Travel Behavior Survey Data Collection Instruments

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There exists a tremendous variety in the structure and form of instruments to collect household travel data. The basis for most instruments was the in-home interview used in the 1950s and 1960s. Current instruments reflect changes in data collection methods, from in-home to mailback or telephone retrieval. The amount and type of information desired to be collected have also changed with the requirements of new legislation and the underlying transportation planning and forecasting models. Current issues in household travel survey instrumentation are discussed, including the pros and cons of various approaches, and recommendations for future practice are presented.

Current views of what is essentially an art form—the design of instruments for travel behavior surveys—are presented. These instruments are designed to maximize the likelihood of obtaining objective, valid, and reliable data. This requires the acknowledgment that respondents do not necessarily interpret questions in the same way as the question designers. The "art" comes in translating the information needs of the transportation planner into the everyday language and meaning of respondents.

Research Objectives

In the United States, federal legislation such as the Intermodal Surface Transportation Efficiency Act of 1991 and the Clean Air Act Amendments of 1990 have placed new requirements on travel demand forecasters. The new demands include greater specificity of time, location, and duration of various operating conditions for all types of motor vehicles; information about choices in vehicle use; analysis of trip chaining, greater information about parking and parking costs for use in transportation demand management; and information about respondents' previous home and job locations and tenure for use in jobs-housing balance analyses.

There also appears to be the beginnings of a paradigm shift in travel demand forecasting away from the traditional four-step process toward an approach that explicitly incorporates household life cycle and travel decision-making characteristics into models. To build new models on this basis, household surveys are starting to collect more and different types of per-

sonal activity data. Despite warnings to the contrary (*1*), it does not appear that large, regionwide household surveys are being phased out in favor of small, targeted surveys. In fact, on the basis of current surveys under way for Portland Metro (*2*), the North Central Texas Council of Governments (*3*), and the New York Metropolitan Transportation Council (*4*), household surveys appear to be growing larger and more complex.

Even in this time of change with regard to research objectives, the same general categories of data persist:

- Household information,
- Person information, and
- Activity or travel information

On the basis of these three categories, the traditional data elements included on household survey instruments are discussed

Household Information

Household data elements include information about the physical household, the household's vehicles, and the household's occupants. Table 1 summarizes the typical household data elements collected and gives a column of comments on the source and usage of selected data elements.

Income

Household income may be collected as either a metric or a categorical variable. In the former case, respondents are asked to name a dollar amount. Whereas some surveys have successfully used this technique, most ask respondents to place themselves in an income category.

There are several approaches to income categorization The most direct involves presenting respondents with a series of ranges and asking them to select the one that is reflective of their circumstances This method is appropriate for written, face-to-face, and telephone instruments. Another technique that may be used in telephone surveys involves asking respondents whether their household income is greater or less than a benchmark amount, such as $40,000. Depending on the response, the interviewer proceeds to a second question that narrows the range further. This approach has the benefit of being somewhat more discreet. It also offers the opportunity to at least grossly categorize respondents, since many will answer the first such question in such a series even if they refuse to reveal their household income within narrower ranges

With the multiple instruments commonly used for household surveys, asking about income more than once (during the recruitment and the retrieval phases) has also proven effective in achieving response rates to this item in excess of 90 percent. When household income levels reported are different at the two collection points, retrieval data have been used for analysis, because they were presumably based on a written record (i e , the household information form) instead of a telephone recruitment call.

Unrelated Persons

Dwelling units occupied by unrelated individuals present challenges in understanding household travel behavior. For instance, the combined household income and vehicle ownership of two apartment mates may be misleading since apartment mates do not generally share financial resources or vehicles There has thus been interest in gathering personal income information and personal vehicle ownership for each household member in addition to or in lieu of household information to gain an understanding of the travel decision making of unrelated individuals within households.

TABLE 1 Household Data Elements

Category	Data Element	Comment
Physical Household	Location of residence	Street address and city
	Type of dwelling unit	Derive from U.S Census categories
	Tenure (own or rent)	Derive from U S. Census categories
	Length of residence	Derive from U S Census categories.
	Location of previous residence	Harder to get full address as length at current residence increases. Collect city at a minimum.
	Reason for moving	
	Number of telephone lines - In the household - Shared with other households - Devoted to fax/modem	Data on telephone lines is used to correct sample weights Data on fax/modem may be useful for analysis of relationships between telecommunications and travel
Household Vehicles	Number of vehicles available to the household	Collect as a continuous variable and categorize during analysis
	Primary driver of the vehicle	
	Make of the vehicle	Collect as open-ended on instrument.
	Model of the vehicle	Collect as open-ended on instrument
	Body type of the vehicle	NPTS includes 8 categories
	Fuel used by the vehicle	Common categories are gas, diesel and other
	Model year of the vehicle	
	Year vehicle was acquired	
	Was vehicle a replacement or addition	
	Vehicle owner/leaseholder	Response options should include household member, employer, rental agency and other
	Odometer reading	Odometer readings at the beginning and end of the diary period may be collected
Household Occupants	Number of persons living in the household	Collect as a continuous variable and categorize during analysis
	Number of workers in the household	Can be used for lifestyle and/or non-response analyses
	Annual household income	Use same categories as U S Census or other source suitable for expansion.
	Language(s) spoken in the home	

Vehicles

Because of the increasing desire to use household transportation surveys to estimate air quality impacts, more complete vehicle information questions are being included on household survey instruments.

