New Approach to Route Choice Data Collection: Multiphase, Computer-Aided Telephone Interview Panel Surveys Using Geographic Information Systems Data Base

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The survey approach is often used in studying drivers' route choice behavior. Surveys enable the researcher to analyze route choice behavior and the effects of traffic information directly from reported behavior and perceptions of the respondent. A sample that represents well the population in the study area could facilitate better understanding of actual drivers' behavior and decision processes. Three route choice surveys targeting a random sample of commuters in the Los Angeles area are presented. The first two surveys were 1 year apart, and the third survey was a follow-up mail questionnaire. The surveys involved two innovative techniques that achieve the data collection required for the analyses of route choice, traffic information acquisition, and commuters' potential use of advanced traveler information systems. The first technique is using computer-aided telephone interviews, and the second utilizes geographic information systems capabilities.

The problem of route choice faced by an automobile driver is complex because of the large number of possible alternative routes through the road networks and the complex patterns of overlap between the various route alternatives. There have been several empirical studies of the factors affecting drivers' route choice. In the urban context the situation is not clear; some researchers have concluded that time minimization is the dominant criterion, whereas others have noted the importance of aspects such as road type (*1,2*), avoidance of congestion (*1*), and avoidance of stops and traffic signals (*3*).

The objective of an ongoing Partners for Advanced Transit and Highways project at the University of California is to understand the factors that influence drivers' route choice and route diversion. It is also to investigate the effect of travel time uncertainty and traffic information on route choice and the potential interplay between travel time reliability, advanced traveler information systems (ATIS), and route choice.

To gather the information needed to achieve these objectives, including capturing each respondent's exact commute route(s) by segment, three route choice surveys were designed and conducted. The first two waves utilized computer-aided telephone interviewing (CATI) techniques to capture all the branchings necessary for the surveys' design, and to be able to collect the high level of detailed information, which varies from one respondent to another, in an efficient manner (the first and second CATI surveys were conducted in May and June 1992 and May 1993, respectively). The third survey was a follow-up questionnaire to the second CATI and consisted of a mail questionnaire (conducted in October 1993), which involved a high level of customization and used information collected in the preceding two surveys, such as the exact commute route by segment, travel time, and an optimal route generated according to each respondent's origin/destination using a geographic information system (GIS) and network data bases of the study area. These survey techniques enabled gathering the data needed to perform the required analyses to the network level in an efficient and unprecedented manner.

This paper presents the design and administration of the three surveys, together with a discussion of each survey's objectives and data collected.

LITERATURE REVIEW

Surveys have been used in several studies with the aim of determining respondents' route choice behavior (and traffic information use). A large-scale survey could achieve a sample size that adequately supports quantitative modeling and forecasting and constitutes a data base for a better understanding of drivers' behavior and decision processes.

Haselkorn et al. (*4,5*) used a large-scale, on-road, mail-back survey that targeted a specific freeway corridor (I-5) in the state of Washington. Mannering et al. (*6*) used the same data set to investigate commuters' route, mode, and departure time flexibility and the influence of traffic information. Khattak et al. (*7*) used mail-back questionnaires to evaluate the effect of traffic reports on commuters' route and departure time changes. The questionnaires were distributed at downtown parking facilities. In a study by Hatcher and Mahmassani (*8*) to observe route and trip scheduling decisions for evening commuters, a mail survey was conducted in two stages. An initial short screening survey and a second stage survey sent to 331 selected first-phase respondents consisted of detailed diaries of actual departure times, route description, and intermediate stops (trip-chaining) information.

To investigate commuters' flexibility in changing routes and departure times Mannering (*9*) surveyed 117 commuters by telephone. Ullman et al. (*10*) also surveyed 44 subjects by telephone to

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study the effect of a freeway corridor's attributes on motorist diversion responses to travel time information.

Polydoropoulou et al. (*11*) used a mail survey and trip diaries to collect data from MIT commuters to model the influence of traffic information on drivers' route choice behavior. Khattak et al. (*12*) used a stated preference approach to evaluate the effects of real-time traffic information along with driver, roadway, and incident characteristics on drivers' willingness to divert. Khattak et al. (*13*) studied stated and reported route diversion behavior and its implications on the benefits of ATIS. Questionnaires were distributed to peak-period commuters crossing the Golden Gate Bridge (San Francisco) during both morning and afternoon rush hours.

