Appendix

Annotated Bibliography

Meta Studies

NCHRP. (2008). *Standardization of personal travel surveys*. Report to the National Cooperative Highway Research Program on Project 08-37. Washington, DC: Transportation Research Board.

This report is one of the most comprehensive and up to date efforts at providing a standardized procedure for personalized travel surveys. The report is organized into 5 major chapters, which cover topics such as recommended standardized procedure and guidelines, training approaches and priorities, procedures and measures for further research, and a sample RFP template. There is also a useful glossary of terms provided at the end of the report and a technical appendix.

Recommendations are made on various topics such as design of survey instrument (questionnaire design and wording), design of data collection procedures, pilot and pretest surveys (sample size), survey implementations (ethics, mailing material, caller ID, answering machines, etc.), data coding and geocoding, data analysis and expansion (assessing sample bias, data archiving, etc.), and assessment of survey quality (computing response rate, calculation of coverage errors, etc.).

There is no specific section on sample design. It is assumed in this report that the survey instrument is a mailing of survey package and diary, followed up by a phone call. Recommendations for sample replacement procedure are also provided. Item non-response and unit non-response are also discussed, and various recommendations are made in terms of contact strategy in order to minimize these. Recommendations are made about when incentives are necessary and how they should be offered.

A number of topics are categorized as "Items Initially Identified as Beyond the Scope of this Project". These include GPS surveys, Internet surveys, and stated preference data. These topics are lightly touched upon in Chapter 4 (Procedure and Measures for Further Research). Some of the topics of relevance that were originally identified as part of this research, but were not researched include: instrument design, sample size, stratification options for samples, and specification of sampling error requirements.

The issue of cell-phones is only lightly discussed and suggestions are made for future research into the issue, while no solid recommendations are made in terms of sampling or survey instrument design.

The Technical Appendix includes detailed descriptions of the research that was undertaken to develop the recommendations in this report, including the results of extensive literature reviews undertaken early in the project.

Bonnel, P., Madre, J., & Armoogum, J. (2007). National transport surveys: What can we learn from international comparisons. Paper presented at the *86th Annual Meeting of the Transportation Research Board,* Washington, DC.

In this study the authors analyze National Personal Travel Surveys conducted in 16 countries in the world to identify the best practices of Travel Surveys used throughout the world to assist France with their 2007 survey. Special attention is paid to whether or not and to what extent each example covers long distance travel. The study tabulated all the various aspects of

each travel survey including mode of contact, proxy, type of questionnaire, choice of day/period, weekday/weekend, sampling database, statistical unit, individuals excluded, sampling method, and sample size.

The recommendations of the paper for the 2007 survey include:

- The survey needs to address the access of mass transit, and personal vehicles.
- Changes in the survey mechanism must be gradual over time to ensure that they are comparable from year to year.
- The data collected will be synthesized using CAPI systems.
- "The travel survey will be conducted over 12 months to account for seasonality."
- A survey day will be allocated to each household rather than a random day picked by the interviewer.

Bonsall, P. (2004). Quality assessment. Paper presented at the *7th International Conference on Survey Methods in Transport,* Costa Rica.

The author asserts that there has been little progress since the 2001 conference, whose keynote paper by Stopher and Jones highlighted the lack of agreement within the transport profession as to what constitutes a good survey. The author suggests that the travel survey community be made aware of pre-existing legislation, professional standards, and influence by clients and the government sector. The author comments on the usefulness of consistent definitions and expresses reservations about suggested methods of measuring quality. The author suggests that more details should be provided on data collection methods at least on the Internet. The conference organizers at both Costa Rica (2004) and South Africa agree that the following quality and standards issues should be analyzed:

• Developing a definition of data quality;
• Suggesting means by which the achievement of "quality" might be measured;
• Determining the achievability, or otherwise, of universal measures of quality; and
• Assessing the potential role of benchmarking standards promoted by the International Standards Organization (ISO) or a similar body.

Bricka, S. (2004). Scheduling considerations in household travel surveys. Paper presented at the *7th International Conference on Survey Methods in Transport,* Playa Herradura, Costa Rica. from http://www.isctsc.let.fr/pastConf/CostaRica/A4/A4%20-%20Resource%20Bricka.pdf

The author states that standardization is useful in comparing data sets and suggests activities to minimize error. The paper describes the steps in implementing a household travel survey.
Travel periods of more than 24 hours provide a better understanding of travel behaviour – which may result in a trade-off of reduced sample size.
Changing the survey method from retrospective to one requiring the completion of a travel diary requires reminder calls. In addition, the author suggests that recruitment and retrieval calls should be made during the proper hours for different types of people -- to avoid bias.
Establishing a stronger rapport (thus ensuring higher cooperation rates) requires a single point of contact and a less structured approach to survey administration, which might lead to the introduction of response bias to the survey.
Survey materials should arrive "just in time" – early arrival might lead to misplacement.
Advance notification emphasizes legitimacy and eliminates the element of surprise.

The paper recommends frequent movement of data for a higher quality of data. Also, a "data freshness window" may be implemented to ensure that respondents recall their travel from the travel period. However, only those households who do not travel are quickly reached, and telescoping biases increase as the time period becomes shorter.

Cambridge Systematics, I. (1996). *Travel survey Manual*. Washington, DC: Department of Transportation.

This relatively old document has a detailed chapter on design of Household Travel and Activity Surveys. Other topics covered in the document that are not of direct relevance to this project are related to options for travel surveys (including household surveys), quality control, accuracy, vehicle intercept surveys, transit surveys, commercial vehicle surveys, workplace surveys, visitor surveys, parking surveys, and geocoding. The Household Travel and Activity Surveys chapter provides a brief overview of the available options (at the time), presents a discussion of advantages and disadvantages of each option, and makes recommendations on how to proceed with each option.

The manual covers topics such as assembling background information, survey deign, organization and sampling, drafting and pretesting the survey, training and briefing, interviewing and questionnaire distribution, data coding and cleaning, and lastly programming and compiling the survey data.

Evert, H. v., Brög, W., & Erl, E. (2004). Survey design: The past, the present and the future. Paper presented at the *Seventh International Conference on Survey Methods in Transport* Costa Rica.

This paper uses the history of the Dutch Travel Survey, from 1978 to 2004, as a guide to describe the evolution of Survey Designs in the past few decades. The latest version of the Netherlands household travel survey is known as Mobiliteitsonderzoek Nederland (MON). The survey follows a hierarchical structure of household, person, trip and stage. The sample size for this survey was largest in 1995, at almost 70,000 households, and is currently at 44,000.

A number of quality principles are defined for the new design of the MON. These include treating respondents as "customers", continuous improvements, fit for the foreseeable future (mainly focused on new privacy issues), high response rates (>60%), imminent validation, interviewing EVERY member of the household, clear definition of linked and unlinked trips, utilizing a large number of data edition and entry staff.

Looking into the future, decision makers in the design of the Netherlands household travel survey do not see a technical vision but a perspective for quality and reliability.

Korimilli, M., Pendyala, R., & Murakami, E. (1998). Meta-analysis of travel survey methods. *Transportation Research Record, 1625*(-1), 72-78.

The authors identified three major factors motivating a comparison of various travel survey methods. These are demand for new and more detailed travel data, declining response rates, and declining resources and budgets. The research looks at and compares the survey methods of 9 non-transportation related surveys, and 35 transportation related surveys in the past decade (surveys prior to 1998). The survey design parameters analyzed in this comparison

include method of administration (e.g. CATI, CASI, etc.), type of instrument, length of reporting period and incentives, length of questionnaire, number of stages, and reminders. A predictive model of response rate is developed using linear regression based on the above survey elements. The model offers a means of predicting response rate given levels of various survey design parameters and of deducing design parameters for achieving certain desired response rates. Given that this is a relatively old document, web-based surveys or use of GPS are not touched upon or evaluated within the model.

Kunert, U., Kloas, J., & Kuhfeld, H. (Eds.). (2002). Design characteristics of national travel surveys - international comparison for 10 countries. *Transportation Research Record*, 1804, pp. 107-116

As part of a pilot study for the 2002 national travel survey in Germany, a sample of 10 national travel surveys from across the globe are introduced and compared in this paper. Countries included in the comparison are Germany, Austria, Belgium, Denmark, France, Great Britain, USA, Netherlands, Norway, and Switzerland. The study is NOT an evaluation of the effectiveness of the employed approaches. The design elements considered in this comparison are frequency and continuity of surveys, issues of sampling and response, and survey process and instrument. A variety of contact methods are observed amongst the sample surveys, while the standard trip oriented diary is common amongst all. The core substance of the type of data gathered is also similar for all cases. Four of the countries in this overview conduct their surveys more or less regularly, while three even do so continuously. Several comparison tables are complied in order to summarize the characteristics of each NTS in addition to type of questions asked.

Lawson, C. T., Fassman, C. W., & Chau, M. Y. C. (2007). Household travel survey research. Report No. RF#49777-15-17)

The primary objective of this metastudy is to provide primary data for use in a transportation planning model for the New York / New Jersey / Connecticut metropolitan area. This comprehensive study is comprised of four sections:

Part One: HOUSEHOLD TRAVEL SURVEY REVIEW relies on the various documents produced by the firms involved in the 1997-1998 Regional Transportation Household Interview Survey to identify problems through the surveying process. Issues revealed in these documents are cited and discussed. Some of relevant issues include weighting factor for households with multiple and no phones and correction calls.

Part Two: COSTA RICA CONFERENCE (2004) DOCUMENT REVIEW summarizes the *Costa Rica Household Travel Survey Conference* and other research that examines or recommends alternative approaches or strategies dealing with those identified issues. The relevant resource paper from the Costa Rica conference are reviewed and documented as individual references in this literature review.

Part Three: HOUSEHOLD TRAVEL SURVEY SYNTHESIS matches the issues identified in part 1 with potential strategies from the document review in Part Two. A matrix is developed in this section illustrates various combinations.

Part Four: DISCUSSION – REVEALED THEMES summarizes the major findings in the surveying process effort and recommends strategies which address these findings. Another

matrix is developed in this section that outlines the approach for each theme, including "evidence", "first step", "next step" and "expectations" for each theme.

In order to improve methodologies in capturing transit data one approach is to scope and pilot test the use of on-body GPS for household members taking transit.
To address sampling frame concerns two alternatives are recommended:
- "mapping" a surface of households - using a synthetic population base; and
- An approach similar to a consumer panel model, for at least some of the households.

A relatively detailed section is also provided on the findings of the "National Transport Surveys: What can we learn from international comparison?" study by Bonell, Armoogum and Madre, where they analyzed National Personal Travel Surveys conducted all over the world to identify the best practices of Travel Surveys used throughout the world to assist France with their 2007 survey. A review of this document is also provided in our annotated bibliography.

Levinson, D., & Zofka, E. (2004). Processing, analyzing, and archiving travel survey data. Paper presented at the *Seventh International Conference on Survey Methods in Transport,* Costa Rica.