However, defining the household vehicle data element is not as obvious as it may seem. Households (or members of households) may own, lease, or borrow vehicles, may use employer-supplied vehicles, or may otherwise have vehicles available for use. Whereas the number of vehicles available to a household is often used as a sampling variable and as a basis for data weighting relative to U.S Census figures, the Census's question is phrased to focus on vehicles "kept at home for use by members of your household," which is slightly different from all vehicles available for household use. As shown in Figure 1, household survey in-

Vehicle Information

Please list all vehicles, including cars, pickups, trucks, vans, minivans or motorcycles that are available for use by your household. Be sure to include any company vehicles or leased vehicles available for personal use and kept at your home. Also include any vehicles that are normally available to your household, but are under repair today. Please provide the mileage (odometer) reading of each vehicle at the start of the diary period, and again at the end of the diary period Please include information for any vehicle(s) that you borrow or rent to make trips during your diary period

Make	Model	Body Type	Model Year and Year Acquired	When acquired, did this vehicle replace an existing one or was it an additional vehicle?	Fuel Type	Vehicle Owner or Leaseholder	Primary Driver (relationship of driver to you)	Beginning Odometer Reading (whole miles)	Ending Odometer Reading (whole miles)
❶		☐ Auto ☐ Pick-up Truck ☐ Van ☐ Other Truck ☐ RV ☐ Motorcycle ☐ Utility Vehicle ☐ Other	Model Year 19__ __ Year Acquired 19__ __	☐ Replacement ☐ Additional vehicle	☐ Gas ☐ Diesel ☐ Other (specify)	☐ Household Member ☐ Employer ☐ Rental ☐ Other (specify)	☐ Self ☐ Other Related ☐ Spouse ☐ Live-in Help ☐ Son/Daughter ☐ Not Related ☐ Father/Mother ☐ No Primary Driver		
❷		☐ Auto ☐ Pick-up Truck ☐ Van ☐ Other Truck ☐ RV ☐ Motorcycle ☐ Utility Vehicle ☐ Other	Model Year 19__ __ Year Acquired 19__ __	☐ Replacement ☐ Additional vehicle	☐ Gas ☐ Diesel ☐ Other (specify)	☐ Household Member ☐ Employer ☐ Rental ☐ Other (specify)	☐ Self ☐ Other Related ☐ Spouse ☐ Live-in Help ☐ Son/Daughter ☐ Not Related ☐ Father/Mother ☐ No Primary Driver		
❸		☐ Auto ☐ Pick-up Truck ☐ Van ☐ Other Truck ☐ RV ☐ Motorcycle ☐ Utility Vehicle ☐ Other	Model Year 19__ __ Year Acquired 19__ __	☐ Replacement ☐ Additional vehicle	☐ Gas ☐ Diesel ☐ Other (specify)	☐ Household Member ☐ Employer ☐ Rental ☐ Other (specify)	☐ Self ☐ Other Related ☐ Spouse ☐ Live-in Help ☐ Son/Daughter ☐ Not Related ☐ Father/Mother ☐ No Primary Driver		
❹		☐ Auto ☐ Pick-up Truck ☐ Van ☐ Other Truck ☐ RV ☐ Motorcycle ☐ Utility Vehicle ☐ Other	Model Year 19__ __ Year Acquired 19__ __	☐ Replacement ☐ Additional vehicle	☐ Gas ☐ Diesel ☐ Other (specify)	☐ Household Member ☐ Employer ☐ Rental ☐ Other (specify)	☐ Self ☐ Other Related ☐ Spouse ☐ Live-in Help ☐ Son/Daughter ☐ Not Related ☐ Father/Mother ☐ No Primary Driver		
❺		☐ Auto ☐ Pick-up Truck ☐ Van ☐ Other Truck ☐ RV ☐ Motorcycle ☐ Utility Vehicle ☐ Other	Model Year 19__ __ Year Acquired 19__ __	☐ Replacement ☐ Additional vehicle	☐ Gas ☐ Diesel ☐ Other (specify)	☐ Household Member ☐ Employer ☐ Rental ☐ Other (specify)	☐ Self ☐ Other Related ☐ Spouse ☐ Live-in Help ☐ Son/Daughter ☐ Not Related ☐ Father/Mother ☐ No Primary Driver		
❻		☐ Auto ☐ Pick-up Truck ☐ Van ☐ Other Truck ☐ RV ☐ Motorcycle ☐ Utility Vehicle ☐ Other	Model Year 19__ __ Year Acquired 19__ __	☐ Replacement ☐ Additional vehicle	☐ Gas ☐ Diesel ☐ Other (specify)	☐ Household Member ☐ Employer ☐ Rental ☐ Other (specify)	☐ Self ☐ Other Related ☐ Spouse ☐ Live-in Help ☐ Son/Daughter ☐ Not Related ☐ Father/Mother ☐ No Primary Driver		

Please turn over and complete HOUSEHOLD INFORMATION!

FIGURE 1 Example of a vehicle information form.

struments often contain considerable language clarifying what is meant by "vehicles available to your household."

Person Information

Personal data elements include information about each household member's socioeconomic and personal characteristics, employment, and schooling In recent surveys a number of questions regarding trip patterns associated with work and school have also been included Table 2 summarizes the types of person data gathered in the most recent household surveys. The discussion that follows touches on several instrumentation issues associated with person information.