All but two of the studies cited used the mail survey design in one way or another. Mail surveys, in general, yield low response rates and do not provide interaction between the interviewer and the respondent. Possibly because of the limitation of mail surveys, none of these surveys has examined the exact routes taken by the drivers. Mannering (*9*) and Ullman et al. (*10*) surveyed the respondents by telephone. However, the administration did not involve any computer-aided structure that enables the survey's design to include branchings to account for differences between commuters in an efficient and timely manner and keeps the survey time to a minimal while gathering all the desired information. Also the computer software checks for errors and inconsistent responses and enables the interviewer to correct them. The random dialing performed in this study achieved a sample that well represents the population in the study area, which is missing from most of the studies cited above, for example, Haselkorn et al. (*4,5*), Khattak et al. (*7,12,13*), Ullman et al. (*10*), Polydoropoulou et al. (*11*), Huchingson et al. (*3*), which targeted either a specific corridor, central business district, or employees of a specific agency. Although Khattak (*12,13*) used stated preference approaches to investigate route switching and information use, neither of his studies accomplished the high level of customization, which was used in both the revealed and stated preference sections of the third survey. Finally, the third and last survey proposes a new application of GIS and data bases in surveying route choice behavior including a high level of customization. This approach was never used in any survey design to study route choice behavior.

RESEARCH DESIGN

The three surveys presented in this paper are designed to collect detailed data on commuters' route choice, information acquisition, and the interplay between route choice and traffic information including the potential effect of ATIS on route choice. The exact commute routes by segment and possible alternative routes were also sought to perform route choice analysis to the network level. The amount and complexity of the data required made it impossible to collect the data in one survey. In addition, there was a need to notice any changes in the routes used during a period of 1 year to investigate the reasons for these changes. Therefore there was a need to conduct a second CATI 1 year after the first one to investigate route changes as well as to gather more detailed data about commuters' attitudes and perceptions. The third survey was a follow-up to the second CATI. The survey design required introducing to the respondents alternative routes generated by a GIS and network data bases of the study area and stated preference customized scenarios that could be achieved only using mail-back questionnaires.

CATI ROUTE CHOICE SURVEY: PHASE 1

A route choice survey was developed targeting Los Angeles-area morning commuters. A mail-out/mail-back survey instrument was initially designed to gather detailed information on commuters' main and alternate routes, to determine the level of information commuters have about these routes, to measure commuters' attitudes toward, and perceptions of, these routes, and to determine how existing traffic information affects their route choice behavior. The mail survey instrument required several branchings, increasing its level of complexity, potentially jeopardizing the response rate and response accuracy. Therefore, it was decided to perform a CATI survey. A CATI survey allows interviewer/respondent interaction and automatically handles branchings with complete reliability and lower interviewer error.

Sampling Procedure

The survey targeted a random sample of households located in the area covered by the South Coast Air Quality Management District, which includes most of the contiguously populated areas of Los Angeles, Orange, San Bernardino, and Riverside counties. The sampling, based on a Mitofsky-Waksberg cluster sampling design (*14*), covered both listed and unlisted numbers. The Mitofsky-Waksberg sampling reduces the number of unproductive dialings and improves efficiency. It was estimated that the Mitofsky-Waksberg design showed an increase of 8 percent efficiency when compared with simple random digit dialing (*15*).

Respondents were limited to adults over 17 years of age who had worked at a fixed location outside their homes at least 1 day in the previous week. For households with more than one qualifying member, the targeted respondent was either the full-time worker (> 20 hrs/week) who answers the phone or who was present at home at that time (this could introduce bias if there is more than one full-time worker but is not considered crucial for this study); a randomly selected part-time worker if there are no full-time workers in the household; or the lone part-time worker. Interviews were performed during weekday evenings and on weekend days. Two callbacks were attempted before a sample telephone number was abandoned. Increasing the number of callbacks is desirable to eliminate nonresponse bias. However past experience has indicated that the effectiveness of additional callbacks diminishes, and the marginal cost per completed interview rapidly increases after two callbacks. Considering available budgets, it was determined to limit callbacks to two.

Survey Content

The survey yielded 944 completed interviews contacted between mid-May and early June 1992. The following information was obtained from each respondent:

- Identification of specific primary commute route by segment (each different road/freeway in sequence for the whole commute route);
- Availability of alternate commute routes and identification of secondary route by segment;
- Detailed information on both primary and secondary routes, including perceived traffic conditions;

• Individual's perception of the severity of different types of delays and other problems;
• Information that respondents receive before and during the commute and its effect on their behavior and awareness of the highway/street network; and
• Demographic and socioeconomic data, including household income, gender, employment status, and education level.