A proposal for a standardized terminology of the steps of a travel survey is provided, serving as a basis for appropriate data documentation and archiving. The paper discussed data processing aspects such as data base building, questionnaire editing, data entry, standardization for flexible coding, geocoding, data editing and cleaning as well as data weighting. Quality management and data validation of survey results are also covered. A specific focus is given to the consideration of standards for archiving in order to ensure maximized use of the data for present day and in the future. Also, a question is addressed as to how to proceed with the implementation of this task successfully with regard to the institutional and organizational framework in the international scientific community.

According to the paper, the value in archiving survey data is as follows:

1. "The historical value and scientific understanding that can be obtained by analyzing this forgotten data:" – a new understanding of how current travel and activity patterns emerged.
2. "Researchers today can apply new statistical modeling to old data sets to learn whether causal factors explained travel decisions".
   a. Travel budget hypothesis and commuting budget hypothesis need long-term data sets – these are necessary for creating and designing sound transportation policies.
   b. Modellers will have additional data to model and calibrate their time series data sets.
3. "Inter-metropolitan comparison of travel behaviour would be possible and would assist in adapting the next generation of travel models from one city to another."
4. "Allow the development of new performance measures that can actually be tracked over time by providing data in much more detail than the invaluable but geographically broad Nationwide Personal Household Transportation surveys of 1969, 1977, 1983, 1990, 1995, 2000; or the decennial Census Journey to work surveys that give great information on journey to work, but none on non-work travel."

Pendyala, R., & Bhat, C. (2004) Emerging issues in travel behavior analysis. Paper presented at the *National Household Travel Survey Conference: Understanding our Nation's Travel,* Washington, DC.

The paper suggests data types that might be obtained through the NHTS in the future. Activity and time use surveys can help in understanding the relationship among in-home and out-of-home activities and among household members; e.g., how the use of technology at home might affect travel. This will require GPS-based and other technology-based data collection devices, which in turn will provide route-choice data. The paper suggests that the NHTS could have an attitudinal survey to understand how travellers might react to alternative policies and to isolate spurious causation from true causation.

Short-term (departure time choice, mode choice, etc.) and long-term (auto ownership, work location choice, etc.) dynamics in travel behaviour can be determined using 10 to 20% of the sample as a panel sample. In addition, the paper suggests collecting at least one weekday and weekend of data travel from each individual in the sample. Several questions could be included to understand behavioural processes.

Constraints (modal, institutional, household, and personal information), flexibility, and opportunities (location of activities, timing of activities, modal options, parking options) contribute to shaping travel choices and behaviour.

The paper also suggests integrating supporting and secondary data such as technology availability and use, personal/public health data, transportation supply data, and land-use data in order to understand relationships.

Sharp, J., & Murakami, E. (2004). Travel survey methods and technologies resource paper. *Data for Understanding our Nation's Travel: National Household Travel Survey Conference,* Washington, DC.

Examples are given of other travel surveys throughout the discussion of various possible methodological and design improvements to the NHTS. Cell phone-only users and address list incompleteness pose problems for traditional surveys. Meanwhile, the Internet has coverage problems, and there are no comprehensive lists for cell phones. The sample size is determined by the desired level of precision, sample design, non-response, and eligibility rates. Cost efficiency would require a reduction in sample size with a larger reference period, but that would create additional estimation issues and would not be seen as an improvement.

Minorities, low-income people, and large households tend to be more non-respondents. Changing the sampling unit to a person might improve response while maintaining the ability to simulate travel for a household. Non-response is attributed to the following, with the reason for the use of some of them in parentheses: multi-stage telephone data collection with no non-response follow-up (high non-response does not always indicate large bias), short data-collection window (meant to reduce response problems), limited reference period of travel, limited proxy allowance (discretionary trips are underreported by proxy), and interviewer assignments.

Comparisons of time-use and trip-based surveys showed that many are soft refusers. GPS and time-use survey data can be used to check the reported information. Implementing activity-based (time-use) surveys instead of trip-based is a matter of a tradeoff between quality and cost. GPS recorded travel on maps helped respondents remember trips even after two weeks. Cell phones are less accurate, have a higher penetration, and cost less. The web is being used more, but mainly for shorter O/D travel surveys.

There must be a tradeoff between improvements and continued ability to track trends over time. Outreach with data user community is necessary for more successful, sustainable designs that meet data needs and produce a more useful and consistent product.

This report introduces and discusses survey methodology considerations for the next series of personal travel surveys conducted by the Department of Transportation in the US. Four options for survey design, including single cross sectional, repeated cross sectional, longitudinal panel and rotating panel are introduced and advantages, disadvantages and examples of each are tabulated. Advantages and examples of continuous surveys are also introduced. The report indicates that 6% of households are considered cell phone only households, and due to the coverage issues this causes, and general low response rates, a number of other sampling frames (as opposed to the conventional RDD) are introduced, while advantages, disadvantages and examples for each are provided. These include area frame, list frame, retired sample, and dual frame. The National Survey of America's Families is provided as an example of survey using dual frame sampling.

Data collection methods, namely FTF, phone, mail and internet are also compared with respect to coverage, response rate, quality and cost. The study suggests that mixed mode surveying is the most viable option in capturing various groups.

A discussion is provided on trip-based versus activity-based (Time Use) surveys, while no conclusions are made about which approach is better. The use of GPS and Cell phone technology for tracking individual's locations and activities is also suggested. The passive GPS study of the Commute Atlanta project is introduced as a useful example. Other topics are discussed such as surveying subgroups of interest, nonresponse-minimizing techniques, stages of contact to complete interview, nonresponse follow-up, reference Period, proxy allowance and effects and questionnaire design.

Stopher, P. R., & Greaves, S. P. (2007). Household travel surveys: Where are we going? *Transportation Research Part A: Policy and Practice, 41*(5), 367-381.

This paper provides a review of recent history of household travel surveys and some of the problems that recent surveys are encountering. The major problems are identified as the new demands being placed on data, increasing non-response rates, errors and inaccuracy in trip reporting, and Do Not Call registries (starting in Canada as of September 30, 2008). The study indicates that it is becoming more difficult to collect quality data by means of the telephone. The paper reviews the data demands of current and emerging travel demand models and concludes that there are many new demands being placed on data, both in terms of the extent of the data required and the accuracy and completeness of the data. Through analysis of the history and effectiveness of the diary survey, while still reluctant to forecast the demise of diary surveys, the research indicates that there are problems with the diary survey and that there is a need to look increasingly at possible alternatives to it.

In terms of future direction for data collection, the study looks at GPS technology and evaluates the advantages in terms small size/weight and high data storing capacities. It is also suggested that aside from time, speed and position, GPS systems can provide additional information such as trip purpose. Recommendations are also made in order to address the problem with loss of GPS signal in areas with tall buildings. Another advantage of GPS identified here is the ability to collect data over much longer time periods. Some of the

disadvantages of using GPS are also introduced notably costs, and sample bias due to the type of people who would complete a GPS survey.

Moving to panel surveys is another recommendation made by the author as a better sampling methodology. The study suggests that a combination of a split and rotating panel for national measurement of travel behaviour has enormous appeal, and could potentially provide a mechanism to overcome some of the growing problems of multiple independent cross-sectional samples in metropolitan areas, including a move away from reliance on the diary survey. Advantages and disadvantages of continuous surveying are addressed here, while no examples are provided of travel surveys experimenting with continuous measurement in the field of transportation. Meeting modeling requirements is noted as the major problem with this type of surveying.

A discussion of data fusion and research supporting improvement in resulting data are also presented. The research claims that univariate ‘‘trip-based’’ approach can clearly be extended in various ways to incorporate greater behavioural reality in the data, which is critical for emerging modelling needs. The study proposes a new paradigm for data collection that places the emphasis on a paid, national panel that is designed as a rotating, split panel, with the cross-sectional component conducted as a continuing survey.

Sampling

Zmud, J. (2007). *Full survey design documentation.* Unpublished manuscript.

This memo documents the design and methods of the 2007 COG/TPB Household Travel Survey. The sample frame is stratified by 30 geographic strata. These strata are composed of aggregations of individual postal carrier routes and area type within jurisdiction. Area types include higher-density, mixed-use urban areas, and lower-density suburban areas that are primarily residential, since demographic and travel behaviour characteristics are known to vary distinctly from these two area types. The sample was designed to result in 10,000 completed households. These include 260 households who agreed to use GPS devices on their vehicles. An address-based sample is obtained, and addresses and names are matched with a different sample of all landlines. After the address matching, sampled records will be assigned to one of two sample types. Address samples for which a current telephone listing match is obtained will be assigned to Sample Type 21 (STYPE 21). Address samples for which no current telephone listing match is obtained will be assigned to Sample Type 22 (STYPE 22). A $50 incentive is offered to the STYPE diaries that are completed. A 34% and 12% response rate is expected from the STYPE 21 and STYPE 22, respectively.

Different survey materials are used to accommodate for the dual-frame sample of the survey. An advance letter will be sent to both samples (STYPE 21 and 22). 3 reminder postcards at 10+, 20+ and 30+ days will be sent to the STYPE 22 records. Mail-in/Mail-back household questionnaires are also sent to the STYPE 22 records only, along with the advanced letter. There will also be a web-version of the HHQ; the link will be provided in the advance letter. STYPE 21 records will complete the hhld interview portion through CATI. Diary letters and diaries are also sent to both groups.

Sen, S., Zmud, J., & Arce, C. (2008). *Evaluating efficiency and effectiveness of cell phone samples.* Unpublished manuscript.

This PowerPoint presentation summarizes the results of research done by NuStats on exploratory evaluation of two sampling frames for travel surveys: Cell-phone sample, and address-based sample. The research compares response rates, coverage (based on age, household size, household income, and education), and cost per interview. The presentation concludes that the address-based frame is “information rich” compared to cell phone. In addition, the coverage of telephone ownership types is broader in address-based frame. Response rates are relatively similar between the two sampling methods. While the cost of cell-phone based frame is focused on telephone interviewing, the costs associated with the address-based frame include mailing, telephone and incentives. Both frames capture the unique characteristics of cell-only users

Bricka, S., Sen, S., & Arce, C. (2007). *Chicago regional household travel inventory – sampling plan.* Unpublished manuscript. Retrieved June 2, 2008, from http://www.nustats.com/chicago/

This memo summarizes the proposed sampling approach work plan for the Chicago Regional Household Travel Inventory. This includes a review of white paper, previously reviewed and included in the “sampling” section of the literature review.

The sampling frame is described as a dual-frame, which combines the 100% coverage provided by RDD frame of the listed and unlisted households with landline telephones, and the coverage of households with no telephones or cell-phone only households provided by address-based frame. The reason for this dual-frame sampling approach is the increasing trends in cell-only households, particularly among the younger single-person households as well as the low-income and immigrant populations. An address-based sample is a random sample of all residential addresses that receive US Mail delivery.
The main disadvantages of recruiting households through this sample frame are:

- That recruitment is passive, as respondents must open the mailing and respond via mail, web, or telephone in order to participate in the survey.
- The use of address-based sample requires additional mailings of reminder postcards and attractive, eye-catching packaging of the initial mailing of survey information.

A stratified probability sample of households is employed, which is said to ensure high levels of coverage, accuracy, and efficiency compared to non-probability samples.
The sampling strategy to maximize the capture of behaviours of interest for the planned activity- and tour-based models considered for future model development in the Chicago region is described from a stratification point of view. It is noted that in a region with a full range of transportation options (from non-motorized travel to auto travel to several transit options), model validity requires sufficient samples from travelers using each mode.
The final sample size is made up of 5,800 surveys where households will record travel details for a 24-hour period and 5,800 surveys where households will record travel details for a 48-hour period.

