the expansion factor for any sample members in those same age groups was increased by that same amount relative to the other sample members.
3. **Larger households:** In this scenario, the fraction of the households in each census tract that are single-person households was decreased by 10%, and the average household size in each tract was increased by 10%. Also, the expansion factor for all sample members in single-person households was decreased by 10% relative to the other sample members.

Each of these scenarios was run in two ways:

- **Only on the expanded survey sample, with no change in the number of people registered:** This used the "sketch version" of the model to estimate the sensitivity of ADA paratransit trips in terms of the number of trips per registered individual, without considering changes in the number of individuals registered and without detailed spatial expansion.
- **On the full model system:** This used the full "regional" version of the model, including running the ADA registration rate model at the census-tract level, and re-expanding the survey sample to be representative of registered people in each tract.

The results are shown in Table 3-15. First, the results of running the model in sketch mode are shown, giving predicted changes in ADA paratransit trips per registered person. Second, results of the registration model alone are shown, predicting changes in the number of registered persons. The third and fourth rows show results for running the model in full regional mode, which adds a prediction of changes in travel patterns. Each scenario assumed a 10% change in some variable(s), and the resulting change in trips or registered people was used to calculate an approximate elasticity. For example, a predicted increase in trips of 1% would imply a +0.1 elasticity (1%/10%).

The results indicate that a rise in incomes would tend to increase the average number of trips per registered person, but would cause a more substantial drop in the number of persons who register, so the overall effect is a negative elasticity of ADA paratransit demand with respect to income of roughly –0.2. An increase in household size shows effects in the same direction, with a similar large drop in the number of registered persons, but with only a slight increase in the

Table 3-15. Sensitivity test results.

Model Mode and Predicted Quantity	Scenario		
	Higher incomes	Older population	Larger households
Sketch Mode: Travel day simulation models Elasticity of ADA paratransit trips per registered person	+0.40	-0.43	+0.13
Full Regional Mode - Registration rate model: Elasticity of number of ADA-registered persons	-0.58	+0.18	-0.53
Full Regional Mode: Travel day simulation models Elasticity of ADA paratransit trips per registered person	+0.41	-0.39	+0.10
Full Regional Mode - all model components Elasticity of total ADA paratransit trips	-0.18	-0.22	-0.44

number of ADA paratransit trips per person, for a net negative elasticity of roughly –0.4. Aging of the population (increase in the fraction of people over age 60) shows effects in the opposite direction, with a slight increase in the number of registered persons, but a larger offsetting drop in the number of ADA paratransit trips per registered person, for a resulting slightly negative net elasticity of about –0.2.

It would be interesting to test the effect of automobile ownership also, net of any changes in income. We did not include automobile ownership/availability in the tract-level registration rate model, because this variable is endogenous to many travel demand model systems. That is, it is not used as an input, but is predicted, because for many households automobile ownership decisions depend on the relative accessibility by various modes. In further research along this line, it may be worthwhile to include automobile ownership as exogenous, because it is unlikely that the level of ADA paratransit service would significantly affect automobile availability levels among the eligible population.

CHAPTER 4

ADA Paratransit Riders and Travel in Dallas-Ft. Worth

Personal and Household Characteristics

Tables 4-1 through 4-15 below show the personal characteristics of DART and MITS ADA paratransit registrants based on the ADA paratransit travel survey conducted in early 2010. These are weighted tabulations (i.e., corrected for the stratification procedure used in sampling). The sample sizes were 406 for DART and 394 for MITS.

Paratransit registrants tend to be women, without a driver's license, either retired or on disability status of some type, living alone or in a two-person household, and with an annual income of less than $14,000. Notably, 39% have a valid driver's license and 66% live in a household with at least one licensed driver. Physical impairments are far more common than mental or sensory impairments. Perhaps contrary to expectations, 60% of paratransit registrants are below the age of 65. 60% have been using paratransit for 1 to 5 years.

Trip-Making Characteristics

Tables 4-16 through 4-31 show the types of trips and modes of travel made by ADA paratransit registrants and rates of travel (by all modes). As before, these are weighted tabulations (i.e., corrected for stratification procedure used in sampling). The samples sizes were 406 for DART and 394 for MITS. The MITS sample includes some respondents who had been certified as eligible in the previous 12 months but had taken no ADA paratransit trips in that time, while the DART sample included only people who had used the ADA paratransit service in the previous 12 months.

There are three types of figures: (1) figures showing the percentage of total trips by mode or by purpose; (2) one showing the percentage of respondents who reported various numbers of trips for the two survey days; and (3) figures showing the average (mean) number of trips (by all modes) per person, depending on various characteristics of the person or their household.

The tabulations show that ADA paratransit registrants make only 1.4 linked trips per day on average, of which about 40% are taken on ADA paratransit and 35% are taken as an automobile passenger. Younger registrants take more trips than older ones, but even those under the age of 45 take just 2.1 unlinked trips per day on average. Surprisingly, possession of a driver's license is not linked to higher trip-making rates. Registrants in larger households travel somewhat more than registrants in smaller households and registrants with higher incomes travel more than those with lower incomes. As would be expected, higher rates of travel are also linked to more vehicles in the household, more licensed drivers in the household, and more workers in the household.

Table 4-1. Gender.

		Dallas (DART)	Ft Worth (MITS)	Total
Gender	Male	34.9%	31.5%	33.6%
	Female	65.1%	68.5%	66.4%
Total		100.0%	100.0%	100.0%

Table 4-2. Valid driver's license.

		Dallas (DART)	Ft Worth (MITS)	Total
Valid Driver's License	YES	34.5%	45.6%	38.8%
	NO	65.5%	54.4%	61.2%
Total		100.0%	100.0%	100.0%

Table 4-3. Employment status.

		Dallas (DART)	Ft Worth (MITS)	Total
Employment Status	Employed full-time	5.2%	4.9%	5.1%
	Employed Part-time	4.6%	4.5%	4.5%
	Not employed	90.2%	90.6%	90.4%
Total		100.0%	100.0%	100.0%

Table 4-4. Non-worker status.

		Dallas (DART)	Ft Worth (MITS)	Total
Non-Worker Status	Not applicable	9.8%	9.4%	9.6%
	Retired	24.7%	30.4%	26.9%
	Disabled / On Disability Status	58.2%	51.7%	55.7%
	Homemaker	.5%	.6%	.5%
	Unemployed but looking for work	3.9%	4.1%	4.0%
	Unemployed and not looking for work	1.3%	.4%	1.0%
	Student	.7%	1.1%	.8%
	Other (specify)	.9%	2.0%	1.3%
	REFUSED		.1%	.0%
Total		100.0%	100.0%	100.0%

Table 4-5. Student status.

		Dallas (DART)	Ft Worth (MITS)	Total
Student Status	Yes - Full-time	3.4%	2.0%	2.9%
	Yes - Part-time	3.0%	2.6%	2.9%
	No	93.5%	95.3%	94.2%
Total		100.0%	100.0%	100.0%

Table 4-6. Level of school attended by current students.

		Dallas (DART)	Ft Worth (MITS)	Total
Level of School Attending	Not a student	93.5%	95.3%	94.2%
	DAYCARE	.1%	.1%	.1%
	GRADE 9 TO GRADE 12	.2%	.1%	.2%
	TECHNICAL/VOCATION SCHOOL	3.8%	1.9%	3.1%
	2 YEAR COLLEGE (COMMUNITY COLLEGE)	2.0%	.6%	1.4%
	4-YEAR COLLEGE OR UNIVERSITY	.2%	1.9%	.8%
	GRADUATE SCHOOL/PROFESSIONAL	.1%	.1%	.1%
Total		100.0%	100.0%	100.0%

Table 4-7. Type of impairment.

(Percent with each type of Impairment – (Average 1.2 impairments per respondent)

Impairment?	Dallas (DART)	Ft Worth (MITS)	Total
PHYSICAL	70.4%	82.9%	75.2%
MENTAL	16.2%	18.1%	16.9%
SENSORY	25.0%	22.5%	24.0%

Table 4-8. Household size.

		Dallas (DART)	Ft Worth (MITS)	Total
Household Size	1	35.6%	47.9%	40.3%
	2	32.7%	28.9%	31.3%
	3	18.7%	12.7%	16.4%
	4	7.1%	4.8%	6.2%
	5	2.5%	3.6%	2.9%
	6	1.8%	.9%	1.5%
	7	1.1%	.7%	.9%
	8	.5%	.5%	.5%
Total		100.0%	100.0%	100.0%

Table 4-9. Household Income.

		Dallas (DART)	Ft Worth (MITS)	Total
Household Income	$0 - $14,999	59.9%	68.8%	63.3%
	$15,000 - $24,999	16.1%	12.4%	14.7%
	$25,000 - $34,999	6.5%	7.4%	6.8%
	$35,000 - $49,999	3.0%	1.2%	2.3%
	$50,000 - $74,999	2.3%	2.5%	2.4%
	$75,000 - $99,999	.9%	2.7%	1.6%
	$100,000 - $149,000	2.6%	.9%	2.0%
	Refused	8.6%	4.1%	6.9%
Total		100.0%	100.0%	100.0%

Table 4-10. Household vehicles.

		Dallas (DART)	Ft Worth (MITS)	Total
Household Vehicles	0	47.0%	51.3%	48.7%
	1	36.1%	36.0%	36.1%
	2	13.1%	8.6%	11.4%
	3	3.1%	2.1%	2.7%
	4	.1%	1.8%	.8%
	5	.6%		.4%
	8		.1%	.0%
Total		100.0%	100.0%	100.0%

Table 4-11. Number of household licensed drivers.

		Dallas (DART)	Ft Worth (MITS)	Total
Number of Household Licensed Drivers	0	34.4%	33.0%	33.9%
	1	36.9%	40.3%	38.2%
	2	23.0%	21.0%	22.3%
	3	4.7%	3.0%	4.0%
	4	.9%	2.5%	1.5%
	5		.2%	.1%
Total		100.0%	100.0%	100.0%

Table 4-12. Number of household members who are workers.

		Dallas (DART)	Ft Worth (MITS)	Total
Number of Household Members Who Are Workers	0	64.1%	71.5%	66.9%
	1	24.6%	18.0%	22.1%
	2	8.3%	8.4%	8.3%
	3	2.7%	2.0%	2.4%
	4	.4%	.1%	.3%
Total		100.0%	100.0%	100.0%

Table 4-13. Age.

		Dallas (DART)	Ft Worth (MITS)	Total
Age	age 16-44	21.7%	16.0%	19.5%
	age 45-64	39.6%	41.1%	40.2%
	age 65-79	26.6%	28.0%	27.1%
	age 80+	12.2%	14.8%	13.2%
Total		100.0%	100.0%	100.0%

Table 4-14. Years since certification.

		Dallas (DART)	Ft Worth (MITS)	Total
Years Since Certification	Less than 1	18.2%	30.4%	22.8%
	1 to 4.9	63.4%	55.2%	60.3%
	5 to 9.9	13.4%	10.7%	12.4%
	10 or more	5.0%	3.7%	4.5%
Total		100.0%	100.0%	100.0%

Table 4-15. ADA paratransit trips in the last 12 months.

		Dallas (DART)	Ft Worth (MITS)	Total
ADA Paratransit Trips in the Last 12 Months	None		18.4%	7.1%
	1 - 11	36.3%	25.7%	32.2%
	12 - 23	14.9%	16.3%	15.4%
	24 - 59	16.7%	14.7%	16.0%
	60 - 119	8.8%	8.9%	8.8%
	120+	23.3%	16.0%	20.5%
Total		100.0%	100.0%	100.0%

Table 4-16. Mode of trip.

Mode of Trip	DART	MITS	Total
Walk	4.1%	5.0%	4.4%
Wheelchair/Electric Scooter	5.5%	3.2%	4.6%
Automobile / Van/ Truck Driver	3.5%	23.6%	11.0%
Automobile / Van / Truck Passenger	38.4%	29.3%	35.0%
Transit (DART or the T)	2.7%	1.8%	2.3%
DART ADA Paratransit	43.1%	.5%	27.2%
MITS ADA Paratransit	.0%	34.8%	13.0%
Other Specialized Transit or Shuttle Service	1.5%	1.1%	1.4%
Taxi	.6%	.5%	.6%
School Bus	.6%	.1%	.4%
Total	100.0%	100.0%	100.0%

Table 4-17. Purpose of trip.