As mentioned earlier, one of the main objectives of this survey was to collect the exact commute route(s) of the respondents (i.e., collect each segment of the route), and to capture the respondents' perceptions and knowledge about these routes. The design of the survey needed to be flexible enough to allow respondents to describe the number of routes they used, the number of segments on each route and the name or number of the street or freeway, and the traffic conditions on each segment, requiring several branchings and interviewer/respondent interaction, which could be achieved only by computer. Figure 1 illustrates a flow chart of the survey, which shows the branchings performed to collect the required data.

Description of Sample

Summary statistics for the sample are presented in Table 1. To test the representativeness of the sample, several socioeconomic and commute characteristics were compared with, and statistically tested against, the 1990 Census (*16*), the 1991 California Statewide Travel Survey results (*17*), and the 1990 California Statistical Abstract (*18*). In most cases the null hypothesis that the values from the route choice survey are not different from the corresponding statistical sources was not rejected at the 0.05 level of significance, implying that the sample well represents the population in the study area. A research report (*19*) illustrates the tests performed with the three cited data bases (among the variables tested with these three data bases are income, mode split, home ownership, and gender) across the four counties. Table 2 shows examples of the comparisons performed for income and mode split.

CATI ROUTE CHOICE SURVEY: PHASE 2

The second route choice survey was developed and targeted the same individuals of 1992, which consisted of the Los Angeles-area morning commuters. Because the survey design also required many branchings, it was decided to also perform a CATI.

Survey Content

The survey was designed to

• Measure any changes within the last year, including home and work locations and primary and secondary routes [in the case of any changes the exact primary route (and secondary route if the respondents use one) is identified by segment];
• Gain an in-depth understanding of commuters' perceptions and decisions of various commute characteristics and problems; and
• Study the effect of travel time uncertainty on route choice using a simple stated preference choice set.

This survey design did not only require capturing the exact commute route and its segments as the CATI I survey, but it required capturing any changes, which complicated the design to a large extent. For example, some commuters changed their origin, destination, primary commute route, secondary commute route, or mode of travel, or a combination of these cases. The survey design had to follow each path of questions according to each commuter's circumstances. Again the CATI design would be the only method to achieve this objective efficiently and promptly. Figure 2 illustrates a flow chart of the survey, which shows the branchings performed to collect the required data.

Description of Sample

A maximum of 10 callbacks was attempted before abandoning a respondent's number, which yielded 564 interviews completed (about 60 percent response rate) in May 1993 (1 year after the first survey of May/early June 1992). Table 3 shows the breakout of the contacted and noncontacted first year's respondents. About 26.5 percent of the respondents either had a disconnected telephone or moved, or had the telephone for less than 1 year, which shows the very high degree of mobility that people in southern California have. The other reasons for not participating in the second survey wave (e.g., refused to participate, had a Fax machine) account for only 13 percent of the respondents. This indicates that increasing the number of call backs would not have increased the response rate (10 callbacks are already very extensive).

Attrition Model

To identify the factors that lead a commuter to participate in the second wave of the survey, a binomial probit model was developed. An attrition model also can be used to develop weights to adjust the sample for further analysis.

The model shown in Table 4 illustrates several socioeconomic factors that increase the probability of the household participation in the second survey. High-income households (income of at least $75,000) and highly educated respondents (college graduates) were more likely to participate. The number of years living at the present address and home ownership affected positively the likelihood of participation. Also whether the respondent in the previous survey was a woman increased the probability of participation in the second year.

Use of the likelihood ratio to test the null hypothesis that all the coefficients are 0 except the alternative specific constant was rejected $\{-2[L(C) - L(0)] = 25.9, df = 5$—number of constrained coefficients, which shows that the model is significant, although the likelihood ratio index is considerably lower. However, this is a good sign because this probably means that attrition is largely random.

Changes in Route Choice

One of the main objectives of the 1993 survey was to measure any changes in the commute routes and to understand the reasons for this change. The survey showed that 195 respondents changed their primary commute routes. Of these, 50 changed their home location and 89 changed their job location. The rest (56 respondents) changed their primary route as a result of factors related to the route itself, and this could be classified as follows:

• Changed route to avoid congestion: 10 respondents;