Low income, African America, and young travelers are of particular interest in survey sample coverage. Therefore, specifications are made as to what percentage of the total surveys is required to be from each of these groups (22%, 18% and 4%, respectively). Higher levels of non-response are anticipated among these respondents as compared to the general population. These groups will be tagged for incentives, and additional sample is gathered through address-based sample and other focused data collection techniques.

Abi-Habib, N., Safir, A., & Triplett, T. (2003). ***2002 National Survey of America's Families: Methods and Data Reliability*** **No. 2). Washington, DC: The Urban Institute.**

The 2002 National Survey of America's Families (NSAF) is a survey of the economic, health, and social characteristics of children, adults under the age of 65, and their families. This report provides readers with an introduction to the National Survey of America's Families, its sample design, sample frame, data collection techniques, and estimation methods. In addition, the methods used to minimize errors and compensate for those that are unavoidable in data collection are described. Interviews were conducted with over 40,000 families, yielding information on more than 100,000 persons under the age of 65.

The survey features a dual-frame sample. The main frame consisted of a random-digit dial (RDD) sample of telephone households. Serving as the supplementary frame, an area sample of nontelephone households was designed to capture respondents living in households without land-line telephones. For the latter sample, households were given in-person screening interviews to determine non-telephone status. In an effort to minimize mode effects, in-person interviewers provided cellular telephones to respondents in non-telephone households to connect

them with interviewing centers for the CATI interview. As such, interviews were conducted in essentially the same way in both telephone and non-telephone households.
The report presents information on the survey's resulting reliability—both in terms of sampling and non-sampling errors.

Yuan, A. Y., Allen, B., Brick, J. M., Dipko, S., Presser, S., Tucker, C., et al. (2005). Surveying Households on Cell Phones—Results and lessons. Paper Presented at the *60th Annual Conference of the American Association for Public Opinion Research*, Miami Beach, FL.

The Joint Program in Survey Methodology (JPSM) at the University of Maryland undertook this study in order to address issues related to surveying cell-only households in a survey for its 2004 JPSM Survey Practicum. The study sampled telephone numbers from a frame of cell phone numbers and a traditional RDD sample in a national survey. Some of the issues related to contacting cell phones are identified to be safety of respondent in case they are involved with other activities (e.g. driving), charges associated with the call, and confidentiality of the conversation since cell phone connections are wireless and can take place in public.

Experiments were constructed, for the cell phone frame, to evaluate the effect of sending an advance text message and of offering different levels of incentives. Results of this experiment suggest that higher offers of reimbursement resulted in a higher response rate. On the other hand, the text messaging experiment did not show that sending text messages enhanced the contact rate or the response rate for the cell phone sample.

A problem with the cell-phone sampling frame was that nearly half (48%) of the Cell Sample numbers were either non-residential or nonworking.
An interesting finding was that households with only a cell phone required a lower level of efforts for completing the survey, compared to households with landline only and those with both services.

Brick, J. M., Dipko, S., Presser, S., Tucker, C., & Yuan, Y. (2006). Nonresponse Bias in a Dual Frame Sample of Cell and Landline Numbers. Public Opinion Quarterly. Special Issue: Nonresponse Bias in Household Surveys, 70(5,SpecIssue), 780-793.

This study evaluates the feasibility of including cell phone numbers in random digit dial telephone surveys in the United States by conducting a dual frame survey of landline and cell phone numbers. The article describes the effect of nonresponse on the practicum survey estimates and the usefulness of statistical weighting adjustments in addressing nonresponse bias. Results suggest that both topic salience and household inaccessibility contributed to nonresponse bias. It was found that cell-only households are more likely to respond to cell phone surveys than households that have both types of service. It is suggested that in order to eliminate the inaccessibility bias by identifying and contacting only those cell-phone numbers that belong to households with no landline, as opposed to households with both landline and cell-phones.

Keeter, S., & Kennedy, C. (2006). The cell phone challenge to survey research. Unpublished manuscript.

This study examines coverage bias in election research by conducting a controlled comparison of estimates across a standard land line sample, cell phone only sample, and blended

landline and cell phone only sample. Findings suggest that cell only Americans tend to be younger, less affluent, and less likely to be married or own their home. The study also assesses the feasibility of conducting a telephone survey in a cell phone sampling frame.

Link, M. W., Mokdad, A. H., Kulp, D., & Hyon, A. (2006). 'Has the national do not call registry helped or hurt state-level response rates?' Public Opinion Quarterly, 70(5), 794-809.

Unlike answering machines and caller ID, the DNC Registry has the potential to rapidly affect the entire RDD sampling based on the registration rate. The study did not find a positive or negative impact on state-level (not individual) response rates as a result of the national DNC Registry. It may take a longer period than 21 months for the registry to have an effect.

The study found that level of effort had a non-uniform effect on response rates, use of advance letters improved response rates, and changes in data collectors has very little effect. The paper suggests that other operational and societal factors beyond those controlled in the study are effecting the steady decline in response rates in most states. The study did not consider separate state DNC registries.

The paper recommends that more research be done to understand how registrants differ from non-registrants.

Paskota, M. (2004). Sample design and survey error. Paper presented at the *Seventh International Conference on Travel Survey Methods,* Costa Rica.

The author claims that sample error has often been ignored in past survey efforts, while errors due to nonresponse are considered the largest source of error. The influence of various survey modes on the sample, including the advantages and disadvantages of each method are discussed here. It is suggested that the best approach in dealing with disadvantages of these methods in combining survey modes and targeting different types of people with different modes (e.g. web based survey for university students, FTF interviewing of households with no land line, etc).

Sample design is looked at from a statistician point of view. Probability samples are the focus of this research. The paper provides a discussion of what needs to be known before beginning the sample design for a survey. Difficulties in obtaining an appropriate list for the sample frame are identified as a part of this paper.

Since error is present with all types of samples, it is only possible to estimate error with probability samples. Probability samples are classified as follows:

- Simple Random Sample – elements are chosen completely randomly, independent from one another and without replacement, that is, an element that has been drawn once can not be chosen again.
- Systematic Sample – dividing the population by the sample size, we get the value called the step.
- Complex Random Sample – stratified sample, cluster sample, multistage sample.
- Sub populations or status are clearly defined in the population
- Standard classification to one-stage and multi-stage samples.
- Biased sample – this error is quite large and is defined

Coverage errors, sampling errors, nonresponse errors and adjustment errors are identified as sample-dependant errors, while measurement errors and processing errors are considered sample independent errors. A detailed discussion of sample size and sailing error estimation is provided for both simple random samples and stratified samples. The sample design and error estimation procedure for the Belgrade 2002 survey is provided in this paper as an example.
The application of principal component analysis, cluster analysis and other multivariate statistics methods would provide solutions both for 'typical ' variances and selection of significant variables. Precision of data is of utmost importance in travel surveys, since the data that have been collected that way are mostly used for modelling and planning in traffic. One should bear in mind that the error that has been propagated through the process of modelling in traffic is total survey error.

Sen, S., Arce, C., & Lawton, K. (2006). Chicago regional household travel survey - white paper: Sampling considerations. Austin, Texas: NuStats.

NutStats is a private company who is contracted for a number of household travel surveys in the US. This report covers the topics related to the sampling of the Chicago household travel survey. Topics of interest related to our study are sampling frame(s), bias related to cell phone only households, treatment of unrelated, student, and multi-family HH, continuous, choice-based sample or fully random sample sample/seasonality effects.

The study proposes using a Dual-Frame sample, which combines the strengths of the RDD and Address-based methods, and provides considerable savings in cost compared to a single frame with similar precision. Two random sample sets are generated, one from a list of addresses with phone numbers attached and another from a list of addresses without phone numbers (cell phone only households).

In terms of sample stratification, the report suggests stratification by composite measures of density and/or mixed use factors. The study also derives a sample size based on recommendations of the Travel Survey Manual (1996).
Issues of item nonresponse and unit nonresponse are discussed here. Some of the suggestion in dealing with unit nonresponse include use of pre-survey monetary incentives, a prenotification letter and reminders, training of the interviewers, and increasing efforts to contact households that are difficult to contact.

Some of the recommendations of the report are based on a pilot study experimenting with mailing cell phone only households, offering various types of incentives, pre-survey letter and offering respondents other methods of communication, etc. The following is a link to the results of the pilot study:
http://surveys.nustats.com/start/Chicago/Documents/Chicago%20Regional%20Household%20Travel%20and%20Activity%20Inventory%20Pilot%20Report.pdf

In support of passive mailing approach for capturing cell-only households the report states "In Washington, we were able to disentangle the telephone matched sample from non-telephone matched. When this was done, we found that the non-telephone matched address-based sample that relied solely on the household questionnaire for participation reached very different types of households than did the RDD sample – cell-only persons in their 20s and 30s. These persons also tend to be zero-vehicle households."

Other topics covered in this report include language needs, participation of communities and influence of politics, participation of newcomers to the region, sampling error, etc.

UK Department of the Environment, Transport and the Regions. (2001). ***National statistics quality review - national travel survey - annex E***

Not a very useful source.

Annex E covers some design and estimation aspects of a 2001 quality review of the UK National Travel Survey. It covers topics related to sample size and design and those associated with maximizing response rates and minimizing nonresponse bias.

Current sample size (2001) of the NTS is 3300 households (proposed expansion to 10,000), which makes sample size almost incomparable with the TTS.

The sampling frame is the small-users sub-file of the Postcode Address File (PAF) and Postcode Sectors are used as primary sampling units. These units are formed into strata as follows: Government Office Regions, Proportions of households in the area with no car, and Proportions of heads of household classified as socio-economic group.

Analysis of response rate to the 7-day diary is also not significantly related to the TTS survey. The reports suggest that the department of transportation should apply weights to correct the bias against multi-household addresses.

Unit of Data Collection

Overview of Literature

	Trip-Based Surveys	Activity-Based Surveys
Advantages	• Detail recording of location/movement details; • Accurate time recording.	• Better capturing of short trips; • Detail recording of parallel activities and sequencing of activities; • Precise description of trips combining different modes; • Higher and better understanding of the context of travel in relation to other activities.
Disadvantages	• High immobility rate as a result of "soft refusal"; • Limited in-home and activity sequence information; • Insufficient capturing of trade-off between in home and out of home activities; • Activity recording linked to trips; • Higher rate of omission of short trips.	• Begin and end times dependant on time reporting intervals; • Increased respondent burden; • It is argued that short trips (eg. Walking trips) might be over represented if the default time intervals are too large, due to rounding.

Examples – about a quarter of current travel surveys are activity-based surveys

- Denmark
- Austria
- Italy
- Germany (activity/trip based)
- Belgium, 1999
- Great Britain Time Use Survey
- Swedish National Time Use Survey

Hato, E., & Timmermans, H. (2008). Electronic instrument design and user interfaces for activity based modeling. *Proceedings of the 8th International Conference on Survey Methods in Transport,* Annecy, France.