Purpose	DART	MITS	Total
Working At Home		.2%	.1%
All Other At Home Activities	42.2%	41.0%	41.7%
Work/Job	4.5%	3.6%	4.2%
Other Work/Business Related Activities	.0%	.1%	.1%
Attending Class	2.5%	.5%	1.8%
Other School-Related Activities	.0%		.0%
Change Type of Transportation/Transfer	.7%	.7%	.7%
Dropped Off Passenger From Car	.1%	.0%	.1%
Other Transportation-Related	1.2%	.0%	.7%
Shopping	11.1%	14.0%	12.2%
Other Household Errands	3.6%	4.8%	4.1%
Personal Business	3.1%	2.8%	3.0%
Eat Meal Outside of Home	4.2%	5.7%	4.8%
Dialysis	3.0%	1.6%	2.5%
Other Health Care	10.7%	13.9%	11.9%
Adult Daycare	1.8%	2.9%	2.2%
Civic/Religious Activities	2.1%	1.3%	1.8%
Recreation/Entertainment	4.7%	4.4%	4.6%
Visit Friends/Relatives	4.0%	1.7%	3.2%
Other	.2%	.7%	.4%
Total	100.0%	100.0%	100.0%

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Table 4-18. Total linked trips by all modes reported in two survey days.

Trips	DART	MITS
.00	29.3%	29.9%
1.00	.5%	.6%
2.00	26.6%	26.1%
3.00	2.9%	4.9%
4.00	19.2%	16.4%
5.00	7.1%	5.5%
6.00	4.2%	9.9%
7.00	2.8%	1.9%
8.00	2.6%	2.2%
9.00	1.4%	.8%
10.00	1.7%	1.7%
11.00	1.5%	
12.00	.1%	
13.00		.1%
14.00	.1%	
Total	100.0%	100.0%

Table 4-19. Average linked trips per day (all modes) by gender.

Gender	Dallas (DART)	Ft Worth (MITS)	Total
Male	1.34	1.34	1.34
Female	1.50	1.40	1.46
Total	1.44	1.38	1.42

Table 4-20. Average linked trips per day (all modes) by age.

	Dallas (DART)	Ft Worth (MITS)	Total
age 16-44	2.22	1.83	2.10
age 45-64	1.52	1.31	1.44
age 65-79	.99	1.12	1.04
age 80+	.82	1.61	1.16
Total	1.44	1.38	1.42

Table 4-21. Average linked trips per day (all modes) by whether respondent has a valid driver's license.

Valid Driver's License	Dallas (DART)	Ft Worth (MITS)	Total
YES	1.27	1.55	1.39
NO	1.54	1.24	1.44
Total	1.44	1.38	1.42

Table 4-22. Average linked trips per day (all modes) by employment status.

Employment Status	Dallas (DART)	Ft Worth (MITS)	Total
Employed Full-Time	2.57	2.43	2.52
Employed Part-Time	2.49	1.90	2.27
Not Employed	1.33	1.30	1.32
Total	1.44	1.38	1.42

Table 4-23. Average linked trips per day (all modes) by student status.

Student Status	Dallas (DART)	Ft Worth (MITS)	Total
Yes – Full-Time	2.47	2.95	2.60
Yes – Part-time	2.87	3.79	3.19
No	1.36	1.28	1.33
Total	1.44	1.38	1.42

Table 4-24. Average linked trips per day (all modes) by type of impairment.

	Dallas (DART)	Ft Worth (MITS)	Total
Physical Impairment	1.31	1.34	1.32
Mental Impairment	1.93	1.23	1.64
Sensory Impairment	1.53	1.29	1.44
Total	1.44	1.38	1.42

Table 4-25. Average linked trips per day (all modes) by household size.

Household Size	Dallas (DART)	Ft Worth (MITS)	Total
1	1.24	1.23	1.24
2	1.48	1.39	1.45
3	1.70	1.72	1.70
4	1.78	1.43	1.67
5	1.56	2.24	1.89
6	1.85	1.06	1.65
7	.00	1.25	.34
8	.50	1.48	.86
Total	1.44	1.38	1.42

Table 4-26. Average linked trips per day (all modes) by household income.

Household Income	Dallas (DART)	Ft Worth (MITS)	Total
$0 - $14,999	1.47	1.22	1.36
$15,000 - $24,999	1.48	1.53	1.50
$25,000 - $34,999	1.11	2.08	1.51
$35,000 - $49,999	2.08	.90	1.85
$50,000 - $74,999	1.01	1.86	1.36
$75,000 - $99,999	2.82	2.16	2.40
$100,000 - $149,000	3.03	3.74	3.15
Refused	.75	1.25	.86
Total	1.44	1.38	1.42

Table 4-27. Average linked trips per day (all modes) by number of household vehicles.

Household Vehicles	Dallas (DART)	Ft Worth (MITS)	Total
0	1.27	1.01	1.17
1	1.45	1.71	1.55
2	1.72	2.32	1.89
3	1.98	1.90	1.96
4	2.50	.32	.52
5	5.50	.	5.50
8	.	2.00	2.00
Total	1.44	1.38	1.42

Table 4-28. Average linked trips per day (all modes) by number of household licensed drivers.

Number of Household Licensed Drivers	Dallas (DART)	Ft Worth (MITS)	Total
0	1.34	.95	1.19
1	1.47	1.56	1.50
2	1.44	1.57	1.49
3	2.21	1.70	2.07
4	.59	2.40	1.72
5	.	2.25	2.25
Total	1.44	1.38	1.42

Table 4-29. Average linked trips per day (all modes) by number of household members who are workers.

Number of Household Members Who Are Workers	Dallas (DART)	Ft Worth (MITS)	Total
0	1.23	1.23	1.23
1	1.70	1.51	1.64
2	2.25	2.21	2.24
3	1.74	2.22	1.89
4	1.80	2.00	1.83
Total	1.44	1.38	1.42

Table 4-30. Average linked trips per day (all modes) by years since certification.

Years Since Certification	Dallas (DART)	Ft Worth (MITS)	Total
Less than 1	1.02	1.33	1.18
1 to 4.9	1.54	1.51	1.53
5 to 9.9	1.39	1.07	1.28
10 or more	1.80	.78	1.48
Total	1.44	1.38	1.42

Table 4-31. Average linked trips per day (all modes) by ADA paratransit trips in the last 12 months.

ADA Paratransit Trips in the Last 12 Months	Dallas (DART)	Ft Worth (MITS)	Total
.00	Not applicable	1.37	1.37
1 - 11 trips	1.32	1.59	1.41
12 - 23 trips	1.41	.94	1.22
24 - 59 trips	1.15	1.10	1.13
60 - 119 trips	1.48	1.29	1.41
120+ trips	1.85	1.84	1.85
Total	1.44	1.38	1.42

MITS registrants report taking 23.6% of their trips as a driver, compared to only 3.5% of trips by DART registrants. This seems very high, but is at least somewhat consistent with the fact that many more MITS registrants (45.6%) report having a valid driver's license than DART registrants (34.5%). MITS registrants are also more likely to report themselves as "retired" rather than "disabled/on disability status," more likely to live alone, more likely to be in the lowest income group, and more likely to have registered in the past year. A little over half of driver trips were taken by respondents between the ages of 45 and 64 who are infrequent ADA paratransit users (at least one trip in the past 12 months, but fewer than six trips in the past 3 months). The rest were taken by all types of respondents.

The many driver trips by MITS respondents are also partly due to the weighting procedure. In the raw survey data, about equal numbers of DART and MITS respondents took trips as a driver, but the MITS respondents took about 3 times as many trips as the DART respondents and also had a larger expansion factor.

Abbreviations and Acronyms

ADA	Americans with Disabilities Act
CATI	Computer Aided Telephone Interviewing
DART	Dallas Area Rapid Transit
FWTA	Fort Worth Transportation Authority
HH	household
IPF	Iterative proportional fitting
MITS	Mobility-Impaired Transportation Service (paratransit service of FWTA)
MPO	Metropolitan Planning Organization
NCTCOG	North Central Texas Council of Governments
NHB	Non-home-based
O-D	Origin-Destination
PUMS	Public Use Microsamples
SP	Stated Preference
TAZ	Traffic Analysis Zone or Transportation Analysis Zone
VOT	Value of time

APPENDIX A

Using the ADA Paratransit Travel Models

The body of the report describes the survey data and the estimated choice models of the travel patterns of ADA paratransit users and demonstrates the models' use to predict demand for ADA paratransit in the Dallas/Fort Worth region under different demographic scenarios and ADA paratransit service scenarios. This appendix provides details about the current implementation of the demand models for the Dallas/Ft. Worth region, followed by a discussion of how a similar implementation could be done in other regions.

The current model implementation is programmed in Delphi Pascal, a high-level programming language similar to C++, Java, or Python. The program is a console application that can run under Windows on any PC (or Mac with a Windows emulator). Depending on the user settings, the program will run for the entire region in less than 10 minutes on a typical PC.

The structure of the program code is given below. This information applies to implementing to the Regional Planning Model, referred to here as "Regional Mode." The documentation describes switches that are set in user-created input files that control whether the model runs in Regional Mode or Sketch Mode. To use the model in Sketch Mode, it is probably easier to do this using the Excel spreadsheet interface available from TCRP and described at the end of this appendix.

Program Structure: ADA Paratransit Demand Model Simulation

A. **ReadUseControlInputs:** Reads in the user program control parameters, described below.
B. **ReadZoneData:** Reads in the user-specified input file with zone-level attraction data.
C. **ReadHighwayMatrices:** Reads in user-specified input files with zone-to-zone highway travel times and distances.
D. **ReadTransitMatrices:** Reads in user-specified input files with zone-to-zone scheduled transit travel times, frequencies, and fares. (Optional: The program can be run without these, if specified.)
E. **CalculateAccessibilityMeasures:** Calculates accessibility measures for automobile, walk, and (optionally) scheduled transit from each possible residence zone.

Steps F through I are run only if the user indicates that the models are to be run for the entire regional population ("Regional Mode"). Steps F through I are not run in "Sketch Mode."

F. **ReadCensusTractData:** Reads in a user-specified file with census tract-level socioeconomic distribution data.
G. **CalculateSurveySampleDistribution:** Reads in all survey sample records to calculate a multi-dimensional distribution across expansion variables.

H. **ApplyADARegistrationModel:** Applies the census tract-level model to predict how many residents in each tract are registered as eligible to use ADA paratransit.
I. **ReexpandSurveySampleToTractsAndZones:** Within each census tract, re-expands the survey sample to approximate the specific ADA-registered population within the tract, including allocation to specific residence zones within the tract.
J. **SimulateTravelDay:** This is the main routine in the program. For each member of the survey sample, the following steps are executed:

If "Regional Mode," repeat the steps below for each zone in the region for which the sample member has a positive expansion factor. Otherwise, in "Sketch Mode," just repeat the steps a given number of times specified by the user. (Each sample member can be simulated multiple times to reduce random stochastic simulation error.)

- ApplyTourGenerationModel
  For each generated tour . . .
  - ApplyTourModeChoiceModel
  - ApplyIntermediateStopGenerationModel
  - ApplyTripModeChoiceModel
  - ApplyTripDestinationChoiceModel
- WriteTravelPredictions: This last routine writes the simulation results to user-specified output files that can later be queried and analyzed by the user. Three different files are written: person-day level, tour-level, and trip-level.

The key program inputs are supplied by the user in a control file, as in the example shown in Appendix B, where each line has a six-letter prefix that indicates what the value is used for, followed by the user-supplied value. The comments at the end of each line that follow the // symbol are for documentation purposes.

The first line is simply a run title that the user can supply. The next switch SKETCH controls whether the program is run in "sketch mode or regional mode." RDSEED is the initial seed for the random number generator. If RDSEED is changed, even without changing other inputs, the forecast results will change somewhat because each choice is predicted stochastically as a discrete choice, which requires the use of random draws from the choice model probabilities.

There are two ways to control the amount of random simulation variability, depending on whether the program is run in sketch mode or regional model. If the program is run in sketch mode, each survey sample person can be simulated for multiple different travel days, with the number input on the SKREPT line. Because discrete choices are simulated stochastically, rather than as choice shares, the results contain some random simulation error if each of the 800 survey sample members is simulated only once. Each person can be simulated for many days to "smooth out" the random error. When the choices are written to the results file, the expansion factor is divided by SKREPT, so the total number of expanded simulated choices always remains constant.

Similarly, when the program is run in regional mode, there is a value MINEXP used to control how many times each sample member will be simulated and thus influence runtime and random simulation error. In the example, with MINEXP at 50, when a sample member has an expansion factor for a given zone of 1/50 (=0.02) or greater, it will always be simulated for that zone. If the calculated expansion factor (CALCEXP) is less than 1/MINEXP, then a uniform random number is drawn between 0 and 1, and if the random number is less than CALCEXP / (1/MINEXP), it will be simulated with expansion factor 1/MINEXP; otherwise, the expansion factor is set to 0, and it will not be simulated for that zone. (This is a variant of "bucket rounding" often used in travel demand forecasting.)

The next sets of inputs give the directories and file names for all input and output files to be used by the program. One special switch is USETRN. If no skim matrix files for scheduled transit are available, then this can be set to 0, and the program will not try to read in any files with scheduled transit travel times—instead transit travel time will be approximated as a multiple of automobile travel time.

The last group of input variables is a series of overall demographic or ADA paratransit service scenario variables. These switches were used to run the sensitivity tests reported in the preceding sections.