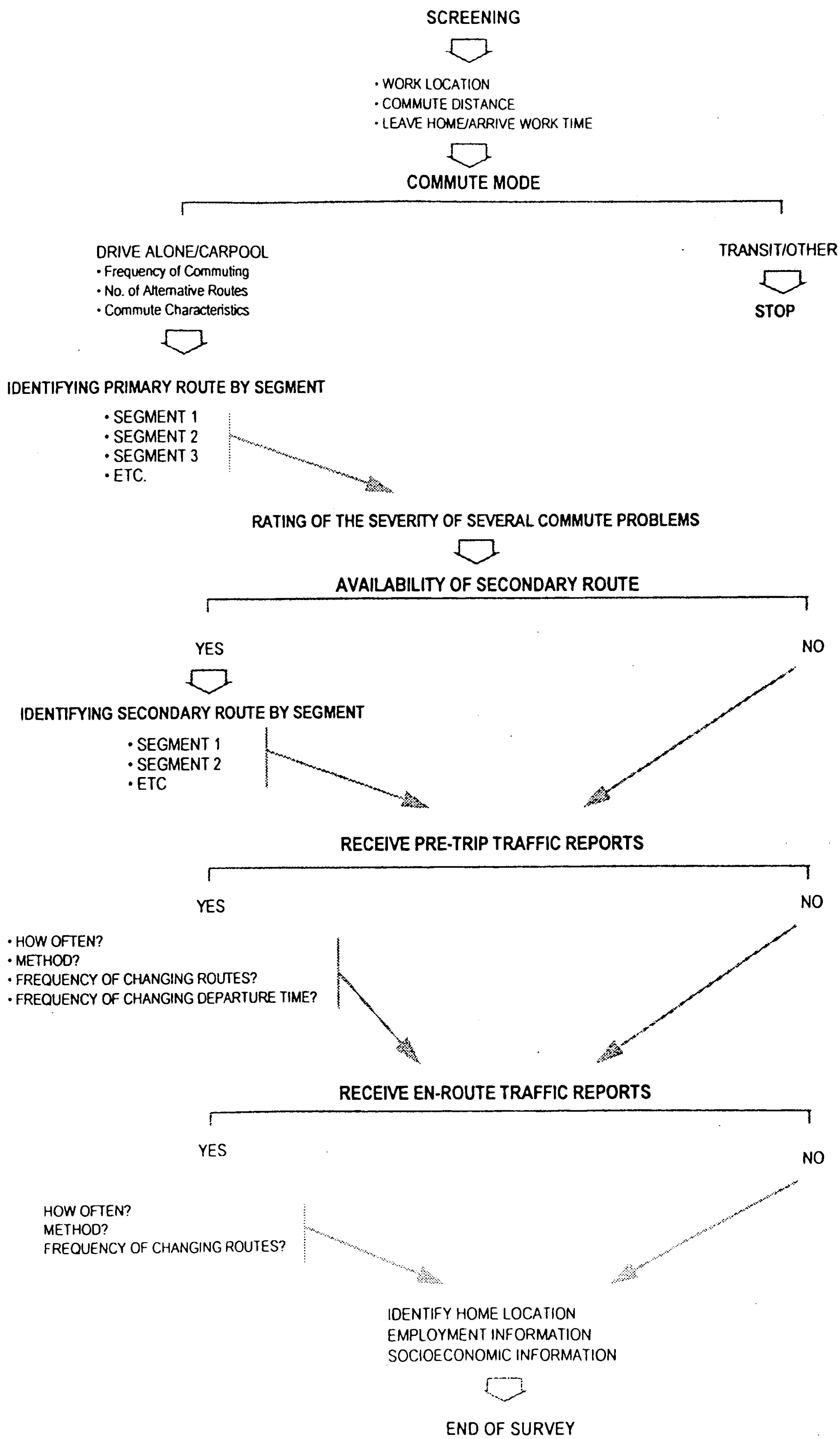

FIGURE 1 **Flow chart of CATI I survey.**

TABLE 1 Sample Summary Statistics (Averages Unless Noted)

Statistic	Value
Commute distance on usual route (miles)	12.75
Travel time on usual route (minutes)	28.14
Trip duration (including stops)	31.9
Percent of respondents commuting in single-occupant autos/carpool/public transit	78.8/14.6/4.9
Percent receiving pre-trip traffic reports	36.5
Percent receiving en route traffic reports	51.25
Percent of respondents with flexible/ somewhat flexible / fixed work starting time	24.4/30.4/45.2
Percent male/female	51.3/48.7
No. of household cars	2.31
No. of years at present address	7.24
No. of years at present job location	5.52
Percent own/rent their homes	59/41
Household income	38,750
Percent of college graduates	43.8
Think traffic congestion is a problem or major problem (percent)	61.3
Think trip time uncertainty is a problem or major problem (percent)	31.9

TABLE 2 Comparison of Income and Mode Share for the Sample, California Statewide Travel Survey, California Statistical Abstract, and 1990 Census