This paper states that traditional travel surveys, organized around trips, were gradually replaced, at least in academic research, by activity-travel and time use diaries, organized around the sequence of activities. It is noted that the more advances activity-based models incorporate household decisions, task allocation, substitution between physical and virtual travel, and travel arrangements. The resulting increased complexity of the measurement and data, and the associated respondent burden are expected to have significant ramifications for the validity and

reliability of the collected data. As a result, the paper attempts to address the question of if and how modern technology can be used to improve the validity of and reliability of such data collection instruments. More specifically, the research looks at how to design the instrument to create excitement, enhance involvement and motivation and reduce boredom, while avoiding that visualization becomes dominant or technology too overwhelming.

The research looks into history, design and user interface and evaluation of computer-assisted activity diaries, stated preference data collection methods, and interactive computer experiments. The research concludes that in order to achieve high quality data respondents need to be motivated to participate in the survey. Innovative interfaces may help and improve data quality. Most important, a professionally designed, high quality, attractive interface may induce people to participate in the data collection and be motivated. While visualization, and attractive design and user interfaces may improve the motivation of respondents and help them better understand the purpose of the data collection and the set of attributes and choice alternatives that are relevant, there is also the potential problem of biased information processing.

Nobel, B. (2001). Using simple time-use surveys to investigate travel. *6th International Conference on Survey Methods on Transport,* Kruger Park, South Africa.

This report describes an experimental time-use survey in Great Britain and compares the results to the GB National travel Survey. The author identifies three main reasons for using a time use survey:

- more accurate measurement, as short travel episodes may be less likely to be omitted
- more understanding of the context of travel in relation to other activities
- a lower cost alternative if a full travel survey is too expensive, provided adequate travel data can be collected accurately as part of a general purpose time use survey.

Short trips, especially non-home based walking trips are known to be better captured through diaries in time-use surveys. The comparison of the Swedish National Time Use Survey and the Swedish National Transportation Survey reveals that the average trip times recorded for people aged 20-64 were 91 minutes per day on the Time Use survey, and 79 minutes on the Swedish NTS. The difference was almost entirely attributable to differing walk times of 25 and 13 minutes per day.

The issue of change in the traditional separation of home and workplace as a result of new technology is brought up to argue that the current methods and data do not meet the needs of the ‘next generation’ of transport planning models.

In the context of reducing survey costs, it is argued that a time-use survey can be funded by a consortium of different interest groups from the commercial and public sectors. Another advantage in implementing time-use surveys in that the data can be compared more easily with that of other countries, compared to data from a travel survey.

Different aspects of a diary such as “closed” (predefined slots for recording of each activity) and “opened, retrospective and prospective are introduced.

The report goes into describing the conduct and results of the GB Time-use surveys, and concludes that a general time use survey is not a substitute for a full survey specific to travel because travel is likely to be under recorded, and there may be insufficient detail to be useful. However, if special attempts are made to record travel, this may well lead to over-recording

Stopher, P. R., & Wilmot, C. G. (2001). Development of a prototype time-use diary and application in baton rouge, louisiana. *Transportation Research Record,* (1768), 89-98.

This study provides a good overview of evolution of activity diaries since the first examples in the 90's in the US, with the purpose of changing the focus of the respondents to activities instead of travel, since anecdotal evidence suggested that trip rates were higher from the activity diaries than from trip or travel diaries. The authors indicate that in spite of all the efforts to improve the data collection method through the years, one problem still remains: the diary format is often poorly understood by respondents, and considerable effort is often required to repair the data. This paper reports in research designed to developed cost-effective ways of improving the diary. A time-use diary is developed that collects data on both in-home and out-of-home activities, treats travel as another activity, but gets away from sequential numbering of activities throughout the day.

A pilot survey and main survey are conducted. Analysis of the results suggest that the developed day-planner format of a time-use diary holds considerable promise for collecting more complete activity and trip data. The overall trip rates reported in this survey are at the high end of those generally seen from more conventional trip, activity, and time-use diaries.

Arentze, T., Dijst, M., Dugundji, E., Joh, C., Kapoen, L., Krygsman, S., et al. (2001). New activity diary format: Design and limited empirical evidence. *Transportation Research Record,* (1768), 79-88.

This project was conducted as part of a research program involving several research groups in the Netherlands. This paper summarizes efforts in developing a new activity diary format that integrates the positive features of the traditional travel diaries with those of a time-use diary.

<u>Trip diaries</u>

> Advantages
- detail recording of location/ movement details
- accurate time recording

> Disadvantages
- Limited in-home and activity sequence information
- Insufficient capturing of trade-off between in home and out of home activities
- Activity recording linked to trips

<u>Time Use Diaries</u>

>Advantages
- Detail recording of parallel activities and sequencing of activities
- Capturing of more trips

>Disadvantages
- Stage-based information limited
- Begin and end times dependent on time reporting intervals
- Increased respondent burden

All three formats were evaluated on their trip reporting rates, rounding of trips, missing activities, and overlapping begin and end times. This was done through testing the diaries using a sample of 62 students, researchers and non-university people.

The study concludes that small differences in the design of activity diaries may have significant improvements in response. The qualitative assessment of the performance of the three diaries suggests that all three formats perform satisfactorily, and that the only exception is that the stage diary (trip-based) perform somewhat poorer for ease of encoding in-home activities, whereas the combined diary performs considerably better regarding the ease of taking the booklet along.

Patten, M. L. (2004). Integrated survey design for a household activity-travel survey in centre county, Pensylvania. ***83rd Annual Meeting of the Transportation Research Board,*** **Washington D.C.**

This report describes new method to maximize participation in activity based travel-related surveys created by a team at the Transportation Survey Center, which is a unit within the Mid-Atlantic Universities Transportation Center at Penn State University. It is noted that activity surveys require a somewhat different design because of the additional respondent burden and the sensitivity of the questions.

Armoogum, J., Axhausen, K. W., Hubert, J. P., & Madre, J. (2004). Immobility and mobility seen through trip based versus time use surveys. ***7th International Conference on Survey Methods in Transport,*** **Costa Rica.**

This study is a comparison of the time-use surveys (TUS) and trip-based surveys of France and Belgium. Immobility rate and mobility in terms of travel time budget and trip frequency of each survey type are compared for each country.
The comparison reveals that estimation of mobility with a TUS is subject to bias in term of immobility rates and travel time budget. It can be said as well that TUS biases time budgets because it rounds durations of very short trips to too large values.

The Belgian time use survey catches more trips than the trip based transport surveys. The activity based approaches give a better description of short (mainly walk) trips; thus, if an overestimation of immobility is due to the omission of short trips, a better description of immobility could be expected from them.

When comparing the indicators for types of activity the surveys diverge less for working people than not working, perhaps because home to work trips are much easier to conceptualize and write down in a transport survey questionnaire.

The study concludes that mobility surveys have advantages: its gathers precise description of trips combining different modes, and better geographical information. We could assess from this analysis that the two surveys correspond qualitatively well to one another, especially on weekdays. Daily number of trips per person, and modal shares in travel time are quite similar, though the time-use survey bias may exaggerate the share of walking.

Madrigal, E., & Monzon, A. (2007). Applying an activity-based travel diary compared to a trip-based travel diary in both a central and an outlying zone in Madrid. ***86th Annual Meeting of the Transportation Research Board,*** **Washington, DC.**

This paper provides an analysis on the result of a pilot survey conducted with the purpose of comparing and evaluating a new activity-based travel diary design with a more traditional trip-

based diary format used in both Spanish local and national travel surveys. This is to determine the relationship between the unit of data collection and the low trip rate reported in Spanish surveys. The report illustrates that the travel survey in Spain shows the lowest daily trip rates when compared to other national travel surveys across the globe.

Results of the pilot survey using the two different diaries show that an increase of 46% in the trip rate reported was experimented with the activity travel diary (57% in central zone and 29% in the outlying one). The underreported trips correspond to non-essential mobility and to trips corresponding to run-on travel movements.

Bose, J., & Sharp, J. (2005). Measurement of travel behavior in a trip-based survey versus a time use survey. *American Time use Survey (ATUS) Early Results Conference,* Bethesda, Maryland.

In other research, more trips are reported, and there is less immobility in time use versus trip-based surveys. In a comparison of the 2003 ATUS and 2001 NHTS, the following were similar: number of trips (after chaining trips in ATUS), modal estimates, and several trip purpose estimates. Similarities are attributed to illustrations to NHTS respondents of desired trips in trip diaries, reconciliation of trips among household members in the NHTS, overestimation of travel times in NHTS because of no bounds as in ATUS, and potential substitution bias in the ATUS.

ATUS provides information about context while NHTS has more transportation-specific data, which can also be collected through the ATUS if necessary. There was difficulty in matching categories across surveys.

Use of Technology

Adler, T., Rimmer, L., Bandy, G., & Schellinger, D. (2000). Use of respondent-interactive geocoding in Baltimore, Maryland, mode choice survey. *Transportation Research Record, 1719*, 154--158.

This stated preference computer-based mode choice survey was undertaken in definite locations (e.g. malls, office parks), interviewing passersby. Questions were asked about the trip chain, stop locations, and mode. The survey was conducted over 17 days and comprised more than 600 respondents. Participants were screened by interviewers, and the selected ones then filled a computer-assisted self-interview (CASI) survey. Interviewers were available to provide help on the CASI part of the survey. Most respondents were able to geographically locate their stops using the GIS tools provided in the CASI survey. Participants could locate their stops using the street address, the business name, the intersection, or by clicking on a map. The authors suggest that all options should be offered, especially if the survey is to be unattended, for example if it is conducted over the Internet.

Schuessler, N., & Axhausen, K. W. (2008). IDENTIFYING TRIPS AND ACTIVITIES AND THEIR CHARACTERISTICS FROM GPS RAW DATA WITHOUT FURTHER INFORMATION. Paper presented at the *8th International Conference on Survey Methods in Transport,* France.

A summary of the use of GPS in travel surveys is provided, and the use of GPS in the Swiss cities of Zurich, Winterthur and Geneva is analyzed. Advantages presented are more detailed information, prevention of under-reporting of trips, and reduction of participants' burden to a minimum. Additional data must somehow be derived – individual trips and activities, start and end times, modes used by participants, routes, and trip purpose.

Person-based GPS studies have recently become more popular. This raises the requirements for the post-processing procedures considerably. The steps involved are data filtering, detection of trips and activities, mode stage determination, mode identification, and map-matching.

Errors can result from the lack of satellites in view, warm start/cold start problems, random errors caused by satellite orbit, clock or retriever issues, atmospheric and ionospheric effects, multi-path signal reflection or signal blocking. Filtering methods take care of systematic errors, and smoothing techniques remove random errors.

The procedure proposed is person-based, covers complete trip and activity chains over several days and can deal with a large amount of data as well as a minimum amount of information available.

The data was compared with the Swiss Microcensus on Travel Behaviour 2005. Mode detection yields realistic results. The fuzzy logic approach of Tsui and Shalaby (2006) is used with new rules.

Map-matching will initially be employed externally, and then integrated into the postprocessing procedure.

For trip purpose, land-use data, time of day, duration of activities, and spatial clustering will be required.

