

**ODOT RESEARCH REQUEST FOR PROPOSALS – FISCAL YEAR 2009  
PS-09-07**

**Research Title:**

GPS-Based Household Interview Survey for the Cincinnati, Ohio Region

**Problem Statement:**

Travel Demand Forecasting Models (TDFM) employ many statistical models to generate estimates of trip generation, distribution and modal split in most urban areas. These models are then used in a variety of purposes, including roadway design and air quality conformity analyses. TDFMs are estimated from information collected from Household Interview Surveys (HIS). Traditionally, HISs have been conducted by recruiting households to complete a paper travel diary on their one or two travel days, and to report that information back over the phone. This requires a substantial burden on the part of the interviewee and has led to poor response rates and missing data.

Global Position System (GPS) devices have been used in recent years in conjunction with HIS to help determine the level of underreporting inherent in the traditional diary-based surveys. In the past, GPS devices were large and therefore installed in household vehicles of survey respondents. In recent years, technology has advanced so that GPS devices are now of a size that can be carried around by a person without hardship; hence, it is now possible to capture all trips by an individual person via GPS, instead of only vehicle trips.

It is appealing to conduct an entire HIS utilizing GPS tracking, as it reduces respondent burden and underreporting and potentially reduces the cost of the survey. It also provides detailed geographic information about trips not captured by traditional survey methods that could potentially influence the way trips are modeled. However, a large scale GPS-based survey has not been conducted in the United States, and it is uncertain whether a GPS-based survey is able to capture all information that has historically been available in a diary-based survey, such as trip purpose, mode, travel cost (e.g. transit fare, driving cost and parking cost) and vehicle occupancy.

**Proposed Research:**

The primary focus of this research will be to deploy a GPS based HIS and develop methods to process the data into trip records with information comparable to that obtained by the Mid-Ohio Regional Planning Commission (MORPC) and Miami Valley Regional Planning Commission (MVRPC) HISs. The information gathered in MORPC and MVRPC surveys were used for development of a tour-based microsimulation TDFM and a trip-based four-step TDFM, respectively. The subject research will contain at least 10 tasks associated with performing a GPS based survey and developing appropriate analytical techniques. It is envisioned that this survey would primarily consist of GPS data with a small sub-sample of data collected by more traditional household interview survey methods. Technical Memoranda will be developed during Tasks 2-9 detailing the work completed in each Task.

**Task 1: Oversight Committee**

The Researcher will convene an Oversight Committee to oversee the methodologies and results of the Survey. The Researcher will make recommendations regarding potential committee members; ODOT will make final recommendations regarding the committee composition. The Oversight Committee will make recommendations on the survey design and methodology, completeness and sufficiency of results, and overall administration.

**Task 2: Work Plan**

A detailed plan will be developed for each task, identifying specific products, schedules, and Data Quality Assurance and Quality Control (QA/QC) measures. In this task, the Researcher with the Oversight Committee will identify and agree upon the data needs from the Survey, focusing on understanding the travel patterns and key characteristics of current residents as well as the needs of the travel demand model. Requirements of a small diary-based control group will be detailed.

**Task 3: Survey Instrument and Materials**

Materials will be developed for use in the Recruitment Interview, Respondent Materials including GPS units and/or travel diary and instructions, Reminder Call or other appropriate reminder contact for households without telephones, and Retrieval Interview. The travel diary for the control group will be developed.

#### Task 4: Sample Design and Response Rate

The Researcher will develop a Survey Sampling Plan for both the GPS-based survey and the diary-based control group. The sampling plan shall be designed to account for the known biases encountered in other travel surveys, and measures will be developed to minimize those biases. It is anticipated that the survey sample will be stratified and controlled within each strata to reduce response biases. These strata will contain at a minimum, household size (1,2,3,4+) and vehicle ownership (0,1,2,3+) but will most likely also include income (quartile), areatype (cbd, urban, suburban, rural) and lifecycle (student, with children, without children, retired). The exact categories chosen will be aggregated such that a sample of approximately 5000 households can be obtained with only a marginal amount of over-sampling (as indicated through analysis of PUMS data from the area). The schedule for the survey will be designed to maximize the use of GPS devices in order to minimize the number of GPS units required for the project. It will be assumed that the GPS units will be deployed with each household for at least 3 full travel days. The researchers shall determine whether the survey will be of average week day or typical week day conditions. If average; the survey will be deployed on all weekdays for 12 full months from March 2009 until February 2010 and sample control on individual sample strata will be maintained every month and the delivered analyses will included an examination of seasonal effects. If typical; the survey will only occur between March and May 2009 and September 15-November 15, 2009, excluding the week days before and after holiday weekends.