Transferring the Models to Other Regions

The sketch mode of running the models uses the survey sample "as is," and is thus specific to the Dallas/Ft. Worth region. The regional mode of running the models, however, can be transferred to other regions. To do so, the user needs to provide region-specific versions of the following:

1. *The input census tract data file*: Can be compiled from the US Census website, either from the 2000 Census or from the 2005–2009 American Community Survey (ACS), or, starting in Autumn 2011, from the 2010 Census.
2. *The input zonal data file:* Typically available from the local MPO or another local planning agency.
3. *The input automobile zone-to-zone travel time matrices*: Also typically available from the local MPO or another local planning agency. If congested automobile travel times are not available, a next-best approximation would be to use free-flow travel times to represent all time periods.
4. *The input scheduled walk-to-transit zone-to-zone travel time matrices (optional):* These are sometimes available from the local MPO. If not, it is possible to run the model system without such data.

Most regions are smaller geographically than Dallas/Ft. Worth, which has over 900 census tracts and 5,000 traffic analysis zones. As a result, the model application will generally run in even less time for other regions, compared to about 10 minutes per run for Dallas/Ft. Worth.

The model application program (.EXE file) can be run "as is," without changing or recompiling the source code. If, however, the user has validation data on actual ADA paratransit ridership and wishes to re-calibrate any model coefficients to match the existing ridership, then it may be necessary to modify parameters in the source code.

Transferring the Model Application to Other Software Systems

Relative to most tour-based model microsimulation software, the Pascal code written for this project is simple and straightforward and uses only very standard types of coding (no object-oriented code, assembly language, etc.). Thus, it would be possible to re-program the model application into any network-based software platform that allows record-based data processing and has a flexible scripting language. This certainly includes the main network packages in the US—CUBE, TransCAD, and Visum—and probably includes EMME as well. However, such software platforms require a license which can be costly, and they may not be available to all potential model users.

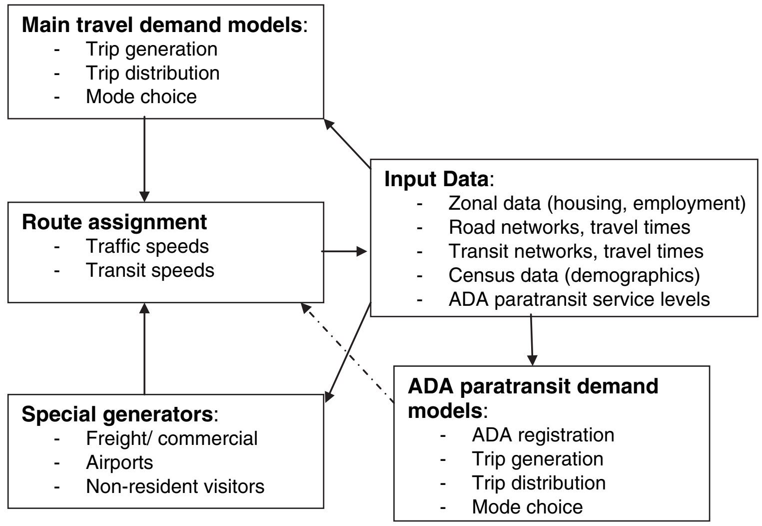


Figure A-1. Diagram of an enhanced regional model framework.

Figure A-1 illustrates how the regional mode of the ADA paratransit demand model could fit into a regional forecasting model framework. Input data includes three main types of data typically used in regional modeling: (1) zone-level data on population, employment, parking, and other relevant variables; (2) zone-to-zone matrix data on travel times and costs for automobiles; and (3) similar matrix data on travel times and costs by transit modes. It also includes (4) census tract-level demographic distributions and (5) ADA paratransit service levels, although such data does not need to vary at a zonal level.

The input data feeds into the main demand models for resident travel, as well as one or more "special generators" for freight and commercial traffic, trips to airports, and sometimes non-resident visitor travel as well. In the route assignment step, the trips predicted by the main models and the special generators are loaded onto the road and transit networks, and new travel flows and speeds on the networks are predicted. These new speeds and travel times are typically fed back into the travel demand models (at least the mode choice model), and (ideally) the whole system is iterated in this way until the predicted trips and speeds remain stable from one iteration to the next. (The diagram is also valid for most new activity-based (AB) model systems, where the activity-based model components reside in the "Main travel demand models" box.)

The new "ADA paratransit demand models" are included at the lower right. These are actually models of travel by ADA-paratransit-eligible people and produce trips by all modes, including ADA paratransit trips, fixed-route transit trips, trips as a passenger in a car, and a small number of trips driving a private vehicle. There are two main ways that ADA paratransit models can fit into this framework.

Integrated as another special generator: In this procedure, the ADA paratransit models are run during the main equilibration loop, just as the other special generators are, and the demand from the ADA paratransit models (both car trips and ADA paratransit trips) are loaded onto the networks for traffic assignment, as indicated by the dashed arrow. (This method could lead to double counting of some trips, because the automobile and scheduled transit trips of all households are already predicted by the main demand models, including households that contain registered ADA paratransit users.)

Run as a post-process: In this mode, the main travel demand models and other special generators are run until equilibrium, and then the resulting automobile and transit travel times are used as input for a single run of the ADA paratransit demand models, with no subsequent route assignment. This mode of using the models is much simpler, particularly if the models are being run by the ADA paratransit agency instead of the MPO. The implicit assumption made is that any changes in network loadings due to changes in travel patterns by registered ADA paratransit users will not noticeably change the traffic speeds in the region. Given that ADA paratransit vehicles and automobiles carrying ADA paratransit users as drivers or passengers are a very minor share of traffic and travelers, this assumption seems valid. We recommend applying the models in this post-process mode. However, it would be possible for any agency to use the models in either manner.

In terms of software for running the models, the model system has been designed as a user-configured executable (EXE) file that can be run from within any of the major network model packages such as CUBE or TransCAD. (Some activity-based model software is run in that same manner.). If used as a post-processor, it is also possible to run the ADA paratransit demand model completely outside of the network model software.

The model system can be run either by the ADA paratransit operator or by the local MPO, whichever seems most efficient. Use of the model will likely require the following:

- Specifying general ADA paratransit-specific parameters for model input, such as travel time factors, fares, and punctuality.
- Providing a census-tract-level file of demographic distributions.
- Executing a run using pre-existing inputs (zonal demographic segmentation and land use data, zone-to-zone travel time, and cost matrices).
- Querying the model output to obtain results in the form of summary tables.

The resulting models are applied with the same inputs used in the regional travel demand models and thus can provide forecasts of ADA paratransit demand at an origin-destination level (and system-wide level) under the following:

- Various ADA paratransit operating scenarios (e.g., fares, service levels, coverage areas).
- Various growth scenarios related to future changes in fuel prices, household size, income, automobile ownership, age distribution, and residential distribution patterns.
- Scenarios related to changes in the service levels and/or coverage of the fixed-route transit system, as well as highway service levels.

Currently, the model only predicts weekday ADA paratransit trips, and not weekend trips. Modeling weekend trips would require collection of additional survey data. Also, we have not modeled trip departure time choice for ADA paratransit users. It would be possible to provide time-of-day distributions by applying fixed time-of-day factors for each trip purpose, but these factors would be based on the observed distributions from our surveys and not be varied.

Using the Sketch Planning Model in Excel

The spreadsheet interface available from TCRP provides a simple way of running the model system in Sketch Mode. Download the file **ADAModel.zip** and unzip the files to a folder on your computer. Make sure you put it in a folder whose complete path name has no spaces in it. For example, you can name your folder “ADAModel” but not “ADA Model” and that folder can be within a folder called “TCRPB-28A” but not “TCRP B-28A” and not within “My Documents.”

Open the spreadsheet **ADAModelRun.xlsm**. On most systems running recent versions of Excel, you will see the warning “Macros have been disabled” as in Figure A-2. Click on the button labeled “Options . . . ,” then in the pop-up window select the radio button “Enable this content,” and then select OK. This enables the macro that will run the demand model when the user presses the “Run Sketch Model” button.

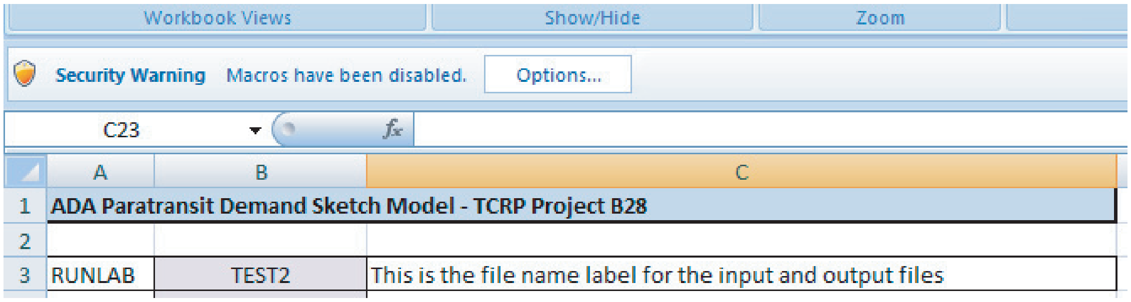


Figure A-2. "Macros have been disabled" warning.

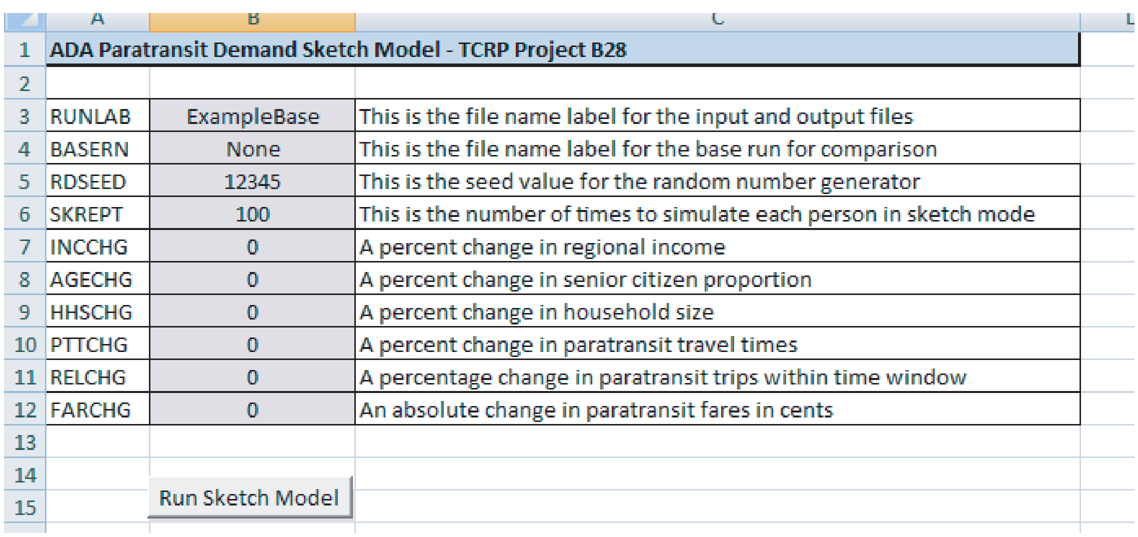
Before running the model, the user should provide input to several fields on the screen. The model is set up so that the user can perform a "base run" and then do a series of runs that test the effect of various changes. For the base run, enter a label of your choice in RUNLAB and enter "None" in BASERN as illustrated in Figure A-3. In the example below, RUNLAB is "ExampleBase." When the model is run, it will then create a results file called "ExampleBase." Once the base run is completed, in the test runs, enter "ExampleBase" (or whatever you named the base run) in BASERN and put a label that describes the change being tested in RUNLAB. For instance, in an example shown in detail later, a run that tests the effect of increasing income levels by 10% has the name "ExampleInc10" in the field for RUNLAB.

The RUNLAB field should always be used, as that provides the label to use to refer to the run and determines the name of the resulting output files. Each time you run the model, it produces a file with a name based on whatever you have specified in the RUNLAB field.

Doing a Base Run

The first step in using the sketch model is to do a base run. Figure A-3 shows how the model might be set up for a base run. RUNLAB has been set to ExampleBase. This will be the name given to the output file created by the base run.