County	Average Household Income			Median Income
	Survey	CA Statewide Travel Survey 1991 using only study area residents	CA Statistical Abstract (1990)	Census (1990)
Los Angeles	32,500	32,750	38,138	34,965
Orange	43,250	40,655	36,151	45,922
San Bernardino/ Riverside	33,500	28,805	35,004	33,081
Overall Sample	38,750			

County	Percent of Drive alone, Carpool and Public Transit Users					
	Survey			Census 1990		
	Drive Alone	Carpool	Public Transit	Drive Alone	Carpool	Public Transit
Los Angeles	79.1	15.2	5.7	85.6	15.5	6.5
Orange	83.2	14.9	1.8	90.4	13.7	2.5
San Bernardino/ Riverside	82.2	15.6	2.2	91.8	17.3	0.8

Note: Totals add up to more than 100% in the 1990 Census because it accounts for multiple mode users. Statistically testing if the percent of carpoolers is not different from expected values from the 1990 census, is not rejected.

- Found a faster route: 7 respondents;
- Work-related reasons (final destination is the same but intermediate stops change, for example, construction worker in different sites): 16 respondents;
- Change mode (e.g., change from drive alone to carpooling): 8 respondents;
- Road construction: 4 respondents;
- Change route to drive more on freeways: 1 respondent;
- Change to be able to use freeway: 1 respondent;
- Opening a new on-ramp enabled freeway use: 1 respondent;
- Avoid traffic signals: 1 respondent;
- Avoid a particular roadway segment with bad pavement condition: 1 respondent; and
- No specific reason (e.g., mood): 6 respondents.