Household Relationships

Greater interest in life-style-based transportation research increases the importance of data on household relationships (5). The U.S. Census approach is commonly used in constructing this data element. Under this conceptualization, the person (in whose name the dwelling is rented or owned, or an adult) filling out the form provides information on the relationship of every other member of the household to him or herself. Categories such as spouse, son or daughter, brother or sister, father or mother, roommate, live-in domestic help, and so forth are used to facilitate reporting. Whereas this method leaves some ambiguity regarding the relationship among members of the household other than the person completing the form, it is relatively straightforward.

Race/Ethnicity

Race/ethnicity usually has not been included in travel surveys, since it has not been an element in most; however, it could be used as a check for systematic nonresponse among ethnic

TABLE 2 Person Data Elements

Category	Data Element	Comment
Socio-Economic and Personal	Relationship within the household	Based on relationship of each household member to the person completing the household form
	Gender	
	Ethnicity	
	Year of birth/age	Year of birth generally results in lower item non-response than age
	Disability status	Disability categories may include both sensory and mobility impairments
	For unrelated individuals - Personal income - Vehicle ownership	
Employment	Employment status	This data element includes categories such as full-time, part-time, retired, unemployed and looking for work, unemployed and not looking for work and full-time homemaker
	Occupation of primary job	The categories for this data element are generally collapsed from U S Census categories
	Industry of primary job	Same as above
	Address of primary workplace	The name of the company/establishment, the street address, and the city are generally collected
	Years at primary job	
	Days per week at primary job	
	Days per week work at home for primary job instead of workplace	Care must be taken in phrasing this question to capture the information desired
	Primary job - usual start and end times	
	Primary job - ability to flex start/end times	
	Primary job - shift rotations, if any	
	Cost of parking at primary job	
	Employer-subsidized transit passes	
	Transportation mode to primary job	May be a complex data element to collect for respondents who use multiple modes, or different modes on different days
	Secondary job, same elements as above	
	Previous job location	
School	Level of school	
	Name of school	
	Address of school	
	Days per week at school	
	Transportation mode to school	May be a complex data element to collect for respondents who use multiple modes, or different modes on different days
	Second school, same elements as above	

groups. When used for this purpose, care should be exercised to construct the question in such a way that comparisons may be drawn with census categories.

Work at Home

Questions regarding work done at home have begun to be introduced in the person information section of household surveys through questions ascertaining the frequency of this behavior. Activity recording also captures this if it occurs during the diary period.

In asking about working at home, definitions are crucial. Framing the question in terms of working at home instead of going to the usual workplace is specific and nonambiguous, capturing those people who practice classical telecommuting. Asking simply about the number

of days the respondent works at home may be expected to capture both telecommuters and those who bring home work to do in the evenings; without specification, it may also trigger reporting of gardening, home improvements, cleaning, or other household work.

Activity Information

The heart of the travel behavior survey is the detailed record of activities or trips made by the respondent during the recorded period. "Trip" does not have the same connotation among the general public as among transportation professionals. People think about their behavior in terms of activities rather than trips. They are therefore more likely to accurately recollect what they did and where they did it (the main activity-based survey questions) than how they got there (the main trip-based survey question).

There is evidence from the 1991 Boston area survey that an activity focus yields higher per person trip rates than does a trip focus (6). Both formats yield the same data on trips; the difference is in how the question is asked. For example, assume a sequence in which a person starts at home, leaves at 7:00 a.m., drives alone to work, arrives at work at 7:30 a.m., and stays at work until 12:30 p.m. In a trip-focused diary, the respondent would be asked about the characteristics of the trip made between 7·00 and 7.30 a.m. In an activity-focused diary, the respondent would be asked about the two activities in this sequence: at home (usually 3:00 a.m. to—in this case—7:00 a.m.) and at work (7:30 a.m. to 12:30 p.m.). The trip information is obtained in terms of how the respondent got from one activity to the other.

Activity Data Elements

Table 3 summarizes the data elements collected on recent household surveys using an activity-based approach. The basic activity categories indicated are derived from traditional trip purpose types.

As interest has grown in understanding more about the substitutability between in- and out-of-home activities, greater detail has been introduced into these categories. The recent survey in Portland, for example, has collected information on all in-home (as well as out-of-home) activities that last 30 min or more. Figure 2 shows the list of activities proposed for the New York study. More moderate innovations have also been made in the activity categories (such as making "buying gas" and "medical/dental" their own categories).

Even with an activity-based approach, however, concerns remain about the accuracy of inferring travel (trip) characteristics between activities. This is especially an issue in considering wait times for transit trips. One alternative, which brings the approach full circle, is to treat travel directly as an activity.

Location Information for Geocoding

It is critical to collect sufficient information to ultimately geocode the addresses. Ideally, one would like to collect the street number, street direction prefix, street name, street suffix, city, and ZIP code, plus the place or business establishment name for each location. If computer-assisted retrieval techniques are used, preprogrammed lists of city and street names and major malls or business districts can facilitate the accurate recording of address information

Parking Costs

In addition to asking questions concerning actual parking costs, recent practice includes asking respondents who use alternative modes that do not require parking what the cost would have been if they had driven.