The BASERN field, immediately below RUNLAB, only needs to be filled in if the user wishes to compare the results to the results of an earlier base run. In this case, we are setting up a new base



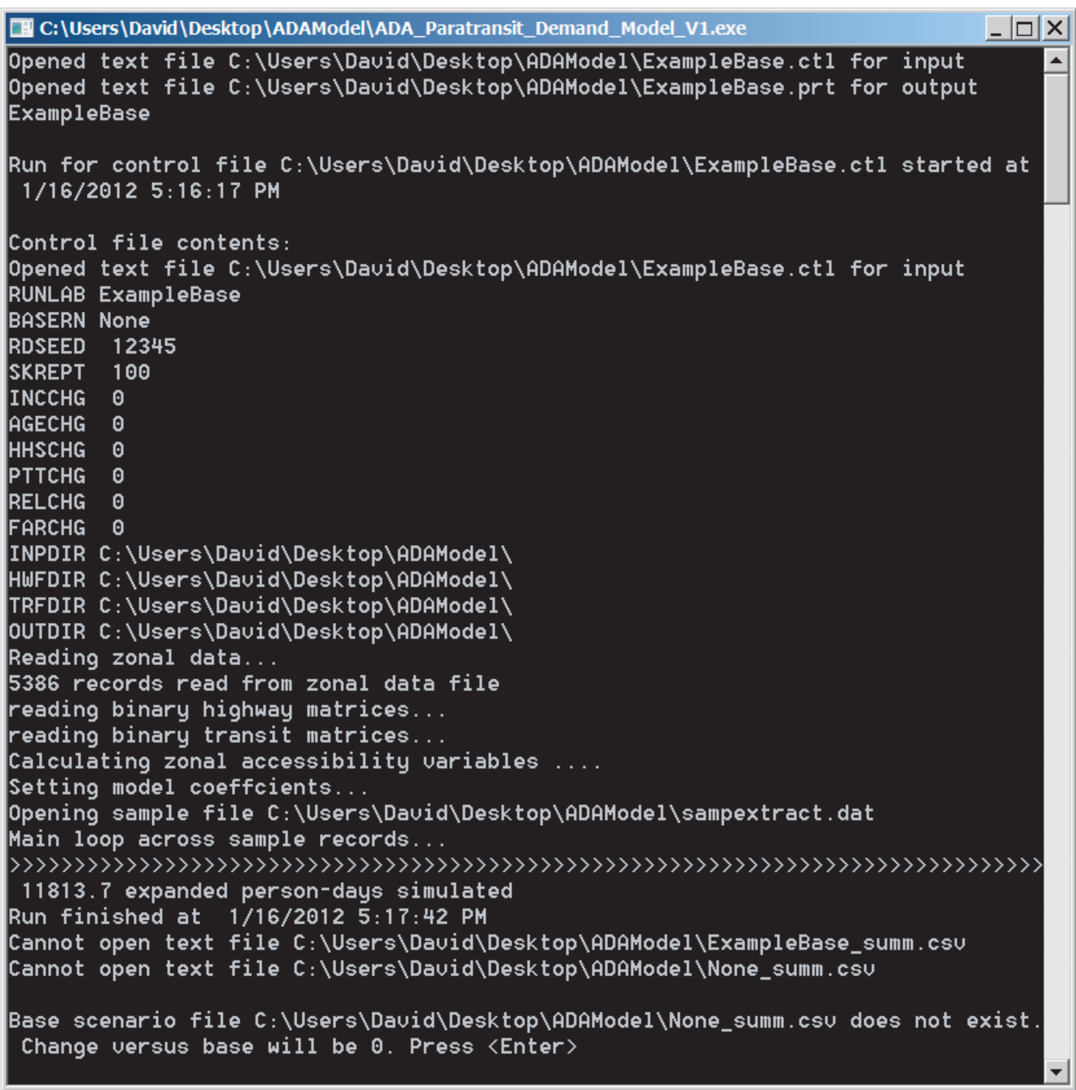
	A	B	C
1	ADA Paratransit Demand Sketch Model - TCRP Project B28		
2			
3	RUNLAB	ExampleBase	This is the file name label for the input and output files
4	BASERN	None	This is the file name label for the base run for comparison
5	RDSEED	12345	This is the seed value for the random number generator
6	SKREPT	100	This is the number of times to simulate each person in sketch mode
7	INCCHG	0	A percent change in regional income
8	AGECHG	0	A percent change in senior citizen proportion
9	HHSCHG	0	A percent change in household size
10	PTTCHG	0	A percent change in paratransit travel times
11	RELCHG	0	A percentage change in paratransit trips within time window
12	FARCHG	0	An absolute change in paratransit fares in cents
13			
14			
15		Run Sketch Model	

Figure A-3. Performing a base run.

run in ExampleBase, so BASERN is set to “None.” In a base run, policy changes for income, age, household size, and ADA paratransit service levels are typically all left at 0, as in the screen above.

The final two user inputs for a base run are RDSEED and SKREPT. RDSEED is the seed for the random number generator used in the simulation. It can be any arbitrary value, such “12345” as shown in the example, but should be the same for a base run and later runs to determine the effect of policy changes, because changing the random number sequence can change the results somewhat, even if no other inputs are changed. The SKREPT value determines the number of model replications run for each member of the proto-typical sample used to run the model. In the example, SKREPT has been set to 100. The higher the number, the longer the program will take to run, but the less influence that random variability will have on the results. Thus, a lower number of replications can be used for initial, more exploratory runs and more replications if one wants results with a lower margin of error.

After the RunSketchModel button is pressed, the model starts to run, and a console-type window, such as shown in Figure A-4, pops up to report the progress of the run. If there are no errors, the window will disappear when the model is done running, and the model results will



```
C:\Users\David\Desktop\ADAModel\ADA_Paratransit_Demand_Model_V1.exe
Opened text file C:\Users\David\Desktop\ADAModel\ExampleBase.ctl for input
Opened text file C:\Users\David\Desktop\ADAModel\ExampleBase.prt for output
ExampleBase

Run for control file C:\Users\David\Desktop\ADAModel\ExampleBase.ctl started at
 1/16/2012 5:16:17 PM

Control file contents:
Opened text file C:\Users\David\Desktop\ADAModel\ExampleBase.ctl for input
RUNLAB ExampleBase
BASERN None
RDSEED  12345
SKREPT  100
INCCHG  0
AGECHG  0
HHSCHG  0
PTTCHG  0
RELCHG  0
FARCHG  0
INPDIR C:\Users\David\Desktop\ADAModel\
HWFDIR C:\Users\David\Desktop\ADAModel\
TRFDIR C:\Users\David\Desktop\ADAModel\
OUTDIR C:\Users\David\Desktop\ADAModel\
Reading zonal data...
5386 records read from zonal data file
reading binary highway matrices...
reading binary transit matrices...
Calculating zonal accessibility variables ....
Setting model coeffcients...
Opening sample file C:\Users\David\Desktop\ADAModel\sampextract.dat
Main loop across sample records...
>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
 11813.7 expanded person-days simulated
Run finished at  1/16/2012 5:17:42 PM
Cannot open text file C:\Users\David\Desktop\ADAModel\ExampleBase_summ.csv
Cannot open text file C:\Users\David\Desktop\ADAModel\None_summ.csv

Base scenario file C:\Users\David\Desktop\ADAModel\None_summ.csv does not exist.
 Change versus base will be 0. Press <Enter>
```

Figure A-4. Report of model progress.

appear automatically in Excel. In the example case, there is no base run name provided, so the program gives a message that the Base scenario 'None' does not exist, and waits for the user to press Enter before returning to Excel. (This warning message is primarily intended for cases where the user intended to provide the name of a valid base run, but that base run cannot be found in the working directory.)

When the model is done running, it writes out numerical results in a file named **RUNLAB_summ.csv**, where **RUNLAB** is the run name provided by the user. So, in this example, the results are in **ExampleBase_summ.csv.** The Excel macro then creates standard tables and charts based on those numbers and saves the results to a file named **RUNLAB_summ.xlsx** (in this case, **ExampleBase_summ.xlsx**). At that point, the user can further edit the tables and graphs if desired, just as in any Excel spreadsheet.

The macro creates the following standard tables and graphs:

- Trips by tour purpose and mode.
- Trips by trip destination purpose and mode (similar to the tour table, but based on each trip, with an extra purpose 'return home').
- Trips by gender/age group combination and mode.
- Trips by main occupation (worker, student, other) and mode.
- Trips by impairment type (physical, mental, sensory, multiple) and mode.
- Trips by household type (numbers of persons and vehicles) and mode.
- Trips by household income group and mode.
- Trips by area type (in terms of accessibility of nearby attractions) and mode.

The following pages show examples for the first set of tables and graphs. In Figure A-5, the tables first show the predicted number of trips, and then show them with percents within rows (mode shares within purpose) and percents within columns (purpose distributions within modes).

In Figure A-6, the first chart shows the number of trips by both mode and purpose in a 3-dimensional graph, while the second chart shows mode share within purpose as a percentage bar chart.

A final table and graph within each set show the percentage change relative to the base scenario, but in this case there is no base scenario, so those are empty.

At the bottom of the **.xslx** (and **.csv**) file is a copy of the run settings, as shown in Figure A-7. This is mainly for documentation purposes, so the user can remember which inputs produced a specific set of outputs.

Testing Policy or Demographic Changes

The values that can be entered for policy changes represent percentages, except for fare change, but must be entered as whole positive or negative numbers *without a percentage sign.* They are as follows:

INCCHG: A percentage increase in household income. For example, a 10% increase would be entered as 10. The fraction of households in each census tract with income below the poverty level is decreased by INCCHG, and the median income in each census tract is increased by the same amount. Also, the expansion factor for any sample members in the lowest income category (less than $15K) is decreased by this same percentage relative to the rest of the sample.

AGECHG: The fraction of the population in all age groups over age 60 is increased by the percentage entered in AGECHG. (Do not enter a percentage sign.) Also, the expansion factor

4	Trips by tour purpose and mode							
5	Count	ADA paratransit	special transit	scheduled transit	car-shared ride	car-drive alone	walk/ wheelchair	Total
6	Medical / dialysis	1211.1	216.4	158.3	2116.3	398.8	567.6	4668.6
7	Work	865.5	17.7	16.4	396.6	31.7	114.6	1442.5
8	School	217.9	15	8.5	114.8	9.5	38.1	403.7
9	Adult daycare	277.6	1.3	4.1	375.8	40.4	75.5	774.8
10	Shopping	312.2	19.1	193.7	2216.8	440.8	623.3	3805.9
11	Personal business	451.8	9.8	70.7	952	114.9	352.1	1951.3
12	Recreation	289.9	4.6	46.3	816.5	101.6	195.4	1454.3
13	Social visit	62	2	25.8	261.2	36.9	64.9	452.8
14	Total	3688.1	285.9	523.7	7250.1	1174.6	2031.5	14954
15								
16	Trips by tour purpose and mode							
17	Row %	ADA paratransit	special transit	scheduled transit	car-shared ride	car-drive alone	walk/ wheelchair	Total
18	Medical / dialysis	25.90%	4.60%	3.40%	45.30%	8.50%	12.20%	100.00%
19	Work	60.00%	1.20%	1.10%	27.50%	2.20%	7.90%	100.00%
20	School	54.00%	3.70%	2.10%	28.40%	2.30%	9.40%	100.00%
21	Adult daycare	35.80%	0.20%	0.50%	48.50%	5.20%	9.70%	100.00%
22	Shopping	8.20%	0.50%	5.10%	58.20%	11.60%	16.40%	100.00%
23	Personal business	23.20%	0.50%	3.60%	48.80%	5.90%	18.00%	100.00%
24	Recreation	19.90%	0.30%	3.20%	56.10%	7.00%	13.40%	100.00%
25	Social visit	13.70%	0.50%	5.70%	57.70%	8.10%	14.30%	100.00%
26	Total	24.70%	1.90%	3.50%	48.50%	7.90%	13.60%	100.00%
27								
28	Trips by tour purpose and mode							
29	Column %	ADA paratransit	special transit	scheduled transit	car-shared ride	car-drive alone	walk/ wheelchair	Total
30	Medical / dialysis	32.80%	75.70%	30.20%	29.20%	33.90%	27.90%	31.20%
31	Work	23.50%	6.20%	3.10%	5.50%	2.70%	5.60%	9.60%
32	School	5.90%	5.20%	1.60%	1.60%	0.80%	1.90%	2.70%
33	Adult daycare	7.50%	0.50%	0.80%	5.20%	3.40%	3.70%	5.20%
34	Shopping	8.50%	6.70%	37.00%	30.60%	37.50%	30.70%	25.50%
35	Personal business	12.20%	3.40%	13.50%	13.10%	9.80%	17.30%	13.00%
36	Recreation	7.90%	1.60%	8.80%	11.30%	8.60%	9.60%	9.70%
37	Social visit	1.70%	0.70%	4.90%	3.60%	3.10%	3.20%	3.00%
38	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
39								

Figure A-5. Model tabular output.