Bricka, S. (2008). Non-response challenges in GPS-based surveys. Paper presented at the 8th International Conference on Survey Methods in Transport, France. from http://www.isctsc.let.fr/papiers/resourcepaper%20%20final%20version/A2%20RP%20bricka.doc

This paper provides a good summary of the use of GPS technology in travel surveys, and it is presented to a workshop whose purpose is to find ways to mitigate for nonresponse and ensure representative samples when GPS is used.

Based on an analysis of two surveys with GPS sub-samples, the author's expectation were confirmed. The GPS samples as compared with the main samples had higher nonresponse rates among low income and less educated respondents and lower nonresponse rates among younger respondents. The author suggests more documentation of factors that influence the levels of unit/item nonresponse within the GPS data.

The author suggests that the response burden of GPS-based surveys be studied. Time saved by using the GPS technology can be offset by battery life, portability, prompted recall surveys, and weight.

Possible ways to reduce item nonresponse are reminders, matching with other widely used technology, and ensuring that design improvements work for all GPS-participants. Based on the higher proportion of large households with children in the sample when there was an opt-out approach, the author states that the opt-in approach is preferrable (where all respondents are asked whether they would like to use the GPS rather than randomly selecting respondents to use the GPS).

Kracht, M. (2004). Tracking and interviewing individuals with GPS and GSM technology on mobile electronic devices. Paper presented at the *Seventh International Conference on Survey Methods in Transport,* Costa Rica.

This paper describes the then ongoing establishment of a GPS/GSM database that would allow for the exclusive use of GSM technology to track individuals (with corrections based on previous GPS measurements). Incomplete and inexact data can be further completed through interactive user response (where streets in vicinity are displayed or a map based on GSM cell ID is shown). This process is meant to reduce user burden and eliminate the use of travel diaries (travel purpose and mode should be detected).

The author justifies the parallel use of GPS and GSM by stating the advantage of combining the accuracy of GPS and the availability of GSM with the purpose of eliminating human inability to report precise and reliable geographic information.

Krygsman, S. C., & de Jong, T. (2008). Deriving transport data with cellphones: Methodological lessons from South Africa. Paper presented at the *8th International Conference on Survey Methods in Transport,* France. Retrieved from http://www.isctsc.let.fr/papiers/workshop%20final%20version/63%20B4%20Krygsman%20and%20DeJong.pdf

The logic behind using cell phones to collect travel data is as follows: person-based (as opposed to vehicle-based) GPS service is less understood/established, GPS is expensive for large-scale application, cell phone has high proliferation. The TeleTravel System in Germany and a trial exercise in Osaka, Japan are mentioned as application of the technology. Issues brought up are obtaining location information from cell phone operators, variable base station

coverage, and locations on the boundary of cells. Additional information, such as whether it is a trip or other activity, the activity type, the duration, etc., need to be obtained.

More travel time is reported through cell phones than through a time use survey in South Africa, possibly because of lumps of 5 minutes in the cell phone data or underreporting in the time use survey. The paper suggests further testing with 1000 units and comparisons with GPS and travel diary data.

Stopher, P. R. (2008). Collecting and processing data from mobile technologies. Paper presented at the *8th International Conference on Survey Methods in Transport,* France. Retrieved from http://www.isctsc.let.fr/papiers/resourcepaper%20%20final%20version/B4%20RP%20Stopher.doc

This is a fairly comprehensive summary of the use of mobile technologies in travel surveys. The author focuses on GPS technology in his discussion, while mentioning cell phone and WiFi. He proposes the use of GPS with GSM instead of dead reckoning devices necessary when GPS signals are lost. There is a discussion of various attributes -- in-vehicle/ portable, interactive (e.g. CHASE)/ passive, and real-time/ logged data. When using passive collection without prompt recall, imputations must be made about information usually provided by respondents. Software must be developed to process and analyze vast amounts of data. Mobile technology is presented as having greater accuracy than conventional means and providing as good information about modes. GPS is mostly used for validation, but the discussion is based on replacing conventional with mobile technology.

Wolf, J. (2004). Applications of new technologies in travel surveys. Paper presented at the *Seventh International Conference on Survey Methods in Transport,* Costa Rica.

This paper is an overview of mainly GPS technology used for travel studies. GPS was initially used to compare reported with measured vehicle trips (vehicle-based because of weight). Wearable GPS logging devices have been developed, which are either passive or have a user interface (PDA). Also, the paper mentions cellular positioning, stating that it is less accurate and that there are privacy and network issues. GPS chips in cell phones might resolve some problems.

If smaller sample sizes were used over longer durations, the cost of GPS would be reduced compared with traditional methods. The paper discusses prompt recall (mail-back, CATI, and CASI) and vehicle-based GPS datasets collected for other purposes.
Future studies will have a combination of high,low, and no technology solutions.

Yen, K. S., Lasky, T. A., Ravani, B., & Adamu, A. (2008). Dear diary: Travel behavior gathered with high-sensitivity GPS. *GPS World, 19*(3), 44-49.

This article describes a first-generation proof-of-concept prototype claimed to be useful for the 2010 California State Household Travel Survey.

The author promotes GPS by comparing it to Internet-only surveying, stating that GPS is more accurate and minimises response burden (automated data collection, reduces data entry, etc.), while providing information about route choice, path, and speed profile. Drawbacks mentioned are power requirement, weight, size, inability to differentiate between short stop and trip end, and signal loss. Appropriate techniques and tools must be developed to extract and

report useful survey data.

Chung, E., and A. Shalaby, 2005. "A Trip Reconstruction Tool for GPS-Based Personal Travel Surveys", Journal of Transportation Planning and Technology, 28(5):381-401.

This article describes the trip reconstruction tool developed by the authors to assign the links travelled and the modes used from the GPS data collected. The authors explain the benefits of using GPS units for travel surveys: GPS eases the data collection for the survey respondents, the routes used are recorded, there are no unreported trips, accurate information can be obtained for each trip (start, end, times, length), and the GPS information can be used to confirm reported trips. The wearable GeoLogger (product of GeoStats) was used, and some difficulties were encountered. Receiving the signal in certain locations (e.g. inside a bus) was sometimes impossible, and cold and warm starts, as well as urban canyons made some data unusable. The authors also explain the HDOP index. This index provides information on the quality of the records, depending on the number and positions of the satellites used by the GPS unit. They also suggest modifications to improve the trip reconstruction tool or the data used. These improvements include connecting the broken ends of the GPS data, the use of other clues in addition to the speed and the location of the mode change points, include a feedback cross-check between the modes and links selection, remove the unreliable data, maintain and update the GIS map, and test the tool with real travel survey data.

Tsui, A. and A. Shalaby, 2006. "An Enhanced System for Link and Mode Identification for GPS-based Personal Travel Surveys", Journal of the Transportation Research Record, 1972:38-45.

This project developed an integrated GPS-GIS system to automate the processing of GPS-based personal travel survey data. Two versions of the analysis system were developed in this project: a GPS-Alone System, which only uses GPS travel data as input, and a GPS/GIS Integrated System, which uses both GPS travel data and topological information in a GIS platform as input. The GPS-Alone System includes an activity identification algorithm and a fuzzy logic-based mode identification algorithm. The GPS/GIS Integrated System includes link identification in a GIS platform, as well as an Interactive Link Matching-Mode Identification Subsystem, which further refines the results from previous identification performed separately. This project demonstrates how GPS travel data analysis can be automated and highlights the benefits brought by an interactive analysis system, providing an innovative analysis method for personal-based GPS multimodal travel surveys.

Li, Z. and A. Shalaby, January 2008. "Web-based GIS System for Prompted Recall of GPS-assisted Personal Travel Surveys: System Development and Experimental Study", CD Proceedings of the 87th Annual Transportation Research Board Meeting, Washington D.C.

This study developed a new web-based software system to support emerging GPS-assisted personal travel surveys. The system, called TRIPS, enables data processing and data display, and it provides editing tools for prompted recall and post validation of GPS-based survey data. An experimental study was conducted using TRIPS to investigate various issues related to prompted recall surveys. The study showed the importance of providing human assistance to survey participants, particularly in tasks of activity/link editing. The study also

addressed other challenges associated with implementing TRIPS, including online data processing performance, multi-task handling and browser variability.

Person location and person tracking – Technologies, risks and policy implications. Clarke, Roger. (2001)

The author refers to many texts on the use of technology to locate and track people, for both real-time tracking and retrospective analysis. He also explains the basics of global positioning systems (GPS). The author lists some individual dangers of location tracking (some of them do not apply to travel surveys): discovery of individuals' behaviour patterns; possible embarrassing disclosures, blackmail and extortion; use of tracking logs as evidence for criminal cases; enhanced visibility of behaviour; repression due to tracking; security issues for persons at risk. He mentions that tracking is facilitated by new technologies and can have negative impacts on personal freedom, and that data retroactive analysis, as well as other data manipulations, also are a form of tracking. Finally, he suggests the use of pseudonymity to manipulate data as a compromise to help increase privacy when tracking is used. According to the author, pseudonyms should used to manipulate data, and matching pseudonyms to persons should only happen when necessary, and the complete data should be made available to appropriate organisations only if required.

Global positioning system as data collection method for travel research. Draijer,G.; Kalfs,N.; Perdok,J.

This pilot study was made in the Netherlands and started in 1997. The authors tested the use of GPS data collection instead (but sometimes with) paper-and-pencil travel diaries. They found GPS data collection was generally easier for the respondents, it gave better and easier to use data. Problems were noted with the reception and the user friendliness (weight, technology) of the GPS units. Privacy was a concern for some respondents (and people who refused to participate) but the authors found the effects of this concern "rather small". An instructor was delivering GPS units to the respondents and explaining how to use them. The instructor also picked-up the GPS units and transferred the data. This study was made in the late 90's, and GPS technology is probably a lot better now, but some of their concerns might still apply (e.g. privacy, technology).

MWCOG Household Travel Survey GPS Pre-Test: Results and Applications for a Large-Scale Regional Survey. Wolf, J.; Oliveira, M.

This paper summarizes the findings of a travel survey Pre-Test conducted in late 2006 on 800 targeted households, 250 of which were also selected for the in-vehicle GPS component. The households participating in the GPS component of the survey were pre-selected by the surveyors to prevent participants from opting in the GPS part and thus eliminate the self-selection bias. The 250 participants goal for the GPS part was not reached, and the authors identified 3 main reasons: the surveyors did not flag as many people as planned for this part of the survey, some selected households did not possess any car, and some refused to participate in the GPS part of the survey. The completion rate is lower than other travel surveys at 67%, probably because of the pre-assignment of the GPS component of the study. The challenges that were encountered for the GPS part include data gaps at the beginning of the trip (cold start); difference between the geocoded and the GPS destinations, which may be due to parking lot away from buildings, or to large business park areas and a lack of precision in the geocodong; and a lack of geocoded

locations for school and work sites. The authors made the following recommendations on the survey process: obtain more geocodes for habitual locations; reduce the turnaround time to get better geocoded CATI (computer-assisted telephone interview) trip information; have a feedback process to report anomalies happening with the CATI system; use a GPS logging device if any is commercially available, otherwise use an in-vehicle GPS unit; compare the GPS and the CATI trips to identify the differences between the two datasets.