TABLE 3 Activity Data Elements

Category	Data Element	Comment
Activity	Type of activity	The level of detailed categories has been proliferating The collection of all activities lasting 30 minutes or more is another trend
	Start and end time of activity	In an activity-based approach, start and end time are the appropriate elements (as versus arrive and leave) Travel time is calculated as the time between the end of one activity and the start of the next
	Name of place where activity took place	Important for geocoding, especially when precise address information is not recorded
	Address where activity took place	Cross-streets are often all that respondents can report
	Frequency activity takes place	This can be an awkward data element to collect, particularly for routine activities
Mode	Mode	Include walk /bicycle prominently in presenting options
Personal Vehicle	Use of household vehicle or other vehicle	Linking the vehicle used for trips to the detailed information collected about each household vehicle permits valuable air quality analyses
	Driver or passenger	
	Vehicle occupancy	
	Type of parking	Refers to parking in a lot on the street, etc
	Parking cost	Collects the amount and the interval (i e $2 00 per hour)
	Parking payment method	Captures parking costs paid for by validation, by the employer, or out of pocket
Transit	Transit fare	
	Transit payment method	
	Location of access/egress	May be captured in several ways
	Mode of access/egress	May be captured in several ways
	Wait time	
	Number of transfers/other transfer data	
	Availability of personal vehicle	Must define "availability "
Walk	Distance	Can be captured in blocks or miles
	Availability of personal vehicle	Must define "availability "
Bicycle	Use of bicycle lanes or bicycle paths	
	Means of securing bicycle at destination	
Shopping	Mall or shopping center	Captures if shopping took place in a mall or shopping center
	If in a mall or shopping center, number of stores visited	
	If in a mall or shopping center, did respondent eat	
Commercial Trips	Commercial vehicles stopping at the household	Captures trip attractions to the household

RECRUITMENT INSTRUMENTS

The recruitment instrument is used primarily to gain a household informant's consent to participate in the diary survey. In practice, the content of the recruitment instrument has varied depending on whether the household has been previously contacted by letter or how much of the household and person data are to be collected during recruitment.

Impact of Recruitment Script on Participation

The recruitment interview is a social interaction in which the interviewer and the respondent are intertwined by the script. The initial challenge is to differentiate the survey from a "junk call." Refusals are much more likely to occur at the very beginning of interviewer contact rather than after a respondent has been selected, after the questionnaire has started, or after the diary has been mailed. Thus, the first 30 to 60 sec of contact are crucial, particularly from the standpoint of minimizing nonresponse.

The skill of the interviewers does much to determine the success of the recruitment call, along with the wording and phrasing of the recruitment appeal. Opinions differ among survey professionals concerning how much information should be given in the appeal, and the

At Home Activities
Sleep/napping
Meals
Personal care
Dependent care
In-home amusements
Household business
Household maintenance
School/school-related
Working at home
At home exercise
Telephone
Computer

At Work Activities
Work
Meals

Outside of Home/Outside of Work Activities
Drop off or pick up someone
Meals
School/school-related
Shopping (general)
Shopping (major purchases)
Medical care
Household business
Culture/entertainment
Formal entertaining
Religious
Civic
Spectator sports
Exercise/athletics
Personal care
Household care
Visiting
Work related/outside work
Professional services
Buying gasoline

FIGURE 2 Detailed activity categories.

research literature does not provide a definitive answer (7). In general, the appeal should be reasonably brief and contain enough information to reduce potential respondent nervousness The longer potential respondents must listen without active involvement, the greater the chance they will lose interest before the questioning even begins.

The following should be considered for inclusion.

1. Identification of the interviewer, the interviewer's affiliation, and the survey sponsor;
2. Brief explanation of the purpose of the survey and the study area;
3. Brief explanation of the household commitment,
4. Positively worded phrase to encourage cooperation; and
5. Statement about the use of the findings.

Not everything in the study must be explained in the introduction In particular, explanations about individual questions or sections should be deferred until the appropriate place in recruitment questionnaire, follow-up questionnaires, or diaries. Also, fallback statements should be devised for interviewers for use with respondents who may want additional information about the study The fallback statements should be honest, standardized explanations that the interviewers can read or paraphrase

Incentives

Surveys depend on respondents' cooperation for their success. It is widely believed, however, that response rates have been declining and that respondent resistance is increasing Thus, there has been an increasing interest in using monetary or other incentives to motivate respondent participation. Any evaluation of incentives must recognize that they are only one feature of a comprehensive survey design that may increase participation. It may be possible to achieve appropriate response rates through careful sample management, experienced interviewers, and prenotification and follow-up calls (8).

Current literature suggests that "prepayment of the incentive had significant positive effects on response rates" (9). It signals to the respondent that the research is "sufficiently important to justify a rather bold and unusual gesture" (9). Others suggest that by including an incentive in advance, "the researcher extends a token of trust to the survey participant

and initiates a social exchange relationship which invokes an obligation for the participant to reciprocate in kind" (*10*)

The amount of the incentive varies according to the group under study. Arbitron Radio Market studies use higher incentives for harder-to-reach populations. Berry and Kanouse suggest that "the size of the incentive payment may be one of several cues that respondents can use to judge a survey's importance" (*9*). However, when public money is being used to fund a household travel study, incentives may not be considered appropriate use of taxpayers' money by the public at large.