#### Task 5: Interviewer Training and Survey Process

The Researcher shall develop and conduct a survey management plan that accounts for personnel training, and other survey administration requirements. Proper training will be given to the interviewers. An interviewer's manual shall be prepared, describing the interviewer's job, from administrative matters through safeguarding of data and courtesy to the public.

#### Task 6: Survey

The full survey will be conducted according to the survey procedures finalized in Task 5. As survey assignments are returned from the field, the Consultant will ensure that the work was successfully completed and that all survey materials were returned.

#### Task 7: GPS Data Processing

Data will be transferred from the GPS units to a database. Algorithms from existing research will be used, or new algorithms will be developed to extract travel diaries from the GPS database. At a minimum, the algorithm will identify the location of origin/destination stops, thereby parsing the GPS data points into trips. Trips will be sequentially numbered and will be subject to QA/QC filters to screen out bad data points. Trip duration and distances will be calculated. Trip paths will be reviewed for consistency with the highway and transit systems and within the household.

#### Task 8: Geocoding, Data Quality Control, and Data Imputation

Responses from the small diary-based control group will be geocoded. The minimum goal for non-home addresses is 90%. The Data QA/QC Plan from Task 2 will be used to ensure that the data collected from both surveys is reasonable and usable. Data for each household will be cross-checked among data files. A Data Imputation Plan will be developed after review of the survey sample with both GPS and diary-based surveys. Information such as trip purpose and mode will need to be imputed for GPS-based surveys, as well as the typical data required from all surveys (such as income). Survey records will be delivered to ODOT in the same format as the 2001 MVRPC HIS records.

#### Task 9: Survey Data Weighting and Expansion

Survey data will be weighted and expanded to match Census based control totals and based upon the survey sample design stratum. The expansion process will be reported so the data could be re-expanded

if records were removed after the completion of the project. Trip weights will vary based on type of survey and possibly trip purpose and mode.

#### Task 10: Final Report

The Researcher will prepare a draft final report, documenting each element of the Survey and presenting the survey findings. The final report is expected to contain data findings, cross-tabulations and data tables, recommendations and interpretation of results. The Oversight Committee will review the survey findings and provide comments. A final report and all datasets will be delivered. All datasets will be considered the exclusive property of the Department in order to protect the confidentiality of the survey respondents.

#### **Assistance from the Department:**

Staff from the Department, OKI and MVRPC will participate on the Oversight Committee and will address questions and issues that arise, review and guide the work done by the researcher. Staff will provide data/reports from previous HIS efforts as well as information on the TDFMs currently in use/envisioned.

#### **Implementation:**

Presently, the regional travel demand model is a combined area model covering both Cincinnati and Dayton regions. Combined with previously collected household interview survey data in the Dayton region, the survey results will be used to estimate a new TDFM for the OKI and MVRPC regions. Furthermore, ODOT Technical Services staff will use the results to determine the potential cost savings or data-quality enhancements or deficiencies of conducting future HISs utilizing only GPS-Based Survey techniques. Future HISs can be used to update the Ohio Statewide TDFM as well as MPO models. In order to prepare a response to this proposal, details about the new TDFM may be obtained from the ODOT and/or OKI and MVRPC contacts listed.

#### **Benefits:**

Potential Benefits of conducting GPS-Based HIS include:

1. Ability to review multiple days of data per household, instead of 1-2 days from a diary-based survey. This will allow for better model estimation data sets.
2. Correction of under-reporting. Since GPS units record all travel, all trips should be captured from the GPS-based survey and the under-reporting found in diary-based surveys should be ameliorated.
3. Correction of Respondent Bias. Certain households are more likely to decline participation in diary-based surveys due to respondent burden. Hence, certain households may be less likely to agree to participate in the survey. If the respondent burden is less with the GPS-based survey than the diary-based survey, the refusal rate may be found to be lower.

#### **Success Criteria:**

The project will be a success if the GPS-based and diary-based surveys can be completed early enough to provide information for the upcoming OKI model update and does not compete with the 2010 decennial Census, if measures can be developed to determine in which situation each type of survey is appropriate, what type of information each survey can accurately collect, and a determination is able to be made as to whether a GPS-based survey can completely replace a diary-based survey.