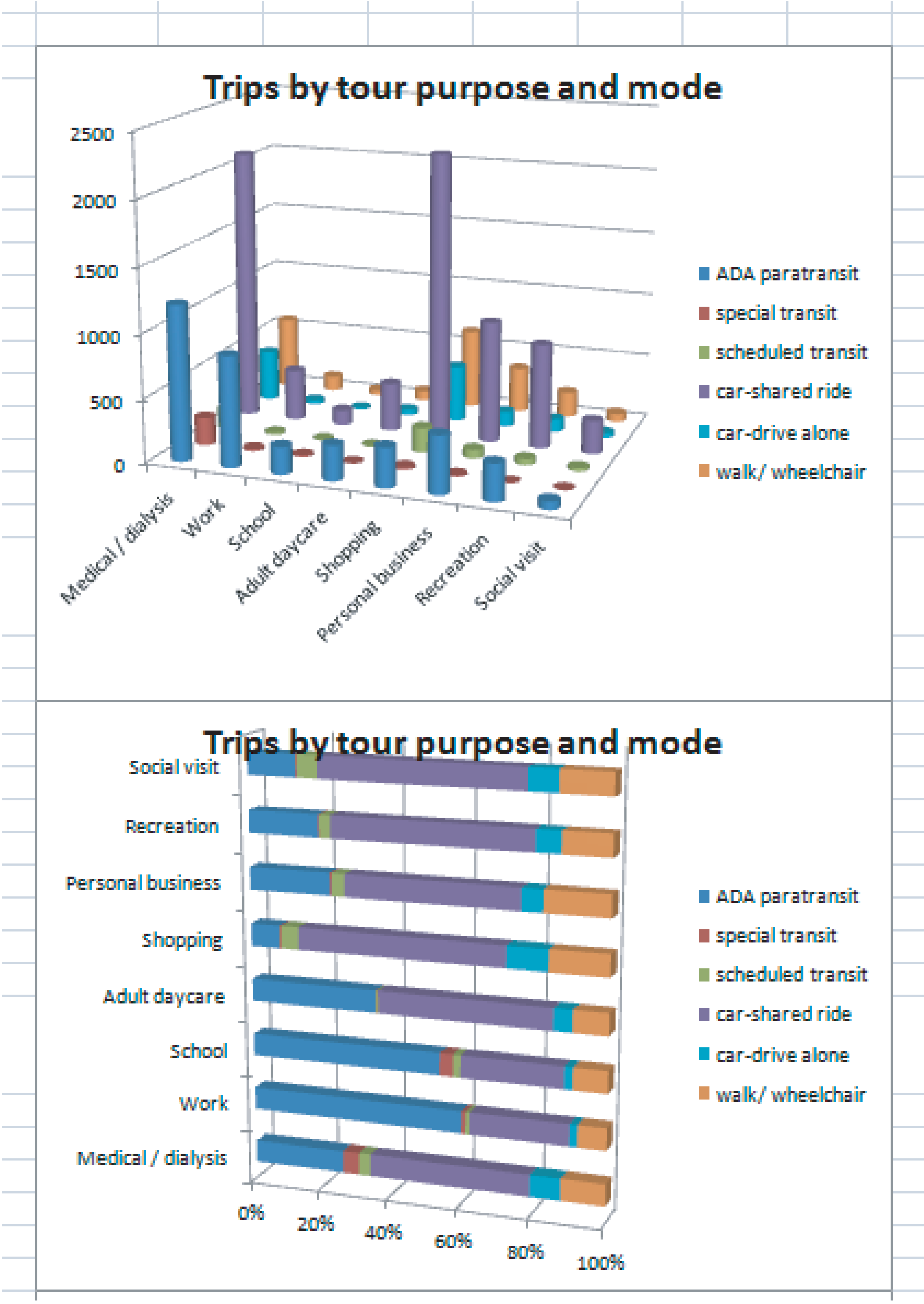
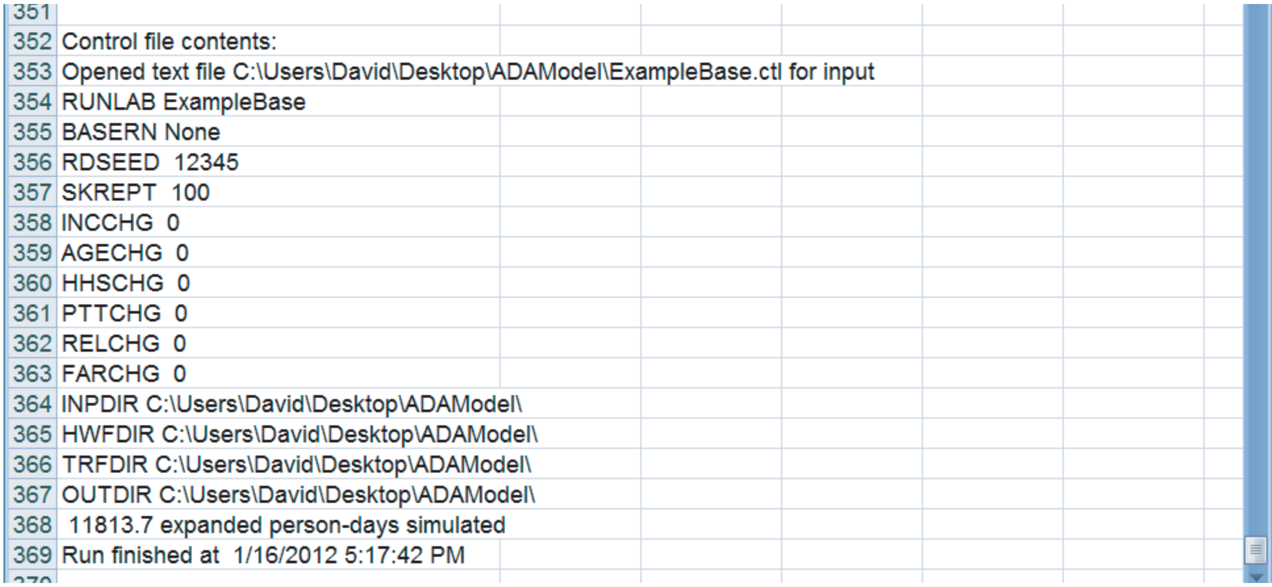


Figure A-6. Model graphical output.



351	
352	Control file contents:
353	Opened text file C:\Users\David\Desktop\ADAModel\ExampleBase.ctl for input
354	RUNLAB ExampleBase
355	BASERN None
356	RDSEED 12345
357	SKREPT 100
358	INCCHG 0
359	AGECHG 0
360	HHSCHG 0
361	PTTCHG 0
362	RELCHG 0
363	FARCHG 0
364	INPDIR C:\Users\David\Desktop\ADAModel\
365	HWFDIR C:\Users\David\Desktop\ADAModel\
366	TRFDIR C:\Users\David\Desktop\ADAModel\
367	OUTDIR C:\Users\David\Desktop\ADAModel\
368	11813.7 expanded person-days simulated
369	Run finished at 1/16/2012 5:17:42 PM

Figure A-7. Output with summary of run settings.

for any sample members over age 60 is increased by the percentage relative to the other sample members.

HHSCHG: The fraction of the households in each census tract that are single-person households is increased by the percentage entered in HHSCHG, and the average household size in each tract is decreased by the same percentage. Also, the expansion factor for all sample members in single-person households is increased by the same percentage relative to the other sample members.

PTTCHG: The travel time by ADA paratransit relative to travel time by car for each trip is increased by the percentage entered in PTTCHG.

RELCHG: The likelihood of a pick-up or drop-off being late is increased by the percentage entered in RELCHG.

FARCHG: The ADA paratransit fare for each trip is increased by the amount (not a percentage) entered in FARCHG in cents (e.g., a $1.00 fare increase would be entered as 100).

Figure A-8 shows the input for a run done for a scenario with a 10% increase in regional income, to be compared to the base case run done above. Only the values for RUNLAB, BASERN and INCCHG are changed from the previous (base) run.

The output now includes the same tables as before, plus values for the change with respect to the base scenario, as shown in Figures A-9 and A-10. In this case, increasing regional income by 10% reduces the number of total trips by about 2%, but that change is very different for certain purposes, such as work tours (a 9% increase), and for certain modes, such as scheduled transit (a 5% drop).

	A	B	C
1	**ADA Paratransit Demand Sketch Model - TCRP Project B28**		
2			
3	RUNLAB	ExampleInc10	The file name label for the input and output files
4	BASERN	ExampleBase	The file name label for the base run for comparison
5	RDSEED	12345	The seed value for the random number generator
6	SKREPT	100	The number of times to simulate each person in sketch mode
7	INCCHG	10	A percent change in regional income and households above the poverty level
8	AGECHG	0	A percent change in the proportion of the population over age 60
9	HHSCHG	0	A percent change in household size and household with more than 1 person
10	PTTCHG	0	A percent change in paratransit travel times
11	RELCHG	0	A percent change in paratransit trips that are late (outside time window)
12	FARCHG	0	An absolute change in paratransit fares in cents
13			

Figure A-8. Model input for a scenario testing run.

39								
40	Trips by tour purpose and mode							
41	% Change vs. Base %	ADA paratransit	special transit	scheduled transit	car-shared ride	car-drive alone	walk/ wheelchair	Total
42	Medical / dialysis	3.40%	-6.60%	-3.90%	4.50%	2.50%	-2.20%	2.40%
43	Work	9.40%	3.40%	5.60%	11.30%	1.50%	4.70%	9.30%
44	School	3.80%	-4.70%	-5.20%	4.80%	9.80%	-2.50%	3.20%
45	Adult daycare	-1.80%	-2.80%	-8.10%	-2.80%	-2.00%	-5.50%	-2.70%
46	Shopping	0.10%	-8.10%	-6.30%	0.80%	-0.50%	-5.30%	-0.80%
47	Personal business	1.40%	-8.00%	-5.70%	1.60%	1.60%	-5.10%	0.00%
48	Recreation	3.50%	-6.00%	-3.40%	5.80%	2.20%	-1.60%	3.70%
49	Social visit	-0.10%	-3.10%	-5.10%	1.20%	-2.30%	-5.90%	-0.60%
50	Total	3.90%	-6.00%	-4.80%	3.00%	1.00%	-3.50%	1.70%
51								

Figure A-9. Sample of tabular output for a scenario testing run.

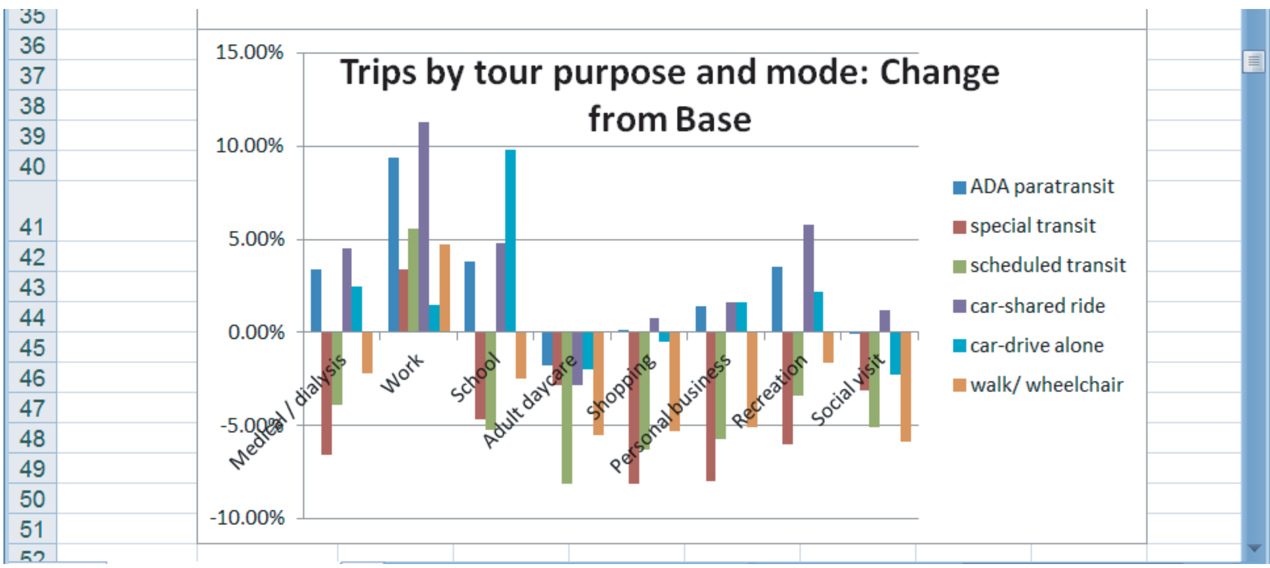


Figure A-10. Sample of graphical output for a scenario testing run.