Incentives may also be more effective when used with populations that have been "oversurveyed." Survey Sampling, Inc., publishes a list of the most frequently surveyed metropolitan areas. The list includes, not surprisingly, most of the major urban areas of the country, as well as many mid-country areas considered by market researchers to be representative of the nation.

Incentives used for travel surveys have included state lottery tickets, cash, and gifts (pens). A direct comparison of monetary incentives was conducted as part of the first wave of the Puget Sound Transportation Panel (*11*). It was found that an incentive of $1 per household sent out with the diary materials yielded slightly better participation rates than $10 per household that returned completed diaries (64 versus 60 percent). Both monetary incentives increased the participation rate over no incentive (49 percent). At this juncture, however, there is no clear consensus among practitioners as to whether, or when, incentives should be considered for travel behavior surveys.

Respondent Materials

There has been general agreement that better data are obtained when respondents are provided instruction and data recording materials in advance. Respondent materials have included diaries, memory joggers, household forms, vehicle forms, cover letters, reminder cards, and fact sheets. These and other materials issues are discussed in this section.

Diaries

Two forms of travel diaries appear to be prevalent in travel surveys: a single-page form, which is often printed double sided on legal size paper, and a multipage booklet. The one-page form may be less intimidating to respondents and costs less to print and mail. However, the space available for respondents to actually write location and other open-ended information is usually tiny, which can lead respondents to simply omit a response when there is no space for them to write it out. This is an important consideration should the addresses need to be geocoded

A multipage booklet offers more space for respondents to record address and other information and provides room for more detailed instructions. The multipage booklets may be more intimidating to potential respondents, and they cost more to produce and mail

The increase in the amount of data to be collected has raised concerns that the forms have become so massive and complex that they deter potential respondents and contribute to a lower response rate. One option has been to print fewer questions on the forms but to use telephone retrieval to ask respondents the full set of questions. This reduces the size of the forms, which should be less intimidating to respondents. However, there are two potential disadvantages. First, reliable data are more likely to obtained when respondents are cued in advance that they are going to be asked about something and that they should write it down or remember it. Second, taking items off the printed forms limits the ability of "proxies" or spokespersons to adequately relay the data from other household members. Most surveys permit someone other than the person actually doing the activities to relay information to the telephone interviewer during the retrieval phase. If key information items are

not written down, proxies will be unable to assist—which negatively affects overall completion rates.

Time Period (24 or 48 hr)

Whether 24- or 48-hr diaries should be used to collect activity and/or travel information is the subject of considerable debate. One issue is the perception that 48-hr data collection places too great a burden on respondents. Another is whether there are significant differences in activities and travel across 2 consecutive days to warrant the additional collection of data

Respondent burden is an issue that should not be treated lightly. The ability to gain and keep a household's participation in the travel survey will largely depend on the perceived burden of responding. Having a respondent track activities and travel for 24 hr is definitely less of a burden than tracking for 48 hr. In addition, a lengthened reporting period for respondents not only increases the burden during the activity days but also makes for a longer retrieval interview to collect the activity and travel data. However, the additional burden created when requesting 48 hr of information may be somewhat mitigated through the diary design Taking into account the literacy level of the target population and the ease of recording information can reduce the respondents' perceived burden and any negative impact on response rates.

An analysis by Golob and Meurs (*12*) of a 7-day diary used by the 1984 Dutch National Mobility Panel found that total trips per person declined 1.0 percent per day because of response bias. The principal cause appeared to be an increasing tendency of respondents to report no travel at all on a given day and a day-to-day increase in the underreporting of walk trips. Both of these tendencies may be corrected by careful prompting in telephone retrieval.