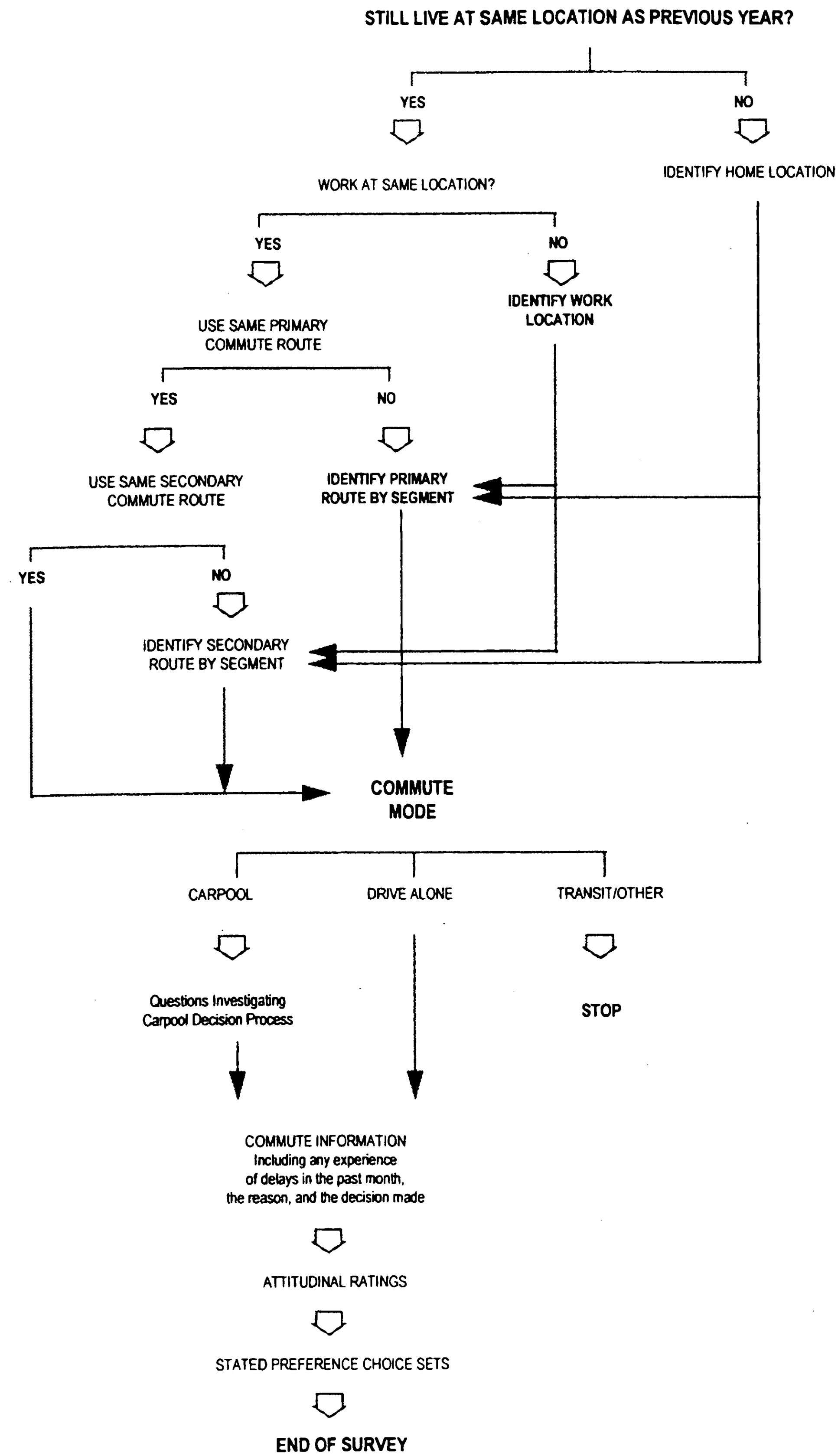

FIGURE 2 Flow chart of CATI II survey.

TABLE 3 Breakout of Frequency of Each Category of Noncontacted Respondents

Case	Number of first year's respondents
- Complete	564 (59.75%)
- Incomplete	
• Disconnected telephone no.	82 (8.70%)
• No one by the required name	59 (6.25%)
• Had the phone for less than 1 year	58 (6.14%)
• Moved from this address	51 (5.40%)
• Answering machine	41 (4.30%)
• No answer and reached maximum no. of call backs	30 (3.20%)
• Refused to participate	28 (3.00%)
• Reached maximum no. of call backs without being able to interview the respondent (e.g someone else answers the phone)	22 (2.30%)
• Fax machine	9 (1.00%)
Total	944 (100%)

TABLE 4 Binomial Probit Model Estimating Whether Respondents Continue To Participate in Second Wave of Survey

	Coef.	t-stat.
Constant	-0.0682	-0.737
X_1 Income dummy (1 if income ≥ $75,000, 0 otherwise)	0.2978	2.309
X_2 Level of education dummy (1 if respondent is a college grad., 0 otherwise)	0.1354	1.378
X_3 Female dummy (1 if female, 0 otherwise)	0.2129	2.265
X_4 No. of years living at present address	0.0105	1.538
X_5 Home ownership dummy (1 if respondent owns his home, 0 otherwise)	0.1380	1.293
Summary Statistics		
L(0) = -529.564		
L(C) = -508.160		
L(β) = -495.232		
Number of observations = 764		

Note: Variables' coefficients are defined for participating in the second survey

These responses show that the main reasons for changing the commute routes since the first wave of the survey were changing home or work location, avoiding congestion, and discovering a faster route.

Investigating Effect of Travel Time Variation on Route Choice

To investigate the effect of travel time variation on route choice, it was decided to include repeated hypothetical choice sets in the CATI survey. A major concern was that the design of the stated preference (SP) choices could be complicated to achieve the trade-offs between reliable and the unreliable routes, while trying to make the design of the choice sets as easy as possible to be understood on the telephone. The degree of travel time variation needed also to be as realistic as possible, which rules out a design that includes choice set with a large variation on one of the routes. If the hypothetical commutes were posed in a form that cannot be thought of as an actual commute, then one would have a reason to suspect whether the respondent's hypothetical choices would relate to actual ones.

Therefore, the SP choices were designed to be as simple as possible, so that respondents could comprehend and answer the choice sets on the telephone. Five SP choices are included in the survey. In each choice the respondent is asked to choose between two hypothetical routes. The first route has always fixed travel time every day (5 days a week), whereas the second route has a possibility that the travel time increases on some day(s): for example, Route 1—travel

time 30 min everyday; Route 2—travel time 20 min 4 days per week and 40 min 1 day per week. In this case the respondent is informed that a choice of Route 1 will ensure that travel time will be 30 min every day, but a choice of Route 2 means the possibility that on any 1 day of the week travel time could be 40 min and on the other 4 days it could be 20 min.

The choices are designed such that the travel time on the first route is longer and certain, whereas that of the second route is shorter but uncertain. Each respondent is presented with five choices, in which Route 1 is certain and longer, whereas Route 2 is shorter and has different levels of variation. The mean travel time on the Route 2 changes and reaches in some choices the mean of Route 1. The average travel time on Route 2 ranged between 24 and 30 min (which is equal to the mean of Route 1). The standard deviation ranged between about 5 min and about 33 min. The sequence of the choices are randomized (different from one respondent to another) to avoid any ordering bias. The objective of this part of the survey is to measure and investigate whether commuters choose longer certain routes or shorter uncertain routes, and if so, to what extent the uncertainty is that will cause them to choose the route with the fixed travel time. A companion paper presents in detail the design of these SP choice sets together with the model estimated using these data (binary logit model with normal mixing distribution to account for the correlation of disturbances resulting from using multiple observations) (See another paper by Abdel-Aty et al. in this Record).