APPENDIX B

File Specifications

Example User Control Input File

- RUNAME The user can put in text here that is the title of the run

- SKETCH 1 // If this is >0, it runs in “sketch” mode, otherwise in “regional” mode
- RDSEED 12323 // This is the seed value for the random number generator
- SKREPT 50 // This is the number of times to simulate each person in sketch mode
- MINEXP 50 // This is the minimum expansion factor for regional mode, as 1/N

- INPDIR c:\user\input\ // The directory path where most input files are located
- ZONEFN zonedata07.dat // The file name of the input zonal data file
- TRCTFN tractvars.dat // The file name of the input census tract data file
- SAMPFN sampextract.dat // The file name of the survey sample data file

- HWFDIR c:\user\2007_highway\ // The directory path for highway files
- AMHWFN amsov.dat // The file name of the AM peak SOV matrix file
- PMHWFN pmsov.dat // The file name of the PM peak SOV matrix file
- OPHWFN opsov.dat // The file name of the off-peak SOV matrix file

- USETRN 1 // This controls whether transit matrices are used
- TRFDIR c:\user\2007_transit\ // The directory path for transit files
- AMTRFN amtran.dat // The file name of the AM peak transit matrix file
- OPTRFN optran.dat // The file name of the off-peak transit matrix file

- OUTDIR c:\output\ // The directory path where output files are to be written
- PRNTFN print.dat // The file name of the output print/message file
- PDAYFN adapersout.dat // The file name of the person-day results data file
- TOURFN adatourout.dat // The file name of the tour level results data file
- TRIPFN adatripout.dat // The file name of the trip level results data file

- INCCHG 0 // A percent change in regional income, for scenario testing
- AGECHG 0 // A percent change in senior citizen proportion, for scenario testing
- HHSCHG 0 // A percent change in household size, for scenario testing
- PTTCHG 0 // A percent change in paratransit travel times, for scenario testing
- FARCHG 0 // An absolute change in paratransit fares in cents, for scenario testing
- RELCHG 0 // An absolute change in paratransit punctuality, in trips/20, for scenario testing

Output Files

The output files are space-delimited ASCII files with a header record and can be easily read into analysis software. SPSS syntax is shown to read in each of the data files, along with some tables generated in the analysis:

- The person-day file: The first group of tables just shows the distribution of the expanded regional sample along a number of household and person characteristics. The second table shows the mean number of predicted tours per day, ADA paratransit trips per day, and ADA paratransit miles per day, along those same person and household dimensions. Note that the walk accessibility measure for the residence zone is also written to the output file, and this variable can be used to create an area type variable.
- The tour file: The tables created from this file show the tour purpose split, tour mode split, tour complexity (number of trips) along a number of household and person dimensions.
- The trip file: The tables from this file tabulate the trip purpose and mode against the tour purpose and mode, respectively. These tables show the hierarchy and dependency between the tour main purpose and mode and the trip purpose and mode. Note that the tables for trip origin purpose and trip destination purpose are identical, because during a tour each stop is a trip origin and a trip destination exactly once. The trip distance and auto travel time are also written to the trip file, and can be used in analysis as well.

Example SPSS syntax to analyze the output results files and resulting tables

1. **Person-day level output**

- GET DATA
- /TYPE=TXT
- /FILE="C:\Users\Mark\Documents\Paratransit\adapersout.dat"
- /DELCASE=LINE
- /DELIMITERS=" "
- /ARRANGEMENT=DELIMITED
- /FIRSTCASE=2
- /IMPORTCASE=ALL
- /VARIABLES=
- SAMPN F7.0
- GEND F1.0
- AGE F2.0
- LIC F1.0
- EMPLY F1.0
- STUD F1.0
- PHYSIMP F1.0
- MENTIMP F1.0
- SENSIMP F1.0
- HHSIZ F1.0
- INCOME F1.0
- HHVEH F1.0

- HHLIC F1.0
- HHWRK F1.0
- HHSTU F1.0
- resarea F1.0
- restract F9.0
- restsz F5.0
- autoacc F7.4
- walkacc F7.4
- expfact F6.4
- numtours F1.0
- adatrips F1.0
- adamiles F4.1.
- CACHE.
- EXECUTE.
- DATASET NAME DataSet1 WINDOW=FRONT.
-
- compute areatyp=1.
- if walkacc>=7.5 areatyp=2.
- if walkacc>=8.4 areatyp=3.
- if walkacc>=9.2 areatyp=4.
-
- compute agegrp=1.
- if age>34 agegrp=2.
- if age>49 agegrp=3.
- if age>64 agegrp=4.
- if age>74 agegrp=5.
-
- weight by expfact.
-
- variable labels
- sampn 'Sample number'/
- gend 'Gender'/
- age 'Age'/
- lic 'Valid Drivers License'/
- emply 'Employment Status'/
- stud 'Student Status'/
- physimp 'Physical impairment?'/
- mentimp 'Mental impairment?'/
- sensimp 'Sensory impairment?'/
- hhsiz 'Household Size'/
- income 'Household Income'/
- hhveh 'Household Vehicles'/
- hhlic 'Number of Household licensed drivers'/
- hhwrk 'Number of household members who are workers'/
- hhstu 'Number of Household students'/
- resarea 'Residence service area'/
- restract 'Residence census tract'/

- restsz 'Residence TAZ number NCTCOG'/
- autoacc 'Residence auto accessibility'
- walkacc 'Residence walk accessibility'/
- expfact 'Expansion factor'/
- numtours 'Number of tours per day'/
- adatrips 'ADA paratransit trips per day'/
- adamiles 'ADA paratransit miles per day'/
- areatyp 'Residence area type'/
- agergrp 'Age group'.
-
- value labels
- gend 1 'male' 2 'female'/
- age 999 'refused'/
- lic physimp mentimp sensimp 0 'no' 1 'yes' 2 'no' 9 'refused'/
- emply stud 1 'full time' 2 'part time' 3 'no' 9 'refused'/
- hhsiz hhveh 98 'dk' 99 'refused'/
- income 1 '$0 - 15k' 2 '$15 - 25k' 3 '$25 - 35k' 4 '$35 - 50k' 5 '$50 - 75k' 6 '$75 - 100k' 7 '$100 - 15k0' 8 '$over 150k' 99 'refused'/
- resarea 1 'DART' 2 'MITS'/
- areatyp 1 'low walk acc' 2 'medium walk acc' 3 'high walk acc' 4 'very high walk acc'/
- agegrp 1 '17 - 34' 2 '35 - 49' 3 '50 - 64' 4 '65 - 74' 5 '75 up'.
-
- freq gend to resarea areatyp.
-
- means numtours to adamiles by areatyp agegrp gend to resarea.
-

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	3968	33.6	33.6	33.6
	female	7845	66.4	66.4	100.0
	Total	11813	100.0	100.0	

-
-

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	17	9	.1	.1	.1
	18	8	.1	.1	.1
	19	79	.7	.7	.8
	20	21	.2	.2	1.0
	21	33	.3	.3	1.3
	22	87	.7	.7	2.0
	23	78	.7	.7	2.7

24	101	.9	.9	3.5
25	49	.4	.4	3.9
26	140	1.2	1.2	5.1
27	118	1.0	1.0	6.1
28	89	.8	.8	6.9
29	119	1.0	1.0	7.9
30	54	.5	.5	8.3
31	81	.7	.7	9.0
32	67	.6	.6	9.6
33	36	.3	.3	9.9
34	27	.2	.2	10.1
35	70	.6	.6	10.7
36	111	.9	.9	11.7
37	14	.1	.1	11.8
38	66	.6	.6	12.3
39	217	1.8	1.8	14.2
40	109	.9	.9	15.1
41	26	.2	.2	15.3
42	149	1.3	1.3	16.6
43	121	1.0	1.0	17.6
44	198	1.7	1.7	19.3
45	158	1.3	1.3	20.6
46	269	2.3	2.3	22.9
47	146	1.2	1.2	24.1
48	111	.9	.9	25.1
49	167	1.4	1.4	26.5
50	127	1.1	1.1	27.6
51	185	1.6	1.6	29.1
52	218	1.8	1.8	31.0
53	139	1.2	1.2	32.1
54	261	2.2	2.2	34.4
55	180	1.5	1.5	35.9
56	252	2.1	2.1	38.0
57	130	1.1	1.1	39.1
58	231	2.0	2.0	41.1
59	304	2.6	2.6	43.6
60	445	3.8	3.8	47.4
61	370	3.1	3.1	50.5

62	392	3.3	3.3	53.9
63	256	2.2	2.2	56.0
64	401	3.4	3.4	59.4
65	165	1.4	1.4	60.8
66	180	1.5	1.5	62.3
67	425	3.6	3.6	65.9
68	251	2.1	2.1	68.1
69	238	2.0	2.0	70.1
70	210	1.8	1.8	71.9
71	123	1.0	1.0	72.9
72	167	1.4	1.4	74.3
73	182	1.5	1.5	75.9
74	158	1.3	1.3	77.2
75	272	2.3	2.3	79.5
76	184	1.6	1.6	81.1
77	56	.5	.5	81.5
78	258	2.2	2.2	83.7
79	224	1.9	1.9	85.6
80	172	1.5	1.5	87.1
81	111	.9	.9	88.0
82	151	1.3	1.3	89.3
83	292	2.5	2.5	91.8
84	83	.7	.7	92.5
85	96	.8	.8	93.3
86	44	.4	.4	93.7
87	107	.9	.9	94.6
88	96	.8	.8	95.4
89	119	1.0	1.0	96.4
90	217	1.8	1.8	98.2
91	35	.3	.3	98.5
92	119	1.0	1.0	99.5
94	11	.1	.1	99.6
refused	45	.4	.4	100.0
Total	11813	100.0	100.0	

➢

➢

Valid Drivers License

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	4575	38.7	38.7	38.7
	no	7238	61.3	61.3	100.0
	Total	11813	100.0	100.0	

Employment Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	full time	600	5.1	5.1	5.1
	part time	536	4.5	4.5	9.6
	no	10677	90.4	90.4	100.0
	Total	11813	100.0	100.0	

Student Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	full time	342	2.9	2.9	2.9
	part time	343	2.9	2.9	5.8
	no	11128	94.2	94.2	100.0
	Total	11813	100.0	100.0	

Physical impairment?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	2923	24.7	24.7	24.7
	yes	8890	75.3	75.3	100.0
	Total	11813	100.0	100.0	

Mental impairment?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	9813	83.1	83.1	83.1
	yes	2000	16.9	16.9	100.0
	Total	11813	100.0	100.0	

Sensory impairment?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	8976	76.0	76.0	76.0
	yes	2837	24.0	24.0	100.0
	Total	11813	100.0	100.0	

Household Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4766	40.3	40.3	40.3
	2	3693	31.3	31.3	71.6
	3	1935	16.4	16.4	88.0
	4	735	6.2	6.2	94.2
	5	345	2.9	2.9	97.1
	6	173	1.5	1.5	98.6
	7	111	.9	.9	99.5
	8	56	.5	.5	100.0
	Total	11813	100.0	100.0	

Household Vehicles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5749	48.7	48.7	48.7
	1	4262	36.1	36.1	84.7
	2	1343	11.4	11.4	96.1
	3	319	2.7	2.7	98.8
	4	90	.8	.8	99.6
	5	44	.4	.4	100.0
	8	5	.0	.0	100.0
	Total	11813	100.0	100.0	

Number of Household licensed drivers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4005	33.9	33.9	33.9
	1	4516	38.2	38.2	72.1
	2	2627	22.2	22.2	94.4
	3	473	4.0	4.0	98.4
	4	181	1.5	1.5	99.9
	5	10	.1	.1	100.0
	Total	11813	100.0	100.0	

Number of household members who are workers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	7905	66.9	66.9	66.9
	1	2606	22.1	22.1	89.0
	2	980	8.3	8.3	97.3
	3	286	2.4	2.4	99.7
	4	36	.3	.3	100.0
	Total	11813	100.0	100.0	

Number of Household students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	9299	78.7	78.7	78.7
	1	1879	15.9	15.9	94.6
	2	284	2.4	2.4	97.0
	3	280	2.4	2.4	99.4
	4	13	.1	.1	99.5
	5	53	.4	.4	100.0
	6	5	.0	.0	100.0
	Total	11813	100.0	100.0	

Residence service area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	DART	7314	61.9	61.9	61.9
	MITS	4499	38.1	38.1	100.0
	Total	11813	100.0	100.0	

Residence area type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	low walk acc	2305	19.5	19.5	19.5
	medium walk acc	4170	35.3	35.3	54.8
	high walk acc	3835	32.5	32.5	87.3
	very high walk acc	1503	12.7	12.7	100.0
	Total	11813	100.0	100.0	

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Residence area type

Statistics=Mean

Residence area type	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
low walk acc	.49	.31	3.744
medium walk acc	.50	.31	3.120
high walk acc	.51	.30	2.600
very high walk acc	.52	.29	2.116
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * agegrp

Statistics=Mean

Age group	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
17 - 34	.93	.71	7.062
35 - 49	.60	.37	3.558
50 - 64	.50	.29	2.785
65 - 74	.30	.18	1.777
75 up	.39	.19	1.820
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Gender

Statistics=Mean

Gender	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
male	.50	.30	2.935
female	.51	.31	2.950
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Valid Drivers License

Statistics=Mean

Valid Drivers License	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
yes	.43	.19	1.833
no	.55	.37	3.648
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Employment Status

Statistics=Mean

Employment Status	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
full time	1.13	1.15	11.397
part time	.88	.88	8.573
no	.45	.23	2.188
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Student Status

Statistics=Mean

Student Status	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
full time	.89	.75	7.495
part time	.76	.58	5.693
no	.48	.28	2.721
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Physical impairment?