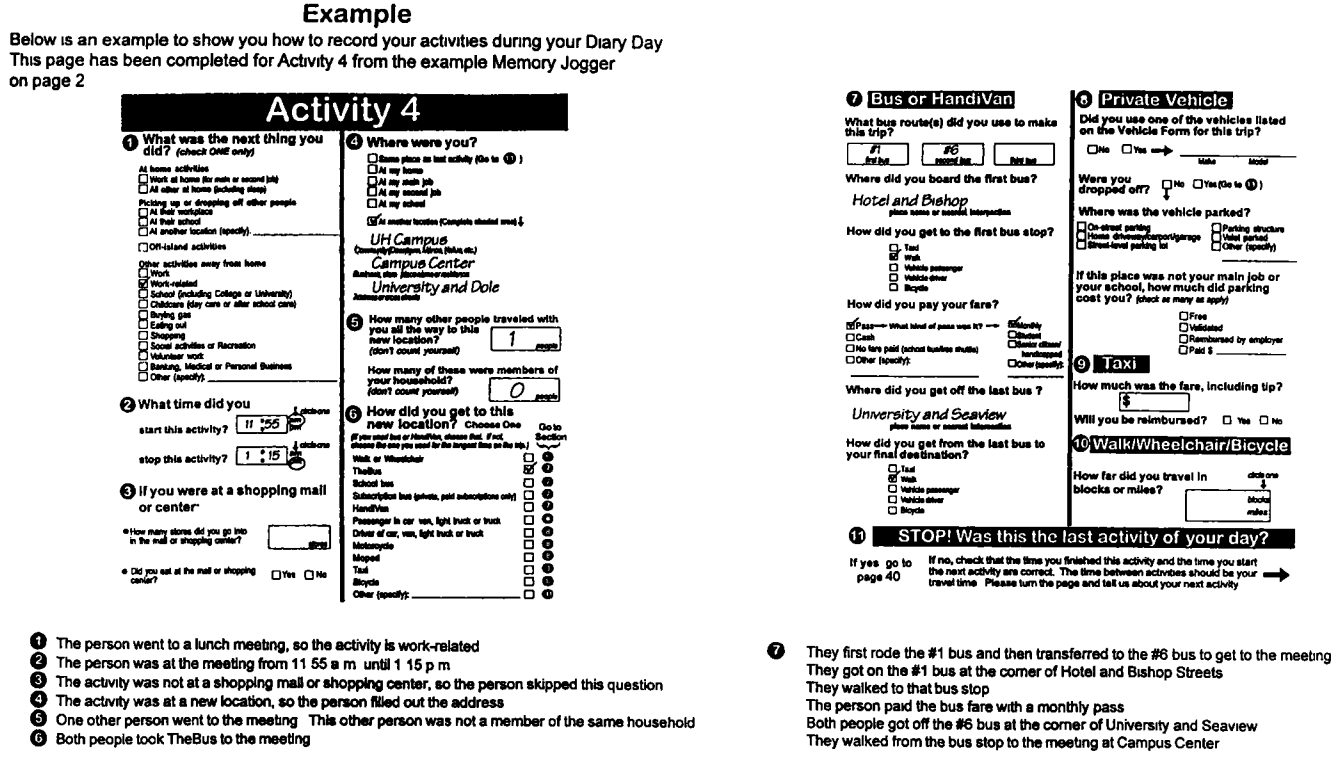
The second issue is the extent to which the activities and travel on the second day mirror those from the first day One theory is that the data from the 2 days will be strikingly similar. Therefore, it follows that it may not be necessary to collect data for both days. However, studies have shown that the ability to capture part-time use of travel modes and trip-chaining greatly increases with the use of a multiday diary A recent study on the variability of route and trip scheduling for the evening commute indicates that only 16 percent of stops made on the work-to-home trip were "routine" (*13*). Another study, which examined 2 days of travel from respondents to Wave 1 and Wave 2 of the Puget Sound Transportation Panel, concluded that the day-to-day variation in activities was substantial enough to warrant the use of 2-day diaries (*14*)

Examples

A common means of illustrating for the potential respondent exactly what information is desired is to provide an example—either of a completed activity or trip—directly in the diary instrument. Example pages from a recent travel survey are shown in Figure 3

Although diaries are designed to collect activity or trip data as the travel is undertaken, it is suspected that many respondents fill out diaries retrospectively. The memory jogger encourages the recording of key data as the travel is undertaken Memory joggers have come in two forms. as a specially designed two-sided pocket card, which household members can easily carry around with them during the assigned travel/activity days, and as a separate page bound in with a booklet travel diary. Whatever the form, the memory jogger provides space to record notes on at least the what, how long, and where of a specific number of activities or trips Respondents are asked to record notes in the memory joggers throughout the day, then transfer their notes to their activity and travel diaries at the end of the day. An example of a memory jogger is shown in Figure 4.

Memory joggers are designed to facilitate recollection of specific elements relating to activities and travel. Particularly in studies where the diaries are somewhat bulky and difficult to carry, the memory jogger provides a convenient forum to aid respondent recall. With the use of more compact diaries, the utility of memory joggers may diminish.



1. The person went to a lunch meeting, so the activity is work-related
2. The person was at the meeting from 11 55 a m until 1 15 p m
3. The activity was not at a shopping mall or shopping center, so the person skipped this question
4. The activity was at a new location, so the person filled out the address
5. One other person went to the meeting This other person was not a member of the same household
6. Both people took TheBus to the meeting
7. They first rode the #1 bus and then transferred to the #6 bus to get to the meeting
   They got on the #1 bus at the corner of Hotel and Bishop Streets
   They walked to that bus stop
   The person paid the bus fare with a monthly pass
   Both people got off the #6 bus at the corner of University and Seaview
   They walked from the bus stop to the meeting at Campus Center

FIGURE 3 Example pages from an activity diary.

Household and Vehicle Forms

Each decision to include a particular data element in a household travel study must be followed by an equally important decision of when to collect that information. Data collection takes place during recruitment, reminder, and retrieval.

As discussed previously, a telephone recruitment interview is frequently used to obtain participation of the household and to collect demographic information about the household. If the recruitment interview is too long (i.e., more than 15 min), there is a higher probability that the household will not participate in the study

To reduce respondent burden and ensure household participation, some agencies have opted to minimize the recruitment contact and include household or vehicle forms, or both, in the materials packet. The data collected on these forms are retrieved during the reminder or retrieval call, or the respondent is asked to mail back the completed forms. As a result, the respondent burden is not actually reduced, but shifted to a later stage in the data collection process The reasoning is that the household has already made an investment in the study and will not be as likely to refuse to participate.

However, it is equally important to remain sensitive to the amount of information included in the materials packet sent to the recruited household. If it appears to be too much work, the household may refuse to participate. A refusal to participate at this stage is more costly, because time and funds were expended during the recruitment call and the mailing of the survey package.

Household Form

The household form typically is used to collect detailed employment and school information from household members. The data elements (discussed earlier) usually fit on one page Depending on household size, the removal of these items from the recruitment interview may shorten that call by 3 to 5 min. This reduces respondent fatigue during the recruitment call but may result in loss of data if some households decide in the interim that they do not wish to participate.