Turning to the frequency of choices for each case, it is clear that in Cases 2, 4, and 5 the majority of the respondents had chosen Route 1. These cases have the largest standard deviations on Route 2 (> 10 min), and also the mean travel time on Route 2 is either 28 or 30 min (the mean on Route 1 is always 30 min). In Case 1 both routes were chosen almost equally; the mean and standard deviation on Route 2 are 24 and about 9 min, respectively. In Case 3, where the standard deviation is the least and the mean is 24 min, Route 2 was chosen by the majority of the respondents. This means that the respondents correctly recognized the time savings and degree of variation and were willing to tolerate travel time variation to a certain limit; after that limit they were more likely to use the certain (although slightly longer) route. Analysis of these data underscored the significant effect of travel time variation on route choice. The results showed that the disutility of 1 min standard deviation on a route is exactly equivalent to a savings of 1 min of travel time (Abdel-Aty et al. in another paper in this Record).

CATI ROUTE CHOICE SURVEY: PHASE 3

A route choice survey was developed targeting a subsample of the respondents interviewed in the second CATI survey.

Survey Objectives

The survey was designed to obtain the following information:

- Which route attributes are considered important by the individual in the decision process that leads to the choice of a route;
- Commuters' willingness to use ATIS; and
- The effect of advanced traffic information on route choice.

Response Rate

The number of targeted respondents was restricted by the availability of their addresses and the success in geocoding their origins and destinations using the GIS. Therefore, 263 respondents' origins and destinations (O-D) were successfully geocoded and their addresses were available (they agreed to provide the address during the second CATI survey). The 263 questionnaires were customized according to each respondent's origin, destination, primary route, and travel time. The questionnaire included each respondent's primary route (from the CATI surveys), an optimal route generated using O-D information and customized SP choice scenarios using primary route and actual travel time data. The questionnaires were sent to the respondents along with a postage-paid return envelope and an incentive of $2.00. A total of 143 respondents completed and returned the questionnaires (54.4 percent response rate), which is considered a very good response rate for a mail-back survey.

Survey Design

As mentioned, the questionnaires were customized for each respondent. Each questionnaire consisted of two main parts. The first is a revealed preference (RP) section, whereas the second is an SP section.

Revealed Preference Section

The main objective of the RP section is to understand why commuters choose a particular route (in this case their primary route); why they do not necessarily use the optimal route; how they perceive both primary and optimal routes; how familiar they are with their streets/highways network; and how willing they are to use and accept the advice of ATIS.

The primary route for each respondent is identified from the previous CATI surveys. If respondents stated in the second CATI that they did not change their primary route then this route is captured from the first CATI; if they stated that they did change their primary route, then this route is captured from the second CATI. Each segment of the primary route is presented to the respondent in a table; then the respondent is asked to rate a series of subjectively measured route attributes related to his primary route.

Given each respondent's origin (home) and destination (work), and using GIS capabilities, the commercial navigation data bases are used to generate minimum path routes. These data bases have details that include all the highways/streets network in the study area. The experience of a large number of drivers that are acquainted with the area indicates that according to their chosen routes each route is assigned with a weight that also enters into the algorithm calculating the optimal (fastest) route. Figure 3 shows the fastest route by segment as presented in the questionnaire. The fastest route is followed by several questions that measure the respondent's familiarity with this route, the willingness to use an ATIS system, and the rating of a series of route attributes related to the route.

The RP data will support developing a route choice model (the choice set is binary: the primary and GIS-based routes) using both subjectively and objectively measured variables. This model also can be combined either sequentially or simultaneously with a route choice model based on the SP data, including the effect of traffic information.

The following route was generated by the computer as an alternative route from your home to work. The questions below are about this alternate route.

POSSIBLE ALTERNATE ROUTE		
Seg #	Road Segment	Distance (miles)
1	S WESTGATE AVE	0.1
2	WILSHIRE BLVD	0.8
3	I-405 SAN DIEGO FWY S	0.7
4	SANTA MONICA BLVD/CA-2 HWY	2.0
5	AVENUE OF THE STARS	0.4

10. Assuming that you use this route from your home to your work in typical traffic conditions, what would be your estimation of the travel time? _______ (minutes)

11. To what extent do you consider yourself familiar with this route?
    - ☐ 1 Extremely familiar
    - ☐ 2 Very familiar
    - ☐ 3 Somewhat familiar
    - ☐ 4 Not very familiar
    - ☐ 5 Not at all familiar

12. Have you ever used this alternate route shown on page 3?
    - ☐ 1 Yes
    - ☐ 3 No
    - ☐ 2 Used a part (or parts) of the route

FIGURE 3 Example of optimal route.