#### **Deliverables:**

- A final report detailing the survey methods, results of the GPS-based survey and the diary-based control group, weighting methodology, trip defining algorithms, imputing methods, limitations of both types of surveys, and recommendations on what type of survey is appropriate in what situations.
- Geocoded, weighted survey data in dbf format.
- Files with GPS coordinates and acceleration rates and speeds for each trip recorded from the GPS units.
- Survey instruments
- Technical memoranda from Tasks

The following required documents must be submitted:

- Quarterly progress reports

- One (1) original and five (5) copies of a draft final report and draft executive summary submitted no later than 120 days prior to the project completion date
- Sixty-five (65) copies of an approved final report and two hundred (200) color copies of an approved two- to four-page dated executive summary submitted by the contract completion date
- Two electronic versions of the approved final report and approved executive summary in the following formats: (1) Adobe Acrobat (.pdf), and (2) Microsoft Word (.doc)
- One article for the R&D newsletter - to be provided upon the request of the Office of R&D

The research team must also participate in the following project meetings:

- Start-Up Meeting
- Review Session
- Project Wrap-Up Meeting

A PowerPoint presentation is required for the review session and the project wrap-up meeting and must be provided in advance. For additional information on these meetings, see the Proposal Formatting and Submission Guidelines.

### **Existing Research:**

1. "Deducing Mode and Purpose from GPS Data," Peter Stopher, Eoin Clifford, Jun Zhang, The Institute of Transport and Logistics Studies, and Camden FitzGerald, PB, 11th TRB National Transportation Planning Applications Conference, 2007
2. *Comparative Analysis of Global Positioning System-Based and Travel Survey-Based Data*, Stacey Bricka and Chandra R. Bhat, UT at Austin, TRR No. 1972, pp. 9-20, 2006
3. *Estimating Trip Rate Under-reporting: Preliminary Results from the Ohio Household Travel Survey*, Ben Pierce, Jesse Casas, Nustats, and Gregory T. Giaimo, ODOT, Presented at 82<sup>nd</sup> Annual Meeting of the Transportation Research Board, 2003
4. "Developing and Deploying a New Wearable GPS Device for Transport Applications," Stopher, P.R., S.P. Greaves, and C. FitzGerald, 2<sup>nd</sup> International Colloquium on the Behavioural Foundations of Integrated Land Use and Transportation Models, 2005
5. "Application of New Technologies in Travel Surveys," J. Wolf, *Travel Survey Methods – Quality and Future Directions*, 2006
6. "Elimination of the Travel Diary. An experiment to derive trip purpose from GPS Travel Data," J. Wolf, R. Guensler, and W. Bachman, Presented at 80<sup>th</sup> Annual Meeting of the Transportation Research Board, 2001
7. *Impact of underreporting on mileage and travel time estimates*, Wolf, Jean, M. Oliveira, M. Thompson, TRR. No. 1854, 2003
8. *Comparison of trip determination methods in household travel surveys enhanced by a Global Positioning System*, Forrest, Timothy and David Pearson, TRR No. 1917, 2005
9. *Enhanced system for link and mode identification for personal travel surveys based on Global Positioning Systems*, Tsui, Sheung Yuen Amy, Amer Shalaby, TRR No. 1972, 2006
10. "GPS for travel surveys : innovation in household travel survey", Berthelsen, Gene, Journal (California. Dept. of Transportation). Vol. 3, issue 4, Jan.-Mar. 2003
11. *Conversion of Volunteer-Collected GPS Diary Data into Travel Time Performance Measures: Final Report*, Srinivasan, Sivaramakrishnan, Prabuddha Ghosh, Aruna Sivakumar, Aarti Kapur, Chandra R Bhat, Stacey Bricka, UT at Austin, 2006
12. *1999 Mid-Ohio Area Household Travel Survey Final Report*, NuStats, MORPC, 2000
13. *2001-2003 Ohio Statewide Household Travel Survey*, NuStats, 2004

Paper 1 details a study, similar to the one proposed, that was conducted in Sydney, Australia. However, it is desired that this study also include auto occupancy and joint travel.

Reports 2 and 3 report some of the deficiencies of diary-based surveys and how GPS-based add-ons can help correct for them.

Reports 4 and 5 relate to the use of GPS-based units in travel surveys.

Reports/Papers 6-11 are related research that may contain information of use to this project.

Reports 12 and 13 are the final reports from the MORPC and Ohio Statewide Travel Surveys. It is intended that this research be able to replicate the data obtained from these surveys as much as possible.

**Additional Use:**

It is intended that the research results would also be used by NOACA, MORPC, other MPOs and other DOTs to inform their decision of travel survey methodology.

**Duration:**

24 months - includes 4 months for review / publication of final report

The survey should be conducted in 2009 so as not to interfere with the 2010 decennial Census.