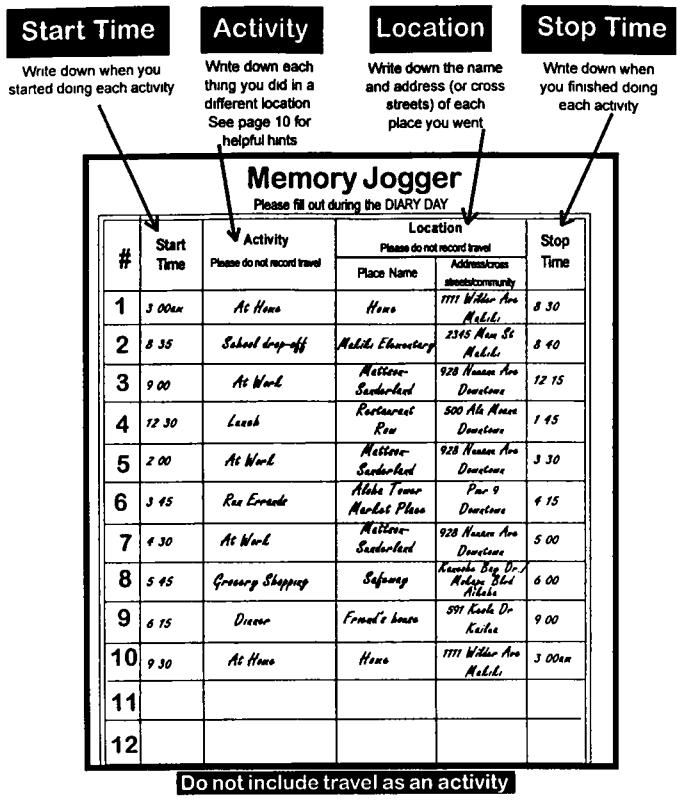


FIGURE 4 Example of a memory jogger.

Vehicle Form

Like the household form, vehicle forms are often included in the packet of materials sent to participating households. If space permits, the vehicle information may be printed on the reverse side of the household form. (See Figure 1 for an example of a recent vehicle form.)

Other Materials

Several other respondent materials may be used in conducting a household travel survey. cover letter, fact sheet, reminder cards, and incentives.

Cover Letter

The cover letter is an important part of the materials packet. In fact, the packet should be assembled so that the cover letter is on top when the respondent opens the packet The cover letter adds validity to the survey process and should be written with respondent literacy in mind. The contents should convey the relevance of the project to the household (i.e , Do traffic conditions in your area concern you?). It should provide a contact person and telephone number in case the household has questions, and it should confirm the steps of the process. Finally, the letter should be signed by a prominent local official.

Reminder Card

Reminder cards, with assigned travel and activity days prominently displayed, may also be included in the materials packet. To be effective, they should be designed for a specific display location (i.e., posted on the refrigerator).

Fact Sheet

A fact sheet has been included in some household surveys to provide respondents more detailed information about the purpose of the household survey than can be communicated in the cover letter. The intent is to motivate higher response rates Structuring the fact sheet in a question and answer format has proven to be an effective way of addressing most of the points commonly raised by survey respondents. Fact sheets can be designed to fit on two-sided letterhead or as tri-fold brochures.

Literacy Level

According to the *National Adult Literacy Survey* (*15*), 23 percent of the nation's adults read below an eighth grade level. This has strong implications for the design of complex survey instruments. Literacy levels were an issue in the recent household survey conducted in the Detroit region, particularly with lower-income participants, who are already harder to recruit and more difficult to retain. One possible solution is to have all sets of instruments checked for reading level and to have appropriate changes in wording made wherever possible to simplify the instruments.

Foreign Language Materials

In regions where there are concentrations of monolingual, non-English-speaking populations, the issue of translating the travel behavior surveys and instruments into other languages emerges. Not only does translation permit the inclusion of non-English-speaking individuals in the sample, it also facilitates data retrieval from persons whose English is limited and who may feel more comfortable in their first language

Household interview instruments are most frequently translated into Spanish; however, in many areas of the country, Asian languages are increasingly being considered for instrument translation. For example, the 1991 Southern California Association of Governments survey was translated into Chinese (Cantonese), Korean, Vietnamese, and Cambodian, in addition to Spanish.

Translating materials into another language introduces additional costs. Besides hiring interviewers who are bilingual (English plus the desired other language), the instruments should be "back-translated" to ensure that the full meaning and intent of the questions is retained Back-translating involves translating materials from English to the other language and then translating the same set of materials back into English. Care must also be taken with producing materials in languages that involve a different typeface system (Chinese, etc).

In general, unless the incidence of monolingual, non-English-speaking households exceeds 5 percent of the total population in the area to be surveyed, the cost to translate the materials into a given language exceeds the benefits from a strict survey design point of view. At this point, the decision to translate becomes a political one

Retrieval Instruments

To date, all travel surveys conducted in the United States have relied on respondents to record their travel. There are, however, many different methods of retrieving the recorded information. In the 1960s and to some extent in the 1970s, interviewers were often sent to the households to physically review and retrieve travel information. Many surveys requested the respondents to return the completed survey forms by mail (mailback). Some surveys collected the information by telephone As computer capabilities were enhanced, recorded travel behavior information began to be retrieved using computer-assisted telephone interviewing (CATI) systems.