SP Section

The main objective of this section is to investigate the effect of ATIS together with road type, travel time, and familiarity with a particular route, on the route choice. SP methods become an attractive option in transportation research when RP methods cannot be used in a direct way to evaluate the effect or demand for nonexisting services (e.g., ATIS). SP methods are easier to control, more flexible, and cheaper to apply (as each respondent provides multiple observations for variations in the explanatory variables).

In this survey, respondents are provided with three scenarios; in each, they have to choose between two routes and indicate their departure times (Figure 4 shows an example of one of the scenarios). The choices are binary: Route 1 is customized for each respondent so that the SP design would be as realistic as possible, whereas Route 2 is hypothetical. For Route 1 it is stated: "Your primary route using . . ." and then a segment of the respondent's actual route is written. The travel time of Route 1 is the respondent's actual commute time as stated in the CATI surveys, and the road type is the actual route type of his or her primary route (mainly freeway, mainly surface streets, or freeway/surface streets). The objective here is to use the route that the respondent is familiar with, and make the SP design realistic. The road type of Route 2 is either mainly freeway, mainly surface streets, or freeway/surface streets.

For the travel time on the alternative route to be as realistic as possible, and because both routes have the same origin and destination,

PART II

On the following 2 pages, we are asking you to choose from among two routes, the first is similar to your primary route, while the second is a hypothetical route.

Suppose one day you are choosing between the following two routes from your home to work

	Route 1 Your primary route using OHIO ST	Route 2
1. Road type	Surface streets	Mainly Freeway
2. Normal Travel Time	15 minutes	13 minutes
3. Traffic Information		
• Estimated travel time on this day	Not available	13 minutes
• Information on the cause of the delay	----	----

24. Given these choices, which route would you choose on this particular day?

☐₁ Route 1 ☐₂ Route 2

25. When would you leave home on that day? _________ AM

FIGURE 4 Example of route choice question.

the travel time on both routes is likely to be close to a great extent. Therefore, normal travel time on Route 2 is one of the following:

0.9 * (Normal travel time on Route 1)

1.0 * (Normal travel time on Route 1)

1.1 * (Normal travel time on Route 1)

Traffic information is available on either Route 1 or Route 2, but not both. If traffic information is available then it gives an estimation of the travel time on that day, which is one of the following values:

0.9 * (normal travel time on the same route)

1.0 * (normal travel time on the same route)

1.1 * (normal travel time on the same route)

1.2 * (normal travel time on the same route)

1.4 * (normal travel time on the same route)

These values are chosen to be as realistic as possible to represent light and usual traffic conditions (Factors of 0.9 to 1.1), mild traffic conditions (factor of 1.2), and heavy traffic conditions that might be caused because of an accident (factor of 1.4), for example.

If the information system estimates a travel time above normal, the cause of the delay is given to the respondent. The cause of the delay is either accident, maintenance, stalled vehicle, or regular

congestion. An ATIS was defined to the respondents as a system that can offer personalized information about a trip and offer advice about other routes while considering current traffic conditions.

All possible combinations of the previous cases are considered, after excluding the obvious choices (e.g., if Route 1 is faster and has information that predicts no delays). In all, 68 different combinations were used, 3 for each respondent randomly.

CONCLUSIONS

In this paper two innovative techniques in developing route choice surveys are introduced. The paper addresses the use of computer software, GIS applications, and network data bases in designing and undertaking route choice surveys, which yield data for modeling route choice decision making and for network analysis. The work introduces a new application of computers and GIS in transportation engineering. Also the SP techniques presented enabled the collection of data for analyzing the effect of travel time variations on commuters' route choice (which would be difficult to observe because it is time consuming to collect data that support the analysis), and the evaluation of the effect of a nonexisting service (ATIS) on route choice. The potential of these methods in collecting detailed information on commuters' routes are discussed. Analyses of the data collected from the three surveys proved the viability of these methods [see, for example, work by Abdel-Aty et al. (*19–22*) and in a paper in this Record]. In general, these suggested techniques in surveying commuters' route choice behavior could be extended to study different aspects of drivers' behavior and transportation planning.

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