Statistics=Mean

Physical impairment?	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
no	.61	.41	4.000
yes	.47	.27	2.598
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Mental impairment?

Statistics=Mean

Mental impairment?	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
no	.47	.26	2.545
yes	.64	.50	4.910
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Sensory impairment?

Statistics=Mean

Sensory impairment?	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
no	.50	.32	3.129
yes	.51	.24	2.362
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Household Size

Statistics=Mean

Household Size	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
1	.42	.25	2.429
2	.49	.28	2.711
3	.62	.40	3.861
4	.76	.51	4.963
5	.61	.35	3.271
6	.58	.39	3.671
7	.34	.11	1.345
8	.53	.36	3.154
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Household Vehicles

Statistics=Mean

Household Vehicles	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
0	.44	.31	2.982
1	.52	.24	2.332
2	.64	.40	3.952
3	.83	.69	6.750
4	.47	.22	1.947
5	.45	.03	.394
8	1.05	1.10	10.249
Total	.50	.30	2.945

Number of tours per day, ADA paratransit trips per day, ADA paratransit miles per day * Residence service area

Statistics=Mean

Residence service area	Number of tours per day	ADA paratransit trips per day	ADA paratransit miles per day
DART	.51	.32	3.089
MITS	.49	.28	2.712
Total	.50	.30	2.945

2. Tour level output

- GET DATA
- /TYPE=TXT
- /FILE="C:\Users\Mark\Documents\Paratransit\adatourout.dat"
- /DELCASE=LINE
- /DELIMITERS=" "
- /ARRANGEMENT=DELIMITED
- /FIRSTCASE=2
- /IMPORTCASE=ALL
- /VARIABLES=
- SAMPN F7.0
- GEND F1.0
- AGE F2.0
- LIC F1.0
- EMPLY F1.0
- STUD F1.0
- PHYSIMP F1.0
- MENTIMP F1.0
- SENSIMP F1.0
- HHSIZ F1.0
- INCOME F1.0
- HHVEH F1.0
- HHLIC F1.0
- HHWRK F1.0
- HHSTU F1.0
- resarea F1.0
- restract F9.0
- restsz F5.0
- autoacc F7.4
- walkacc F7.4
- expfact F6.4
- numtours F1.0
- adatrips F1.0
- adamiles F5.1
- tourn F1.0
- tourpurp F1.0

```
tourmode F1.0
tourtrips F1.0.
CACHE.
EXECUTE.
DATASET NAME DataSet2 WINDOW=FRONT.

compute areatyp=1.
if walkacc>=7.5 areatyp=2.
if walkacc>=8.4 areatyp=3.
if walkacc>=9.2 areatyp=4.

compute agegrp=1.
if age>34 agegrp=2.
if age>49 agegrp=3.
if age>64 agegrp=4.
if age>74 agegrp=5.

weight by expfact.

variable labels
sampn 'Sample number'/
gend 'Gender'/
age 'Age'/
lic 'Valid Drivers License'/
emply 'Employment Status'/
stud 'Student Status'/
physimp 'Physical impairment?'/
mentimp 'Mental impairment?'/
sensimp 'Sensory impairment?'/
hhsiz 'Household Size'/
income 'Household Income'/
hhveh 'Household Vehicles'/
hhlic 'Number of Household licensed drivers'/
hhwrk 'Number of household members who are workers'/
hhstu 'Number of Household students'/
resarea 'Residence service area'/
restract 'Residence census tract'/
restsz 'Residence TAZ number NCTCOG'/
autoacc 'Residence auto accessibility'
walkacc 'Residence walk accessibility'/
expfact 'Expansion factor'/
numtours 'Number of tours per day'/
adatrips 'ADA paratransit trips per day'/
adamiles 'ADA paratransit miles per day'/
areatyp 'Residence area type'/
agergrp 'Age group'/
tourn 'Tour number in day'/
```

- tourpurp 'Tour main purpose'/
- tourmode 'Tour main mode'/
- tourtrips 'Trips in tour'.
-
- value labels
- gend 1 'male' 2 'female'/
- age 999 'refused'/
- lic physimp mentimp sensimp 0 'no' 1 'yes' 2 'no' 9 'refused'/
- emply stud 1 'full time' 2 'part time' 3 'no' 9 'refused'/
- hhsiz hhveh 98 'dk' 99 'refused'/
- income 1 '$0 - 15k' 2 '$15 - 25k' 3 '$25 - 35k' 4 '$35 - 50k' 5 '$50 - 75k' 6 '$75 - 100k' 7 '$100 - 15k0' 8 '$over 150k' 99 'refused'/
- resarea 1 'DART' 2 'MITS'/
- areatyp 1 'low walk acc' 2 'medium walk acc' 3 'high walk acc' 4 'very high walk acc'/
- agegrp 1 '17 - 34' 2 '35 - 49' 3 '50 - 64' 4 '65 - 74' 5 '75 up'/
- tourpurp 1 'medical' 2 'work' 3 'school' 4 'adult daycare' 5 'shop/meal' 6 'pers.bus' 7 'recreation' 8 'social' 9 'home'/
- tourmode 1 'ADA paratransit' 2 'other special trans' 3 'scheduled transit' 4 'car shared ride' 5 'car drive alone' 6 'walk/wheelchair'.
-
- cross areatyp agegrp gend to resarea by tourpurp tourmode tourtrips/cell row.

Residence area type * Tour main purpose Crosstabulation

% within Residence area type

		Tour main purpose								Total
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	
Residence area type	low walk acc	35.4%	11.9%	2.7%	5.5%	21.2%	11.9%	8.6%	2.7%	100.0%
	medium walk acc	33.8%	11.8%	3.0%	5.4%	21.4%	12.7%	9.0%	2.9%	100.0%
	high walk acc	32.7%	10.7%	3.4%	5.1%	22.8%	12.9%	9.3%	3.0%	100.0%
	very high walk acc	31.1%	10.5%	3.5%	5.0%	22.8%	14.1%	10.2%	2.9%	100.0%
Total		33.4%	11.3%	3.1%	5.3%	22.0%	12.8%	9.2%	2.9%	100.0%

Residence area type * Tour main mode Crosstabulation

% within Residence area type

		Tour main mode						Total
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelchair	
Residence area type	low walk acc	32.5%	3.1%	3.7%	48.5%	6.1%	6.1%	100.0%
	medium walk acc	31.8%	2.8%	5.3%	44.2%	6.4%	9.4%	100.0%
	high walk acc	30.6%	2.6%	5.4%	42.4%	6.3%	12.8%	100.0%
	very high walk acc	28.5%	2.3%	5.6%	39.1%	5.9%	18.5%	100.0%
Total		31.1%	2.7%	5.1%	43.8%	6.2%	11.1%	100.0%

Residence area type * Trips in tour Crosstabulation

% within Residence area type

		Trips in tour							Total
		2	3	4	5	6	7	8	
Residence area type	low walk acc	70.2%	18.0%	7.5%	3.5%	.6%	.2%	.0%	100.0%
	medium walk acc	70.9%	17.5%	7.1%	3.7%	.6%	.1%	.0%	100.0%
	high walk acc	71.1%	17.0%	7.4%	3.8%	.6%	.2%	.1%	100.0%
	very high walk acc	71.4%	17.2%	7.0%	3.7%	.5%	.1%	.0%	100.0%
Total		70.9%	17.4%	7.3%	3.7%	.6%	.2%	.0%	100.0%

Gender * Tour main purpose Crosstabulation

% within Gender

		Tour main purpose								Total
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	
Gender	male	23.0%	16.2%	4.0%	9.5%	18.5%	15.2%	12.4%	1.2%	100.0%
	female	38.6%	8.9%	2.7%	3.2%	23.8%	11.6%	7.6%	3.8%	100.0%
Total		33.4%	11.3%	3.1%	5.3%	22.0%	12.8%	9.2%	2.9%	100.0%

Gender * Tour main mode Crosstabulation

% within Gender

		Tour main mode						Total
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelch air	
Gender	male	31.1%	1.9%	3.3%	40.5%	4.5%	18.7%	100.0%
	female	31.1%	3.2%	6.0%	45.4%	7.1%	7.3%	100.0%
Total		31.1%	2.7%	5.1%	43.8%	6.2%	11.1%	100.0%

Gender * Trips in tour Crosstabulation

% within Gender

		Trips in tour							Total
		2	3	4	5	6	7	8	
Gender	male	72.1%	16.9%	6.9%	3.5%	.5%	.1%	.0%	100.0%
	female	70.3%	17.6%	7.4%	3.8%	.6%	.2%	.0%	100.0%
Total		70.9%	17.3%	7.3%	3.7%	.6%	.2%	.0%	100.0%

agegrp * Tour main purpose Crosstabulation

% within agegrp

		Tour main purpose								Total
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	
agegrp	17 - 34	12.8%	26.5%	7.4%	9.9%	12.9%	10.9%	17.0%	2.6%	100.0%
	35 - 49	29.2%	15.0%	4.9%	6.0%	18.2%	13.8%	10.0%	2.8%	100.0%
	50 - 64	38.1%	9.2%	1.6%	4.1%	24.5%	14.9%	5.5%	2.1%	100.0%
	65 - 74	51.9%	1.3%	.6%	2.2%	24.7%	12.9%	4.2%	2.2%	100.0%
	75 up	40.1%	1.0%	1.0%	3.6%	29.7%	9.6%	9.6%	5.3%	100.0%
Total		33.4%	11.3%	3.1%	5.3%	22.0%	12.8%	9.2%	2.9%	100.0%

agegrp * Tour main mode Crosstabulation

% within agegrp

		Tour main mode						Total
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelch air	
agegrp	17 - 34	39.4%	1.5%	2.2%	46.4%	1.1%	9.4%	100.0%
	35 - 49	31.4%	2.9%	5.3%	45.2%	5.1%	10.0%	100.0%
	50 - 64	29.5%	2.5%	5.1%	37.6%	6.1%	19.2%	100.0%
	65 - 74	31.4%	4.1%	6.6%	44.5%	10.1%	3.3%	100.0%
	75 up	24.7%	3.4%	7.1%	50.4%	10.8%	3.6%	100.0%
Total		31.1%	2.7%	5.1%	43.8%	6.2%	11.1%	100.0%

agegrp * Trips in tour Crosstabulation

% within agegrp

		Trips in tour							
		2	3	4	5	6	7	8	Total
agegrp	17 - 34	75.2%	14.7%	6.5%	3.0%	.4%	.1%	.0%	100.0%
	35 - 49	68.4%	17.7%	8.1%	4.7%	.9%	.2%	.1%	100.0%
	50 - 64	72.1%	17.1%	6.7%	3.3%	.6%	.2%	.0%	100.0%
	65 - 74	70.4%	18.3%	6.9%	3.8%	.5%	.2%	.0%	100.0%
	75 up	67.0%	19.8%	8.5%	3.9%	.6%	.3%	.0%	100.0%
Total		70.9%	17.4%	7.3%	3.7%	.6%	.2%	.0%	100.0%

Household Income * Tour main purpose Crosstabulation

% within Household Income

		Tour main purpose								
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	Total
Household Income	$0 - 15k	32.2%	5.8%	2.7%	6.6%	26.1%	14.5%	8.5%	3.5%	100.0%
	$15 - 25k	37.4%	14.8%	3.3%	3.1%	18.7%	11.4%	8.8%	2.3%	100.0%
	$25 - 35k	38.0%	16.8%	2.4%	3.2%	17.6%	10.7%	9.0%	2.2%	100.0%
	$35 - 50k	39.0%	11.0%	6.8%	3.4%	17.8%	13.0%	6.8%	2.1%	100.0%
	$50 - 75k	26.5%	25.3%	3.0%	6.6%	14.5%	10.2%	12.0%	1.8%	100.0%
	$75 - 100k	21.6%	44.4%	3.1%	3.1%	7.4%	5.6%	13.6%	1.2%	100.0%
	$100 - 15k0	19.3%	36.5%	5.1%	4.6%	8.6%	7.6%	17.3%	1.0%	100.0%
	refused	40.4%	12.5%	4.0%	2.9%	17.8%	10.5%	9.2%	2.6%	100.0%
Total		33.4%	11.3%	3.1%	5.3%	22.0%	12.8%	9.2%	2.9%	100.0%

Household Income * Tour main mode Crosstabulation

% within Household Income

		Tour main mode						
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelch air	Total
Household Income	$0 - 15k	26.7%	3.9%	7.3%	40.4%	6.9%	14.7%	100.0%
	$15 - 25k	35.4%	1.3%	2.6%	47.9%	6.0%	6.8%	100.0%
	$25 - 35k	36.8%	1.0%	2.9%	48.3%	6.4%	4.7%	100.0%
	$35 - 50k	35.6%	1.4%	.7%	48.6%	4.1%	9.6%	100.0%
	$50 - 75k	35.9%	1.2%	1.8%	50.3%	5.4%	5.4%	100.0%
	$75 - 100k	40.7%	1.2%	.0%	48.8%	3.1%	6.2%	100.0%
	$100 - 15k0	29.6%	1.5%	.0%	58.2%	4.6%	6.1%	100.0%
	refused	44.1%	.9%	2.0%	43.6%	4.2%	5.3%	100.0%
Total		31.1%	2.8%	5.1%	43.8%	6.2%	11.1%	100.0%