The choice of retrieval mode affects the survey cost, forms used, and response rates. The three main retrieval approaches (in-home, mailback, and telephone) are discussed in this section.

In-Home Interview

In-home interviews usually involve an initial in-home visit to recruit households to participate in the survey and a second visit to retrieve completed surveys. The advantages of this approach are that the interviewers can check the activity information directly with the respondents, the sampling frame can be controlled to the Census block level, and households without telephones are (relatively) easily included. There are conflicting views on whether the in-home approach enhances response rate Response rates to the in-home surveys conducted in the 1960s were higher than those obtained in more recent telephone surveys. However, response rates to all types of surveys have declined in the 1990s, making it difficult to determine the extent to which the retrieval method was the causal factor.

In-home interviews have the disadvantage of being more costly on a per household basis. The challenges faced by interviewers in recruiting households in-home has been exacerbated by the increase in "gated communities" and other residential areas with controlled access

Mailback

The least costly method of household travel survey data collection involves a multimode method. Households are recruited by way of a brief qualifying telephone interview After it agrees to participate, the household is mailed a packet of survey instructions and travel diaries to be completed and mailed back to the survey management team. This method has been used by the Chicago Area Transportation Study (*16*) and by researchers in Europe and Australia (*17*).

There have been concerns about the extent to which respondents may underreport trips using a self-administered mailback method A travel behavior study in San Antonio, Texas (*18*), found just the opposite. In that survey, participating households were asked to mail their completed diaries back in addition to having the data retrieved by telephone. When the data from the mailback were compared with the data collected from the phone interview, statistically significant undercounting of trips was uncovered in the mailback. Overall, the phone data collection generated 9.75 trips per household, compared with 9 12 trips for the mailback. The "within-case" difference was 0.63 trips per household.

Under the mailback method, the researchers must budget time to telephone or otherwise recontact households to clarify incomplete, illegible, or missing data. Completed data must also be entered into computer files for analysis.

In general, response rates are 10 to 15 percent lower for mailback than for telephone retrieval For sample sizes exceeding 4,000, the mailback method presents challenges in the management of paper data. On the positive side, mailback may be more cost-efficient than telephone retrieval, especially for smaller samples

Telephone Retrieval

Travel information has been retrieved by telephone since the 1970s. Early methods had interviewers writing the information into survey forms on the basis of their conversation with the respondent. The information was subsequently key entered for checking and analysis. As computer systems became more sophisticated, programs were developed for interviewers to key information directly into a data base Later enhancements permitted the programming of the exact question being asked, as well as skip patterns based on specific responses. Systems that include the exact "script" on a computer screen, into which the interviewer directly inputs the responses, are CATI systems.

CATI systems have become increasingly capable of complex checking and programming. The ability of the CATI system to accommodate complexity is dependent on the skill of the programmer and the CATI software being used. Many survey firms use commercially available software (e.g., Ci3 software for PCs and Survent software for mainframes). Other sur-

vey firms have developed their own proprietary software for data collection. For example, a "trip-rostering" routine has been built into the interviewing software for the 1995 NPTS. This routine was established to reduce the interview time and the redundancy of trip reporting, particularly when household members travel with each other. As each person is interviewed, trips that are taken with other household members are tracked. When subsequent members mention these same trips, the information is copied over. This and other enhancements to telephone retrieval procedures point out the real differences in the ability of CATI systems to program in desired logic checks as real time, on-line checks, while keeping screen refreshment time minimal.

There has been concern that telephone retrieval methods may yield fewer trips. The concern has been that "telephone fatigue" sets in as the number of trips to be reported increases and that households simply underreport trips to finish what can be a very lengthy telephone call. Even when the CATI system permits respondents to skip over information that was already provided by other family members and the screen refreshment time is kept to less than 1 sec, retrieval of travel information from all family members can last 45 min or more This period is rarely one telephone call—retrieval of a complete household usually requires several telephone calls to the same household

CONCLUSIONS

The amount of information desired from household surveys by transportation planners has increased tremendously over the past few years. Accompanying the increase in data elements has been a decline in response rates. Current practice, as outlined in this paper, has evolved from attempts to reduce nonreponse.

User-Friendly Forms

Careful attention to the wording and layout of questions should help in the design of user-friendly forms Wording of questions can be checked by professionals for grade reading level Professional graphics designers may be used to review layout and design. The importance of the visual aspects of travel diaries and related materials cannot be overemphasized Unfortunately, there is often a direct trade-off between visual simplicity and the amount of data desired.

There are a number of unresolved issues regarding materials, including single-page compared with booklet travel diaries, the need for memory joggers, and when to use incentives

Potential Enhancements to Household Travel Surveys

Several enhancements could improve the collection of household travel data.

Linking CATI to a Geographic Information System

One enhancement to current telephone retrieval methods would be to directly link the CATI system on-line with a geographic information system (GIS). As respondents described the location of their trip origins or destinations, the interviewers could follow the trip on a GIS display and simply point and click on the reported locations. The geocode for each address could thus be directly input into the data base

Use of Passive Data Collection Instruments

As the amount of information desired increases, the use of passive data collection devices needs further exploration. Such devices might include the use of global positioning systems

to track vehicles or even persons, or other forms of in-vehicle monitoring. The spread of "smart card" technology for payment of transit and toll fares may provide another source of travel information.

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