Survey Instrument

Overview

Telephone and Mail

The most common modes of data collection have been telephone and mail-back. Response to telephone surveys has been declining because of various reasons, including call screening devices, unlisted numbers, cell-only households, survey requests being defined as intrusions, and privacy issues (Alsnih, 2004; Sharp et al; Tucket et al, 2002). Challenges facing the TTS, which uses only a telephone-based instrument, are described in the Sample Design section.

Web/Internet Surveys

Although there have been small-scale Internet surveys, the high level of research and testing following the transition from face-to-face to telephone surveys is yet to be applied for the transition from telephone to web surveys (Dillman 2007). An example of the use of the Internet is the Internet Prompt Recall where GPS tracking information is presented to the respondent on the Internet to additional information (Stopher et al., 2004). While there are various promising benefits in this transition, caution must be exerted while certain challenges are addressed. The benefits and challenges mentioned in most relevant papers are summarized below.

- **Benefits**

  Advantages of using web-based surveys mentioned in all papers discussing the issue are lower cost of distribution and retrieval, interactive features, visual aids and animation, quick response times, automated skip patters and randomisation of questions, possible capture of traditional non-respondents to conventional travel surveys (young and busy people), automated data entry and checking, no interviewer bias, and privacy. Several papers confirm that incorporating Internet-based questionnaires to a multi-instrument can help to attract younger and more affluent respondents, while using it exclusively is advised against (Adler et al., 2002; Alsnih, 2004; Dijst et al, 2006; Dimitris et al, 2008).

- **Challenges**

  - **Quality**
    Although there is no interviewer bias, doubts are raised about quality based on frustrated respondents providing misleading information and the view of the Internet as a means of entertainment (Alsnih, 2004; Dillman et al., 2007).

  - **Technological Problems and Selective Access**
    Completing the survey requires access to a computer, Internet penetration, computer literacy, and familiarity with the software (Alsnih, 2004), thus raising problems for exclusive use of the Internet for the general population. This can be described as problems with coverage and representativeness of the data. Server

availability and browser compatibility are examples of issues than need to be addressed to prevent frustration and nonresponse (Alsnih, 2004).

- **Contact/Recruitment Method**
  Internet questionnaires are usually closed access, where a URL and a unique password are provided to each respondent (Bonnel). There is no proven or generally approved method of recruiting and inviting potential respondents. Some possible methods are mentioned below. (Web and newspaper open invitations are also possible, but these could create bias.)

- **E-mail**
  E-mail messages are treated with suspicion or deleted before being opened because of the abundance of spam. If it is to be used, there must be prenotification through other modes.

- **Postal Mail**
  There is some evidence that sending an advance letter does not allow for a cognitive connection with an email message containing a link to the survey received afterwards, and sending the URL with a post card leads to respondents burden (Porter, 2007). Another study found that response rate and speed were less for contact with non-electronic means (Dimitris et al, 2008).

- **SMS**
  SMS is suggested as an alternative method of recruitment with higher immediacy and legitimacy, because spam is scarce and SMS messages have higher immediacy than e-mail; however, invitation should be trough e-mail to reduce burden (Bosnjak, et al., 2008).

- **Compatibility/Comparability of data**
  Assuming that the Internet is used to complement other modes, comparability of data can affect the quality of results and the potential for trend analysis. One paper suggests that if responses are similar across modes, lower response rates in web surveys would not be as critical, especially with its low cost (Manfreda et al., 2008; Alsnih, 2004). Consistency checks, reminders, and graphical shortcuts available in Internet questionnaires have resulted in more trips being reported than through either CATI or mail-back (Adler et al., 2002). Also, differences in substantive variables (attitudes, intentions, and behaviours) might make sub-samples incompatible (Roster et al., 2004). The difference between visual and audio stimuli as well as the significant effect of design elements on how respondents interpret and answer questions must be noted (Dillman et al., 2007). Sample selection bias must be accounted for when using several modes; the same respondents might provide different answers to the same questions in different

survey modes (Bayart et al., 2008). Most papers merely recommend that further research be done into whether data collected using different survey media results in comparable data (Bonnel).

Cell phone

Although cell-phone-only households pose problems for traditional surveys, there are no comprehensive lists of cell phones. This can be addressed by using the phone as the primary contact mode, while combining this with other modes such as mail-back and Internet to capture different groups of people (Zmud et al, 2006).

Bosnjak, M., Neubarth, W., Couper, M. P., Bandilla, W., & Kaczmirek, L. (2008). Prenotification in web-based access panel surveys: The influence of mobile text messaging versus e-mail on response rates and sample composition. *Social Science Computer Review, 26*(2), 213-223.

The reasoning behind the use of SMS (short messaging service) for prenotification about web surveys is as follows: (1) responding to an advance notification possibly with a prepaid incentive is seeing as repayment of a gift, favour, or concession; (2) post and telephone may not solve the problem of legitimacy in email prenotification due to increased telemarketing efforts; (3) SMS messages have higher immediacy and legitimacy (SPAM is scarce). In addition, clicking on link in an email message poses less burden than an SMS invitation. Corresponding with expectations, the combination that led to the most action on invitation was prenotification by SMS and invitation by email.

There was no evidence that some types of students are differentially attracted to the web surveys using SMS versus email for prenotification and invitation.

Dillman, D. A., & Smyth, J. D. (2007). Design effects in the transition to web-based surveys. *American Journal of Preventive Medicine, 32*(5 SUPPL.)

There is a brief discussion of measurement errors involved in the design of web surveys particularly in comparison with the more researched and tested telephone surveys. Several factors external to the design are mentioned -- cultural and social challenges in terms of how the Internet is typically used or perceived, technological challenges (connectivity, browsers, software, etc.) and user skill and willingness.

Design elements can significantly affect how respondents interpret and answer questions in the survey, and a direct copy of the telephone survey might alter meaning and/or expectations. Noting the visual instead of audio stimuli used for cues, the paper described the effects of various elements -- horizontal/vertical arrangement, grouping questions/choices, error messages, and graphics. More work has to be done to determine how to balance the utilization of features only found in web surveys with the need for mode compatibility.

Manfreda, K. L., Bosnjak, M., Berzelak, J., Haas, I., & Vehovar, V. (2008). Web surveys versus other survey modes: A meta-analysis comparing response rates. *International Journal of Market Research, 50*(1), 79-104.

This paper analyses only response rate differences among modes and based on characteristics of respondents. It proposes that further research be done about qualitative differences (item non-response, consistency of answers, etc.). Based on a meta-analysis of experimental comparisons, web-surveys are found to yield an 11% lower response rate compared to other modes. The paper suggests that if responses are similar, lower response rates would not be as critical, especially with the low cost of web surveys.

The difference in response between web and other modes is less for panel members (implying that mode concerns are more significant for one-time use), it is larger for mail solicitation compared to email (easier to complete when requested by email), and it gets larger for a greater number of contacts.

It is stated that web-survey methodology has not yet sufficiently developed. The response rate was expected to be lower for web-surveys because of security and privacy issues, limited possibility to improve response rates, lack of new techniques, limited web literacy, infrequent computer use, increased burden, technical limitations, no continuous reminder (with email contact), impersonal nature, and easiness to decline participation.

Porter, S. R., & Whitcomb, M. E. (2007). Mixed-mode contacts in web surveys. *Public Opinion Quarterly, 71*(4), 635-648.

A small-scale study where pre-notification and reminders are done through mail or e-mail is presented. All participants receive an email with a link to a web survey. The results show that the mode of contact (mail/e-mail) does not have a large effect on response rates. This is attributed to one of the following: (1) the respondents with the postal mail contact did not make a cognitive connection with the email message they later received or (2) there were more responses to the email contact because the source was a ".edu" address. The increase in cost might not be worth using postal mail contact, though non-response bias is not addressed in the paper.

The basis for this study was the concern that emails are either deleted before being opened or treated with skepticism, while postal mail may provide more legitimacy.

Roster, C. A., Rogers, R. D., Albaum, G., & Klein, D. (2004). A comparison of response characteristics from web and telephone surveys. *International Journal of Market Research, 46*(3), 359-373+386.

Web surveys are found to be equally or more accurate in predicting behaviour while costing less than telephone surveys. Weighting schemes and sampling adjustments are suggested to mitigate the overrepresentation of younger respondents in Internet samples. The removal of interviewer apprehension is seen to have caused increased item omissions.

The paper notes that differences in substantive variables (attitudes, intentions, and behaviours) might make sub-samples incompatible and have "far-reaching implications" for trend analysis. The common issues with Internet surveys are mentioned -- internet access, technology unevenness, coverage error, and sample representativeness.

Adler, T., Rimmer, L., & Carpenter, D. (2002). Use of internet-based household travel diary survey instrument

The paper describes a small-scale multi-instrument survey and asserts the usefulness of incorporating internet-based surveys. As most of the respondents who chose the internet option were younger and more affluent, it is suggested that incorporating CAWI (computer assisted web interview) is more effective if the area being surveyed has a significant proportion of younger and more affluent people (with higher Internet penetration). After linear regression to separate the effects of demographic and survey mode factors, users of the internet option were found to have reported more trips over both CATI and mail-back. The paper attributes this to consistency checks, reminders and graphical shortcuts available in the internet survey. In addition, internet respondents were satisfied by having completed the survey at their convenience. In comparison to CATI, CAWI allowed for graphical elements only possible in self-interviews while reducing costs. Although the internet option showed less nonresponse, the paper makes no conclusion about nonresponse rates.

Respondents using the internet option had to complete travel diary forms during the day and then input the information into the Internet. Access was closed through unique passwords.

Alsnih, R. (2004). Characteristics of web based surveys and application in travel research. ***Seventh International Conference on Survey Methods in Transport,*** **Costa Rica.**

Answering machines, caller-ID, cell phones, multiple phone line households, and unlisted phone numbers are presented as problems with using CATI. Web and email (not as popular) surveys reduce respondent burden in relation to self-administered surveys. It is noted that besides the data collection mode, topic salience might affect the response rate.

Advantages mentioned are low distribution and retrieval costs, automated data entry, visual aids and animation to assist, quick response times, automated skip patterns and randomisation of questions, possibility to obtain information about response behaviour, easy execution, and possible capture of a group of traditional nonrespondents to conventional travel surveys (busy or mobile people, larger households and households with higher socio-economic status).

However, using the Internet exclusive for the general population may cause problems as the method of recruitment determines who has access to the survey (representativeness and computer literacy issues arise). There might also be technological problems (e.g., server disruptions, inconsistent presentation, and complex survey design) and potential costs to the respondent (passing download limit or excessive download times). A small sample would make Internet survey more expensive than traditional survey modes, but variable costs are negligible and a high fixed cost for the first survey would lead to lower subsequent fixed costs.

The paper advises that Internet-based travel surveys be part of a mixed-mode travel survey to overcome representation problems and improve response rates. Also, it is recommended that a simple and coherent structure be adopted for all survey modes to be employed and respondents be given a choice as to how to respond. There is a thorough discussion of web-based survey design considerations.

The paper suggests that face-to-face interviews are perceived to have better quality because of their high response rates, when in fact they are more likely to produce socially desirable responses. Even so, Internet surveys often do not allow respondents to leave questions unanswered, thus raising doubts about quality.

The Internet Prompt Recall survey described by Stopher et al. 2004 is mentioned. GPS tracking information is presented to the respondent on the Internet to obtain additional

information.

Bonnel, P. ***Web-based surveys: Potential for travel survey?***
http://cost355.inrets.fr/IMG/doc/web-bonnel.doc

The paper outlines the advantages, disadvantages, and unresolved issues regarding the use of the Internet to conduct travel surveys. It recommends the use of Internet-based questionnaires in a multi-instrument survey (since Internet penetration and presence of required skills and equipment are too low for it to be used exclusively), specifying the following advantages: lower cost, interactivity extended to a self-administered survey, flexible time and place of survey, capture of individuals who do not respond to other survey modes, automated data entry and checking (e.g. consistency), and a faster response time. While computing developments make possible greater sophistication of design, respondent burden must be reduced through simplification.

The paper describes possible solutions to several problems -- contact method, server unavailability, non-uniform presentation of survey, and loading times. The author suggests that further research be done on the effects of the following: contact method, proxy reporting, incentives, number of reminders, survey duration, and compulsory completion of certain items in survey. There must also be research into whether data collected using different survey media result in comparable data.

Closed (as opposed to universal) access surveys are recommended since they allow for statistical inferences.

Dijst, M., Farag, S., & de Blaeij, A. (2006). Effects of data collection methods in travel behaviour surveys; comparing an internet and a mail sample. ***85th Annual Meeting of Transportation Research Board,*** **Washington, DC.**

The study found that there were less inconsistencies in the internet survey responses. Respondents had a choice between Internet and mail, and most of the Internet responders had experience using it. Exclusive use of the Internet would probably not have the same result.

Item nonresponse and rounding off of departure times were higher in the mail questionnaire. Those who responded by Internet mostly had the following characteristics: male, high-income, experienced/frequent users, and were in bigger cities. Unexpectedly, older people were more likely to use the Internet.

The paper mentions the same advantages and disadvantages as in other papers.

Dimitris, P., & Karanoglou, P. (2008). Comparison of phone and web based surveys for collecting household background information. Paper presented at the ***8th International Conference on Survey Methods in Transport,*** **France. from**
http://www.isctsc.let.fr/papiers/workshop%20final%20version/45%20A2%20Potoglou%20%20and%20Kanaroglou.doc

The survey discussed in this paper consisted of two stages. The first stage involved probability sampling with mail as the contact method, and respondents were given a choice to respond with phone or the Internet. The second stage involved convenience sampling with email, web, newspaper, and response was through only the Internet.

It is recommended that the Internet surveys be used complementary to traditional methods for the following reasons: telephone performed better when respondents were given a choice and coverage and sampling problems would be solved. This recommendation avoids the issue of selectivity of the Internet -- the limited availability of a representative sampling frame of email addresses and the requirement of computer literacy and familiarity with IT.

Response rate and speed of the Internet survey were found to be low when respondents were contacted through non-electronic means. The unit cost of the phone interviews was greater than that of the Internet interviews with convenience sampling, but the former was less than the unit cost of the Internet interviews with probability sampling. This implies that the Internet is a viable alternative when the contact method and design are properly selected.

Younger people were overrepresented in the respondents who deliberately used the Internet survey (through convenience sampling). The paper presents the Internet as suitable for reaching busy professionals and people who are younger, are higher educated, or have higher income. Advantages noted regarding the Internet as a survey mode are speed, lower cost, no interviewer bias, privacy, no typing and measurement errors, automatic data entry, and larger sample sizes.

Russell, N., Bose, J., & Giesbrecht, L. (2004). ***Nonresponse bias in a travel survey of nontelephone households.*** **Unpublished manuscript.**

The study uses supplementation survey to estimate potential nonresponse bias in two BTS sponsored random digit dial (RDD) surveys, the 2002 National Survey of Pedestrian and Bicyclist Attitudes and Behaviours and the 2002 National Transportation Availability and Use Survey. Results suggest that no telephone households are more likely to have less than a high school education, have children in the household, be younger than 35 years of age, male, zero vehicle household, and have a lower than average household size.

Sharp, J., & Murakami, E. ***Travel surveys: Methodological and technology-related considerations.*** **http://www.bts.gov/publications/journal_of_transportation_and_statistics/volume_08_number_03/html/paper_07/index.html**

Examples are given of other travel surveys throughout the discussion of various possible methodological and design improvements to the NHTS.

Cell phone-only users and address list incompleteness pose problems for traditional surveys. Meanwhile, the Internet has coverage problems, and there are no comprehensive lists for cell phones. The sample size is determined by the desired level of precision, sample design, nonresponse, and eligibility rates. Cost efficient would require a reduction in sample size with a larger reference period, but that would create additional estimation issues and would not be seen as an improvement.

Minorities, low-income people, and large households tend to be more nonrespondent. Changing the sampling unit to a person might improve response while maintaining the ability to simulate travel for a household. Nonresponse is attributed to the following, with the reason for the use of some of them in parentheses: multi-stage telephone data collection with no nonresponse followup (high nonresponse does not always indicate large bias), short data-collection window (meant to reduce response problems), limited reference period of travel, limited proxy allowance (discretionary trips are underreported by proxy), and interviewer

assignments. Comparisons of time-use and trip-based surveys showed that many are soft refusers. GPS and time-use survey data can be used to check the reported information. Implementing activity-based (time-use) surveys instead of trip-based is a matter of a tradeoff between quality and cost.

There is a comparison of data collection methods at (http://www.bts.gov/publications/journal_of_transportation_and_statistics/volume_08_number_03/html/paper_07/table_07_03.html).

GPS recorded travel on maps helped respondents remember trips even after two weeks. Cell phones are less accurate, have a higher penetration, and cost less. The web is being used more, but mainly for shorter O/D travel surveys.

There must be a tradeoff between improvements and continued ability to track trends over time. Outreach with data user community is necessary for more successful, sustainable designs that meet data needs and produce a more useful and consistent product.

Tuckel, P., & O'Neill, H. (2002). The vanishing respondent in telephone surveys. *Journal of Advertising Research, 42*(5), 26-48.

Problems relating to response that are noted in the paper include survey requests being defined as intrusions, reluctance to disclose private information (privacy), proliferation of telephone numbers dedicated to fax machines and/or computers, widespread access to the internet using a non-dedicated phone line, and ownership of call-screening devices. The mere availability of the call-screening devices makes it easier to filter out survey requests. (There is no inherent link between orientation toward survey participation and screening behaviour).

The paper proposes the following strategies to reduce rejection levels: improving quality of interviewing and making several attempts to convert initial refusal. In order to reduce inaccessibility, the author suggests making numerous call back attempts, using a prepaid incentive with an accompanying letter, and creating "brand awareness."
Individuals who register in "do not call" lists may become more receptive to surveys over time. (The list prohibits telemarketers but not survey researchers from contacting them.)
This study was not done through telephone to avoid bias.

Zmd, J., Dawson, G., Wivagg, J., Bachman, W., & Wolf, J. (2006). *Chicago regional household travel survey - white paper: Efficient data collection*. Austin, Texas: NuStats.

NutStats is a private company who is contracted for a number of household travel surveys in the US. This report covers topics such as data collection modes: telephone, web, GPS, in-person, mail, structure and length of survey instruments, GPS – vehicle, on-person.
A number of questions are raised and addressed. These include:
- How do we optimize the efficiency and effectiveness of using multiple modes to obtain higher levels of respondent participation and response?
- Where might the use of multiple modes add or reduce bias?
- Which modes are most appropriate for each type of sample, each type of respondent, and each stage of data collection?

To attempt to address the cell phone-only issue, a pilot survey was implemented. Based on this and other pilot projects the report makes a number of recommendations:
- Using phone as the primary contact phone, while combining this with other modes such as mail

back and internet to capture different groups of people.
- Achieving widest population coverage with address-frame and telephone match. Based on a pilot project the addressed-based frame, an incentive, and use of unlisted numbers did appear to be successful in capturing younger, single persons, apartment dwellers and persons with zero vehicles relative to RDD.
- Being creative in advance mailing packaging.
- Employ a "household questionnaire" to capture cell-only persons (Passive mailing). Literature review, pilot projects, and past experiences with this method are presented here to present the usefulness of this approach in capturing those groups of population that cannot be captured otherwise, although the response rate is lower and slower.
- Planning for and conducting follow-up activities for hard to reach populations.
- Using a GPS subsample for information value

The following is a link to the results of the pilot study:
http://surveys.nustats.com/start/Chicago/Documents/Chicago%20Regional%20Household%20Travel%20and%20Activity%20Inventory%20Pilot%20Report.pdf

Other topics covered in this report are timing of special population surveys, household surveys, visitor surveys, employer surveys, commercial travel.

Continuous Surveys

Summary

Continuous surveys provide data on temporal variability of travel and the effect of changes on responses (Ampt et al, 2008). Sampling is undertaken on a continuous basis with the data providing rolling averages over some predefined period of years (Stopher et al, 2007). As described in the literature, cross-sectional and panel surveys have been transferred to continuous or ongoing surveys (Sharp et al, 2004). Some advantages and disadvantages of conducting surveys continuously are listed below.

Advantages:

- Flatten budget over all years
- Fixed expenditure year after year, requiring less effort to secure funding
- Retain staff expertise
- Data collected throughout the year
- Problems can be rectified more easily with ongoing assessments

Disadvantages:

- Issues associated with aggregating data for expansion purposes
- Difficulty keeping field force motivated and keeping high level of advertising

Examples of continuous surveys mentioned in the literature are the UK National Travel Survey, the Household Travel Survey for the Greater Metropolitan Region of Sydney, Australia, the Victoria Activity and Travel Survey, and the German Mobility Panel. The U.S. Census Bureau has transitioned to a continuous measurement methodology named the American Community Survey, giving more reason for the use of continuous measurement for the U.S. National Household Travel Survey (Heather et al, 2008).

Ampt, L., Merz, S. K., Ortuzar, J. d. D., & Richardson, T. (2008). On large scale on-going mobility surveys: The state of practice. Paper presented at the *8th International Conference on Survey Methods in Transport,* France. Retrieved from http://www.isctsc.let.fr/papiers/resourcepaper%20%20final%20version/A6%20RP%20Ampt%20et%20al.doc

On-going or continuous surveys provide data on temporal variability of travel and the effect of various changes (cost of cars, land-use, etc.) on responses. The discussion is based on repeated cross-section surveys, and the surveys mentioned are the Sydney HTS, the Victorian Integrated Survey of Travel and Activity (VISTA), and the Sandiago, Chile survey.

Problems noted are that it is difficult to keep the field force motivated, and it is not possible to keep a continuous level of advertising about the survey. There are issues associated with aggregating data for expansion purposes, including changes in geographical boundaries in consecutive censuses and significant changes in travel supply and demographics. Vacant dwelling or those under construction pose problems as well.

Problems that a one-off survey does not rectify can be in on-going surveys with ongoing assessments of work, and the burden of panels where people are asked to contribute on a repeating basis is not an issue.

The paper states that the impact of on-going surveys on climate change must be determined. Other methods (e.g. Internet) could be used, and large samples could be used every four years with smaller samples in the years in between.

Ruiz, T., Timmermans, H., & W. Polak, J. (2008). IMPROVING CONTINUOUS SURVEYS: ANALYSIS OF ATTRITION AND REPORTED IMMOBILITY IN THE MADRID-BARCELONA CORRIDOR PANEL SURVEY. Paper presented at the *8th International Conference on Survey Methods in Transport,* France.

Panel surveys are presented as being more accurate than cross-sections, while drawbacks are mentioned. Reasons for unit-nonresponse include failure in tracing mobile respondents, the field agency did not get into contact with the target person, the target person may be ill and therefore not able to respond, and the target person is no longer willing to cooperate. If attrition is non-random (experience shows that attrition is almost always non-random), any result from the analysis of the survivors sample will be biased. Several panel surveys are mentioned, in which the most cited factor related to attrition is low income and other important factors are low educational status and small size of household. Re-contacting panellists who abandoned the panel is an effective wave of avoiding a strong reduction of sample size as survey waves go on. It is difficult to differentiate between true immobility and under reporting.

Respondents recruited from the sample who participated in a previous in-person survey, declared to be mobile during the period of research to a higher degree than those recruited by random phone calls in any survey wave and no matter what their usual trip frequency was. It is generally difficult to investigate low frequent travelers.

Panel vs. Cross-sectional Surveys

Das, J. W. M., Toepoel, V., & Soest, A. H. O. v. (2007). Can I use a panel? Panel conditioning and attrition bias in panel surveys. ***Tilburg University, Center for Economic Research Discussion Paper,*** **(2007-56) Retrieved from http://arno.uvt.nl/show.cgi?fid=63036**

Two problems with panel surveys for social sciences are discussed -- attrition bias (non-random drop out) and panel conditioning (response influenced by previous participation). The latter can benefit the survey by allowing respondents to better interpret questions, but it may also allow them to learn ways to reduce burden (e.g. by answering 'no' to avoid answering consequent questions). It is noted that it is difficult to separate effects of panel conditioning from those of other survey changes between waves. In four Internet-based surveys studied, where there is no interviewer bias, panel conditioning is found to play a role in knowledge questions, and not in questions on attitudes, actual behaviour, or expectations concerning the future. Solid and sizable refreshment samples are recommended to deal with attrition and panel conditioning.

Advantages of panel surveys mentioned are analyzing changes at micro level, distangling permanent from transitory characteristics, distinguishing between causal effects and individual heterogeneity, etc.

Travel Survey Literature in French

TrÈpanier, M., Chapleau, R. & Morency, C. ***Tools and methods for a transportation household survey.***
http://www.urisa.org/publications/journal/articles/tools_and_methods_for_transportation

This article is currently under peer review by URISA Journal. It presents the background and the fundamentals of the Montreal 2003 survey. The Montreal survey has a relatively large sample size of 70,000 households, which is about 5% of the residing population.
Some of the characteristics:

- CATI system.
- Retrospective trip information: All the trips made on the previous day are collected for every person residing at the contacted household;
- Trip-based. "Even if emerging issues regarding the substitution of out-of-home activities by in-home activities are discussed in the literature, the metropolitan steering committee on travel surveys sees no need to move toward an activity-based survey since the main purpose of the origin-destination surveys is to precisely measure the use of transportation networks." It is decided that compatibility with previous data is more essential;
- Proxy reporting;
- Sample of residential phone numbers.

The report also covers topics on transportation object-oriented modeling and survey information system framework.
It is noted that the use of smartcard payment systems on a large scale will provide fresh data to update and complete those obtained via telephone survey. The cell-only household issue is brought up as a potential issue in the future years but not addresses to any extend.

Enquêtes origine destination Transports Québec

Surveys are regularly made in Montréal, Québec, Trois-Rivières, Sherbrooke, and in Outaouais. The OD surveys made in Outaouais are made in collaboration with Ottawa, and are described further at www.ncr-trans-rcn.ca. This website is governmental and intended for the general population, therefore there are not many technical information. For the Montréal survey, MADITUC (École Polytechnique) is in charge of technical support and data analysis. Most surveys are telephone interviews, and use a validation software during the interview. TRANS (Ottawa-Gatineau) used a mail-in mail-back paper survey in 1986 but only 3% of urban and 6% of rural population responded. Surveys are generally made in the fall. The information are divided into 3 main parts: household, persons, trips. Sociodemographic data is validated using the latest Statistic Canada Census. Respondents are chosen randomly with the list of phone numbers in the local phone book(s). This method still allows the surveyors to reach about 90-95% of the population (according to the Transports Québec website). The geocoding is based on information such as postal code, roads geocoded datasets, work location inventories, etc. For the Montréal survey, the websites of the CIMTU & of MADITUC can also be consulted (but CIMTU website does not provide a lot of technical information and the MADITUC website has not been updated lately). In the Sherbrooke survey, a letter sent to chosen households have proven effective in providing a better response rate and shorter call durations. A publicity plan

was also used (television, radio and local newspapers). Interviews were conducted in French or English, depending on the respondent's preference. In Trois-Rivières, the random sample is drawn from the postal codes database.
www.mtq.gouv.qc.ca/portal/page/portal/ministere/ministere/recherche_innovation/modelisation_systemes_transport/enquetes_origine_destination

Miscellaneous

Bayart, C., Bonnel, P., & Morency, C. (2008). Survey mode integration and data fusion: Methods and challenges. Paper presented at the *8th International Conference on Survey Methods in Transport,* France. Retrieved from http://www.isctsc.let.fr/papiers/resourcepaper%20%20final%20version/A7%20RP%20Bayart%20et%20al.doc

A discussion is presented of the issues and methods involved in the increasing combination of data from various modes within a survey or of data from several surveys (data fusion). Data fusion is used when no database contains all relevant data required for modeling. Besides other surveys, data can be collected from network monitoring systems, cell phone traces, bluetooth makers, GPS traces, and interactive GPS interfaces within the survey.

Combining data from different modes can lead to self-selection bias, meaning that responses might not be comparable. A survey in Lyon where non-respondents to face-to-face interviews were offered Internet questionnaires is described as evidence of the existence of sample selection bias. The paper suggests that the determinants of survey mode choice be considered.

Madre, J., Axhausen, K. W., & Brög, W. (2007). Immobility in travel diary surveys. *Transportation, 34*(1), 107-128.

Although those who claim not to have left the house might be ill, bed-ridden, have no business on survey day, etc., many may do so to politely refuse to participate (soft-refusal). In order to improve the quality of estimates, the paper suggests that respondents be challenged to reconsider the refusal by, for instance, inviting the respondent to describe his or her activity level over a longer period. Also, the consistency of a report can be checked by making calculations based on variables in the travel diary.

The author lists statistics that should be made available for the benefit of future meta-analyses.

Murakami, E. (2008) 'Hard to reach populations.' Paper presented at the workshop for MPOs and NYMTC Member Agencies on Best Practices in Household Travel Survey Design and Management, New York, NY.

This is a brief presentation on capturing hard-to-find and hard-to-reach populations. Some of the suggestion are:

- Special targeted time periods of specific populations
- Work with neighbourhood schools
- Work with University to add legitimacy
- Adding legitimacy by local knowledge and jargon
- Differential incentives
- Easy to read materials (6th or 7th grade) Use graphics to translate message and purpose
- Use choice-based samples

Riandey, B., & Quaglia, M. (2008). SURVEYING HARD TO REACH GROUPS. Paper presented at the *8th International Conference on Survey Methods in Transport,* France.

This paper outlines a variety of topics relating to groups not included in collected data -- people missing from the sampling frames (completely absent subpopulations or only some units of the population), people out of home during hours or days of data collection, people refusing contact, people refusing to answer the questionnaire, and people who cannot answer to the interviewer. There is a discussion of various contact and non-response mitigation methods. Some strategies can minimize the bias induced by unsuitable hour or day of interviewer's visit – extending the data collection period, proposing a multi-mode data collection, and surveying a proxy. Another mode of data collection can be proposed – mail or Internet self administered questionnaire. Self administered surveys without interviewers lose the benefit of an interpersonal incitation, and the respondent has the freedom to choose the time of response.

To prevent attrition in panels, the panelists can be regularly contacted and contact information of friends and relatives can be collected. Interviewers, supervisors, and incentives can be useful in fighting non-response.

Nakamya, J., Moons, E., Koelet, S., & Wets, G. (2007). 'Impact of data integration on some important travel behavior indicators.' Transportation Research Record, (1993), 89-94.

The author suggests combining data from different surveys as a plausible option when sample sizes have to be reduced due to high unit costs. This is called statistical matching, data fusion, data integration, or synthetic matching.

Data from the Flemish Time Use Survey (individual) was used to enrich the data from the Flemish Household Travel Survey. The combined data was similar to the FHTS data, except for the duration. Because FHTS respondents had to fill out travel diaries retrospectively and the FTUS respondents were more cautious in reporting duration, the combined data showed a higher duration than the FHTS. The combined data resulted in a larger sample that is more representative of the population with respect to the weighting variables.

The author outlines the following steps in integrating data: (1) ensure the compatibility of data sources (sample surveys, census results, and administrative sources); (2) reconcile concepts and definitions (homogenization); (3) recategorize, recode, and transform variables; and (4) harmonize time periods.

The paper recommends use of personal identification numbers and uniform definition of similar variables in future surveys in order to benefit future data integration efforts.

M. Contrino, H., McGuckin, N., Nakamoto, H. (., & Santos, A. (2008). A re-examination of methods in the U.S. national household travel survey. Paper presented at the *8th International Conference on Survey Methods in Transport,* France.

This paper examines the past four decades of the U.S. NHTS over the, discussing past methods to improve quality and future improvements. Non-response has been reduced through pre-contact letters and incentives, refusal conversion techniques, increasing the intensity of call attempts, lessening the interview burden by streamlining the questionnaire. The CATI/RDD method for large-scale surveys gained popularity in the U.S. throughout the 1970s and 1980s because of the lower cost, higher accuracy and less burden on respondents and interviewers. The RDD design is continued in the 2008 NHTS with additional emphasis on non-response bias measurement and on estimates of coverage as a cell phone only test sample is included in the design. The 1995 survey introduced the use of a travel diary, resulting in an improvement in the

trip reporting for incidental trips. NHTS Program adopted the use of a person based travel diary and the protocols for proxy reporting, along with outcomes have been monitored closely. Due to the significant difference in trip rates between self and proxy reports, every attempt is made to obtain travel information directly from each adult household member. Incentives may be useful in increasing response rates, but they may raise response rates for the groups already included at a greater rate or train respondents to refuse future surveys unless they receive compensation. In addition to incentives and other strategies for gaining participation, design elements such as data collection mode, sample frame, periodicity, and research protocols are being evaluated – e.g. Google Earth and GPS.

Regarding continuous surveys, the ability the NHTS program to coordinate and inform on Departmental policy and planning has diminished due, in large part, to the periodicity of the study and timeliness of final data and report delivery. A continuous measurement approach may allow for annual monitoring of national trends on travel behavior, while providing key indicators for intermodal, and interdisciplinary use of the data. With the advent of the era of real time measurement, annual performance measures, and the change in the Decennial Census Long Form to the American Community Survey, there is increased movement towards making several national sources of data continuous.

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