Household Income * Trips in tour Crosstabulation

% within Household Income

		Trips in tour							
		2	3	4	5	6	7	8	Total
Household Income	$0 - 15k	72.5%	17.4%	6.6%	2.9%	.4%	.1%	.0%	100.0%
	$15 - 25k	67.8%	17.4%	8.7%	4.9%	.9%	.2%	.1%	100.0%
	$25 - 35k	67.3%	18.5%	8.0%	5.1%	.7%	.2%	.0%	100.0%
	$35 - 50k	69.2%	16.4%	7.5%	6.2%	.7%	.0%	.0%	100.0%
	$50 - 75k	69.3%	16.3%	8.4%	5.4%	.6%	.0%		100.0%
	$75 - 100k	73.5%	15.4%	7.4%	3.1%	.6%	.0%	.0%	100.0%
	$100 - 15k0	69.7%	16.4%	8.2%	4.6%	1.0%	.0%	.0%	100.0%
	refused	69.0%	18.0%	7.9%	4.2%	.7%	.2%	.0%	100.0%
Total		70.9%	17.4%	7.3%	3.7%	.6%	.2%	.0%	100.0%

Household Vehicles * Tour main purpose Crosstabulation

% within Household Vehicles

		Tour main purpose								
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	Total
Household Vehicles	0	36.7%	6.1%	2.5%	.4%	26.9%	15.8%	7.8%	3.7%	100.0%
	1	32.1%	13.2%	2.1%	8.8%	20.8%	10.8%	9.6%	2.6%	100.0%
	2	29.0%	17.8%	7.1%	9.5%	13.8%	10.2%	11.0%	1.8%	100.0%
	3	25.0%	25.4%	3.8%	8.3%	12.9%	9.5%	13.3%	1.9%	100.0%
	4	51.2%	.0%	7.0%	4.7%	23.3%	7.0%	4.7%	2.3%	100.0%
	5	50.0%		.0%	5.0%	20.0%	15.0%	10.0%	.0%	100.0%
	8	.0%	60.0%	.0%	.0%	.0%	20.0%	20.0%	.0%	100.0%
Total		33.4%	11.3%	3.1%	5.3%	22.0%	12.8%	9.2%	2.9%	100.0%

Household Vehicles * Tour main mode Crosstabulation

% within Household Vehicles

		Tour main mode						
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelch air	Total
Household Vehicles	0	36.1%	4.5%	11.1%	33.8%		14.5%	100.0%
	1	23.9%	1.5%	.8%	53.1%	11.3%	9.4%	100.0%
	2	32.5%	1.5%	.4%	49.1%	9.5%	7.1%	100.0%
	3	42.6%	1.1%	.4%	44.2%	4.2%	7.5%	100.0%
	4	23.8%	.0%	.0%	38.1%	35.7%	2.4%	100.0%
	5	4.8%	4.8%		38.1%	47.6%	4.8%	100.0%
	8	50.0%	.0%	.0%	33.3%		16.7%	100.0%
Total		31.1%	2.7%	5.1%	43.8%	6.2%	11.1%	100.0%

Household Vehicles * Trips in tour Crosstabulation

% within Household Vehicles

		Trips in tour							
		2	3	4	5	6	7	8	Total
Household Vehicles	0	75.6%	16.2%	5.7%	2.2%	.2%	.0%	.0%	100.0%
	1	66.1%	19.1%	8.9%	4.9%	.8%	.3%	.0%	100.0%
	2	69.9%	16.4%	7.7%	4.8%	.9%	.2%	.1%	100.0%
	3	73.1%	15.9%	6.8%	3.4%	.8%	.0%	.0%	100.0%
	4	61.9%	19.0%	9.5%	7.1%	2.4%	.0%		100.0%
	5	47.4%	26.3%	15.8%	10.5%	.0%			100.0%
	8	80.0%	20.0%	.0%	.0%		.0%		100.0%
Total		70.9%	17.4%	7.3%	3.7%	.6%	.2%	.0%	100.0%

Residence service area * Tour main purpose Crosstabulation

% within Residence service area

		Tour main purpose								
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	Total
Residence service area	DART	32.0%	10.9%	4.0%	4.4%	22.9%	13.4%	9.6%	3.0%	100.0%
	MITS	36.0%	12.0%	1.7%	6.8%	20.6%	11.7%	8.4%	2.8%	100.0%
Total		33.4%	11.3%	3.1%	5.3%	22.0%	12.8%	9.2%	2.9%	100.0%

Residence service area * Tour main mode Crosstabulation

% within Residence service area

		Tour main mode						
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelch air	Total
Residence service area	DART	32.3%	2.5%	5.5%	42.4%	6.2%	11.2%	100.0%
	MITS	29.1%	3.2%	4.4%	46.1%	6.3%	11.0%	100.0%
Total		31.1%	2.7%	5.1%	43.7%	6.2%	11.1%	100.0%

Residence service area * Trips in tour Crosstabulation

% within Residence service area

		Trips in tour							
		2	3	4	5	6	7	8	Total
Residence service area	DART	71.3%	17.0%	7.2%	3.7%	.6%	.2%	.0%	100.0%
	MITS	70.3%	17.9%	7.4%	3.6%	.6%	.1%	.0%	100.0%
Total		70.9%	17.4%	7.3%	3.7%	.6%	.2%	.0%	100.0%

3. Trip level output

- GET DATA
- /TYPE=TXT
- /FILE="C:\Users\Mark\Documents\Paratransit\adatripout.dat"
- /DELCASE=LINE
- /DELIMITERS=" "
- /ARRANGEMENT=DELIMITED
- /FIRSTCASE=2
- /IMPORTCASE=ALL
- /VARIABLES=
- SAMPN F7.0
- GEND F1.0
- AGE F2.0
- LIC F1.0
- EMPLY F1.0
- STUD F1.0
- PHYSIMP F1.0
- MENTIMP F1.0
- SENSIMP F1.0
- HHSIZ F1.0
- INCOME F1.0
- HHVEH F1.0
- HHLIC F1.0
- HHWRK F1.0
- HHSTU F1.0
- resarea F1.0
- restract F9.0
- restsz F4.0
- autoacc F7.4
- walkacc F7.4
- expfact F6.4
- numtours F1.0
- adatrips F1.0
- adamiles F4.1
- tourn F1.0
- tourpurp F1.0
- tourmode F1.0
- tourtrips F1.0

- tripn F1.0
- tripopurp F1.0
- tripdpurp F1.0
- tripmode F1.0
- tripozone F5.0
- tripdzone F5.0
- tripdist F5.2
- triptime F5.2.
- CACHE.
- EXECUTE.
- DATASET NAME DataSet3 WINDOW=FRONT.
-
- compute areatyp=1.
- if walkacc>=7.5 areatyp=2.
- if walkacc>=8.4 areatyp=3.
- if walkacc>=9.2 areatyp=4.
-
- compute agegrp=1.
- if age>34 agegrp=2.
- if age>49 agegrp=3.
- if age>64 agegrp=4.
- if age>74 agegrp=5.
-
- weight by expfact.
-
- variable labels
- sampn 'Sample number'/
- gend 'Gender'/
- age 'Age'/
- lic 'Valid Drivers License'/
- emply 'Employment Status'/
- stud 'Student Status'/
- physimp 'Physical impairment?'/
- mentimp 'Mental impairment?'/
- sensimp 'Sensory impairment?'/
- hhsiz 'Household Size'/
- income 'Household Income'/
- hhveh 'Household Vehicles'/
- hhlic 'Number of Household licensed drivers'/
- hhwrk 'Number of household members who are wc
- hhstu 'Number of Household students'/
- resarea 'Residence service area'/
- restract 'Residence census tract'/
- restsz 'Residence TAZ number NCTCOG'/
- autoacc 'Residence auto accessibility'
- walkacc 'Residence walk accessibility'/
- expfact 'Expansion factor'/

- numtours 'Number of tours per day'/
- adatrips 'ADA paratransit trips per day'/
- adamiles 'ADA paratransit miles per day'/
- areatyp 'Residence area type'/
- agergrp 'Age group'/
- tourn 'Tour number in day'/
- tourpurp 'Tour main purpose'/
- tourmode 'Tour main mode'/
- tourtrips 'Trips in tour'/
- tripn 'Trip number within tour'/
- tripopurp 'Trip origin purpose'/
- tripdpurp 'Trip destination purpose'/
- tripmode 'Trip mode'/
- tripozone 'Trip origin zone'/
- tripdzone 'Trip destination zone'/
- tripdist 'Trip auto distance'/
- triptime 'Trip auto time'.
-
- value labels
- gend 1 'male' 2 'female'/
- age 999 'refused'/
- lic physimp mentimp sensimp 0 'no' 1 'yes' 2 'no' 9 'refused'/
- emply stud 1 'full time' 2 'part time' 3 'no' 9 'refused'/
- hhsiz hhveh 98 'dk' 99 'refused'/
- income 1 '$0 - 15k' 2 '$15 - 25k' 3 '$25 - 35k' 4 '$35 - 50k' 5 '$50 - 75k' 6 '$75 - 100k' 7 '$100 - 15k0' 8 '$over 150k' 99 'refused'/
- resarea 1 'DART' 2 'MITS'/
- areatyp 1 'low walk acc' 2 'medium walk acc' 3 'high walk acc' 4 'very high walk acc'/
- agegrp 1 '17 - 34' 2 '35 - 49' 3 '50 - 64' 4 '65 - 74' 5 '75 up'/
- tourpurp tripopurp tripdpurp 1 'medical' 2 'work' 3 'school' 4 'adult daycare' 5 'shop/meal' 6 'pers.bus' 7 'recreation' 8 'social' 9 'home'/
- tourmode tripmode 1 'ADA paratransit' 2 'other special trans' 3 'scheduled transit' 4 'car shared ride' 5 'car drive alone' 6 'walk/wheelchair'.
-
- cross tripopurp tripdpurp by tourpurp/ tripmode by tourmode /cell col.

Trip origin purpose * Tour main purpose Crosstabulation

% w Double-click to activate urpose

		Tour main purpose								
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	Total
Trip origin purpose	medical	42.7%								13.8%
	work	.2%	45.1%							4.7%
	school	1.4%	1.0%	50.0%						1.8%
	adult daycare	.4%	.3%		42.8%					2.3%
	shop/meal	7.5%	4.8%	.0%	8.4%	51.7%	11.3%	11.8%	11.8%	18.9%
	pers.bus	3.9%	2.5%	.0%	4.3%	7.6%	45.6%	6.0%	5.9%	10.2%
	recreation	.8%	.5%		.7%	1.4%	1.1%	40.6%	1.4%	4.7%
	social	1.4%	.9%	.0%	1.4%	2.7%	2.2%	2.2%	41.5%	3.0%
	home	41.9%	45.0%	50.0%	42.4%	36.6%	39.9%	39.5%	39.4%	40.6%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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Trip destination purpose * Tour main purpose Crosstabulation

% within Tour main purpose

		Tour main purpose								
		medical	work	school	adult daycare	shop/meal	pers.bus	recreation	social	Total
Trip destination purpose	medical	42.7%								13.8%
	work	.2%	45.1%							4.7%
	school	1.4%	1.0%	50.0%						1.8%
	adult daycare	.4%	.3%		42.8%					2.3%
	shop/meal	7.5%	4.8%	.0%	8.4%	51.7%	11.3%	11.8%	11.8%	18.9%
	pers.bus	3.9%	2.5%	.0%	4.3%	7.6%	45.6%	6.0%	5.9%	10.2%
	recreation	.8%	.5%		.7%	1.4%	1.1%	40.6%	1.4%	4.7%
	social	1.4%	.9%	.0%	1.4%	2.7%	2.2%	2.2%	41.5%	3.0%
	home	41.9%	45.0%	50.0%	42.4%	36.6%	39.9%	39.5%	39.4%	40.6%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Trip mode * Tour main mode Crosstabulation

% within Tour main mode

		Tour main mode						
		paratransit	other special trans	scheduled transit	car shared ride	car drive alone	walk/wheelchair	Total
Trip mode	paratransit	89.7%						24.5%
	other special trans	.1%	81.3%					2.1%
	scheduled transit	.6%	3.9%	63.2%				3.3%
	car shared ride	6.6%		2.6%	98.5%			48.1%
	car drive alone	.1%				100.0%		8.4%
	walk/wheelchair	2.8%	14.9%	34.2%	1.5%		100.0%	13.7%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation