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TravInfo Evaluation: Traveler Response Element Broad Area Study: Phase 2 Results Analysis of Wave-2 Survey

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Y.B. Youngbin Yim

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ABSTRACT

TravInfo was a Field Operational Test (FOT) sponsored by the Federal Highway Administration (FHWA) and California Department of Transportation. It aimed to develop a multi-modal traveler information system for the San Francisco Bay Area, combining public and private sector talents. The Broad Area Study was part of the TravInfo FOT evaluation. It addressed issues on how travelers obtain traffic/transit information and how the information influences travel behavior. Two waves of telephone surveys of Bay Area households were conducted, one prior to and one after the Field Operational Test. The initial survey was conducted in November 1995, eight months prior to when the TravInfo FOT began; the final survey was conducted in November 1998, three months after the FOT was ended. The purposes of the Broad Area study were to establish a baseline traveler behavior of Bay Area households based on traveler information and to assess the impact of traveler information on the entire Bay Area traveling population. The surveys showed that there was little change in the way people obtain traveler information, but more people modified their travel behavior in 1998 than did in 1995 based on the traffic information. As shown in the 1995 survey, most people changed departure time or took an alternate route. Mode shift was fairly negligible in both surveys.

Keywords: TravInfo traveler information travel behavior

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EXECUTIVE SUMMARY

As part of the TravInfo Evaluation project, two waves of Broad Area surveys were conducted in the San Francisco Bay Area. The first wave survey was conducted in November 1995; eight months prior to when the TravInfo Field Operational Test officially began. The second survey was done in November 1998, three months after the field test ended. This working paper presents the findings of the first and second wave of the Broad Area surveys of San Francisco Bay Area residents. The purposes of the Broad Area surveys were to establish baseline travel data for the assessment of the general impact of TravInfo on the travel behavior of Bay Area travelers and to compare the results of the surveys before and after the TravInfo field test.

For both surveys, computer-aided telephone interviews were conducted among San Francisco Bay Area households. One thousand interviews were completed for each survey with over a 50% response rate of those households contacted by random digit dialing according to telephone prefixes and area codes. The survey questions were developed for four traveler groups by trip purpose and mode; 1) commuters who use personal vehicles, 2) commuters who use mass transit, 3) non-commuters who use personal vehicles, and 4) non-commuters who use mass transit. The survey results presented are primarily the distributional profiles of the sample, using frequency analysis and cross tabulation. In some cases, bivariate statistical methods were used to compare means and proportions of responses. In other cases factor analysis or logistic regression methods were used to explore interdependencies and interaction effects among explanatory variables.

- The survey results show that there is no significant change in the way people acquire traveler information, but there is a change in travel behavior influenced by traveler information. The key findings of the 1995 and 1998 surveys are:

- Commuter/non-commuter and modal splits in 1995 and 1998 were similar. In 1995, 67.1% of the sample was commuters while 69.6% was commuters in 1998. Of the

1995 sample, 86.2% of the sample was personal vehicle users while 85.2% was in 1998. Public transit users in 1995 were 13.6% while 14.8% in 1998.

- Approximately one third of the survey participants obtained traffic information regularly, one third occasionally when they expected traffic problems, and the remaining one third never listened to traffic reports. Commuters tend to listen to traffic reports more often than do non-commuters.

- The most popular means of receiving traffic/transit information in 1995 and 1998 was commercial radio broadcasts both for pre-trip and en route travel decisions. More people listened to radio traffic reports while driving than before leaving home or for home. There was a slight increase in obtaining traffic information over the telephone between 1995 and 1998. Among the currently and potentially available media, radio broadcasts were still the most preferred medium for receiving traveler information, followed by in-vehicle navigation devices.

- Less than 10% of the Bay Area households had heard of TravInfo's Traveler Advisory Telephone System (TATS) information service in 1998. Of the people who were aware of the TravInfo TATS service, over two thirds of them did not try it. They believed that radio or television was the best media to advertise the TravInfo TATS service.

- Factor analysis suggests that there are two groups of information seekers preferring conventional media such as radio, television, and telephone, and advanced media such as the Internet, cellular phone, and in-car navigator. The ANOVA analysis with the factor scores shows that more educated women are likely to obtain traffic information from advanced media while no significant difference is found among men who received higher education and those who didn't receive higher education for obtaining traffic information either from advanced or conventional media.

- The survey participants rated the quality of a traffic report excellent or good when judged on its usefulness. Over two thirds of those who listen to traffic reports rated radio, television, and telephone information as excellent or good. The most-valued information for personal vehicle users were: 1) those which would identify the best alternate routes to avoid traffic congestion, 2) real-time traffic information and 3) fastest route information via an in-vehicle navigation device. These types of information were equally desirable. As expected, real-time transit information was most valued by transit users followed by the best alternate transit route information. The benefits of traffic information were perceived to be in the area of trip planning, including trip cancellation, as well as in travel timesavings and reduced anxiety.

- The 1998 household survey in the Bay Area showed that approximately 15% of motorists on average modified their travel behavior each day, 13% was based on radio traffic information and 2% was for reasons not related to traffic reports. Of those who learned about traffic problems on their planned routes from the radio, about 25% changed their travel behavior. In most cases, people tended to take an alternate route or change their departure time. Very few people chose to take mass transit even if they expected traffic problems mainly because the transit service was inconvenient. When all information media is considered, over half (53%) of drivers who obtained traffic information changed their travel behavior in 1998 while one third (29.7%) of drivers changed their travel behavior based on traffic reports in 1995, a significant increase in travel change. The 1998 survey also showed that most people took an alternate route and changed departure time.

- Why do some people drive alone and others do not (share rides)? The 1998 survey data suggests that the probability of driving is closely correlated with a number of variables. The greater automobile accessibility at home, the less likely drivers are to share rides with other people. Commuters are more likely to choose ride share. The higher the miles driven per year, the less likely drivers are to share rides with other people. Women are more likely to share rides than men. The higher the disposable

income per capita (persons in a household), the less likely drivers are to share rides. The longer the travel distance, the more likely drivers are to share rides. The younger age group between 18-24 and the older age group 45-55 are more likely to choose ride share than other age groups.

- Both 1995 and 1998 surveys suggest that proportionally more non-commuter drivers changed their travel habits than did commuter drivers (t-test of means, at the 95% confidence level); the reason may be that their schedules are more flexible. According to the survey, more non-commuter drivers tend to make travel decisions before leaving home than commuters; more commuter drivers seem to make their travel decisions en route than non-commuters. The surveys also suggest that people who listen to traffic reports *both* before leaving home and en route are more likely to change their travel habits than those who listen to only pre-trip or en route reports (at 95% confidence level).

It was expected that more people would seek for traveler information in the 1998 survey because the content and delivery of traveler information services under TravInfo would improve. Furthermore, there would be an increase in the number of people who changed their mode choice from drive alone to mass transit. The 1998 survey did not show significant overall changes in the acquisition of traffic information, but significant changes were observed in travel behavior. More people modified their travel behavior in 1998 than did in 1995. Notable changes are also an increase in the use of traffic Web sites and the public perception of traffic information over the telephone being more reliable.

1. INTRODUCTION

TravInfo was a Field Operational Test (FOT) sponsored by the Federal Highway Administration (FHWA) of the US Department of Transportation (DOT) and the California DOT (Caltrans). The Field Operational Test began in August 1998 and officially ended in August 1998. Over its two-year lifetime, the field test was to develop a multi-modal traveler information system for the San Francisco Bay Area, combining public and private sector talents. Its objective was not only to provide benefits to Bay Area travelers, but also to stimulate the deployment of privately offered traveler information products and services. The FHWA intends to make the results of this test accessible to others across the nation who may wish to engage in similar enterprises. To achieve this aim, California PATH was commissioned to perform an independent evaluation of the test (Hall, et al, 1995; Yim, et al, 1995).

The evaluation project as a whole initially included four test elements: institutional, technology, traveler response and network performance, but the network performance evaluation was later excluded due to the lack of reliable data to perform the evaluation. The traveler response element, of which this working paper is a part, investigates the effectiveness of TravInfo on travel decisions to avoid traffic congestion. The traveler response evaluation has four coordinated studies, all of which employ a survey methodology. The effects of traveler information on the Bay Area traveler population are assessed from the Broad Area study. The site-specific impacts on a selected corridor, during incidents, are assessed from the Target study (Koo, et al, 1997; Koo and Yim, 1998a, 1998b, 1999a, 1999b; Tam and Yim, 1998). The impacts on the travelers with ATIS (Advanced Traveler Information System) devices are assessed from the VAR (Value Added Resellers) Customer study. Finally, the impacts on travelers who directly access TravInfo by telephone are assessed through the TATS (Travel Advisory Telephone System) study (Yim, et al, 1998). The Broad Area study involves a comparative analysis of before and after TravInfo. Other traveler response studies are only concerned with the effects of TravInfo after it becomes operational.

This working paper presents the findings of the post-TravInfo Broad Area study. The first wave of the Broad Area survey was administered in November 1995, eight months prior to when TravInfo began operation (Yim, et al, 1996; Khattak, et al, 1999). Its purpose was to establish a baseline in reference to trip characteristics of San Francisco Bay Area households for the assessment of the general impact of traveler information on individual travel behavior. The second wave of the Broad Area survey was administered in November 1998, three months after the TravInfo field test ended.

The objectives of the pre-TravInfo Broad Area survey were to:

1) Identify trip attributes associated with the acquisition of traveler information.
2) Assess perceptions of the quality of traveler information.
3) Document opinions on the benefits of traveler information.
4) Identify stated preferences for information content and delivery.
5) Describe the trip characteristics and profiles of Bay Area households.

The objectives of the post-TravInfo Broad Area survey were to:

1) Compare the post-TravInfo survey results to the pre-TravInfo survey results.
2) Assess changes in travel behavior before and after the TravInfo field test.
3) Identify any travel behavior changes due to TravInfo being on line.

The paper begins with the methodology used for survey design and administration, followed by the findings of the second wave Broad Area survey. Comparisons are then made between the results of the first wave survey and the second wave survey. The issues concerning the willingness to pay for traveler information were addressed in a separate paper (Liu, et al, 1999).

2. METHODOLOGY

Survey Design and Administration

The wave-2 Broad Area survey was conducted during the first and second weeks of November 1998, three months after the field test ended. GLS Research, a market research consultant, administered the survey using the computer aided telephone interview (CATI) technique. The sample was drawn from households in all nine Bay Area counties by random digit dialing according to telephone prefixes and area codes. The random digit dialing method was used mainly because it can ensure that all households, which have a telephone, are included in the sampling pool, regardless of whether or not their telephone numbers are listed. Since over 95% of Bay Area households have a telephone, the exclusion of non-telephone households from the sampling pool should not pose a serious problem for the representativeness of the resulting sample.

One thousand telephone interviews were completed. This sample size was determined based on the expectation that there should be enough respondents from commuter and non-commuter groups to develop statistically reliable profiles of each group's travel behavior.

Other important subgroups for sampling were defined by mode. Their relative occurrence in the commuter population, according to the 1990 census data, is: 68.2% drive alone, 13% rideshare, 11.2% take public transit and 7.6% choose another transportation mode. We estimated that sufficient numbers would be obtained in the drive-alone category but the rideshare and public transit categories were unlikely to be sufficient to draw statistically significant conclusions. Over sampling of transit users was considered but was rejected because of the relatively high cost associated with sampling an additional 200 transit users via random digit dialing.

To prevent any response bias by gender, an interviewing quota of no more than 52% female respondents was imposed. It has been well documented that women tend to respond more

readily to surveys than do men. By imposing a gender quota we were able to ensure that the resulting sample population was representative of the total adult population of the Bay Area with respect to gender. Multiple contact attempts and refusal conversion procedures were employed to minimize non-response bias. Interviews were conducted with those who met the predetermined criteria; only individuals who were at least 18 years old were considered eligible for interviewing; non-residents and those who had language barriers were excluded in the survey; if the primary mode was walking or bicycling, the interview was also terminated.

Repeated calls were made up to five times and 1,000 interviews were completed with an over 50% response rate of those households which answered the call in both 1995 and 1998 surveys. The response rate was computed based on the ratio between the number of households which were willing to respond to the interview and the number of households which refused to participate.

Sampling

The sample was supplied by Scientific Telephone Samples (STS), a company specializing in scientific sampling. The sampling frame is based on a database of all working residential telephone exchanges and working blocks (sampling areas such as county or zip code). The sample is pulled using a *pure unweighted methodology* from nine counties based on household density in each county (Table 1). Each possible telephone number within each county had an equal chance of being selected. Using this sampling method, completed interviews from the pulled sample, if dialed exhaustively, are highly representative of the population under study. Each sample taken in 1995 and 1998 shows the representativeness of the Bay Area household population in 1995.

Table 1. The Sample and San Francisco Bay Area Households by County

County	Households in % N=2.3 million	1995 Sample in % n=1,000	1998 Sample in % n=1,000
Alameda	20.9	19.3	20.9
Contra Costa	13.8	15.2	17.5
Marin	4.3	5.4	3.2
Napa	1.7	3.0	2.0
San Francisco	13.2	11.9	11.0
San Mateo	11.0	9.4	9.0
Santa Clara	22.9	21.4	23.3
Solano	5.4	4.9	6.1
Sonoma	6.8	9.5	7.0

N= number of Bay Area households in 1995 census (n= total observation of the sample)

Survey Content

The survey questions were directed to six subject areas, concerning:

1. General trip characteristics of commuters and non-commuters by mode, frequency, origin and destination, and specific routes people normally take.
2. Acquisition of pre-trip and en route traffic information in terms of frequency and the selected medium.
3. The effects of pre-trip traffic information on departure time, route and mode choice, and trip cancellation, and the effects of en route information on route diversion.
4. Perception of traveler information with regard to its quality and benefits to travelers.
5. Stated preference for traveler information in terms of the content and the means of receiving information.
6. Demographic profiles of survey participants

In the interest of keeping the interviews within 15 minutes, separate interview instruments were used for four traveler groups: 1) commuter driver, 2) commuter transit user, 3) non-commuter driver, and 4) non-commuter transit user. Drivers as defined in this paper are the users of personal vehicles who either drive alone, carpool, or ride a motorcycle. Travelers who use both a personal vehicle and transit (park and ride) are treated as transit users because their primary mode is transit. Descriptive statistical methods are used to determine

distributional profiles of the sample. In some cases, bivariate statistical methods are used to compare means and proportions of responses. Both factor analysis and logit models are used to explore interdependencies and interaction effects among explanatory variables. The explanatory variables include demographic and trip characteristics and the dependent variables include information acquisition and attitudes toward traveler information.

3. DESCRIPTION OF THE SAMPLE

This section describes the samples taken in 1995 and 1998 and their characteristics. The 1995 sample was compared with the 1995 Bay Area census to determine whether the sample represents the relative occurrence in the population with respect to commuter and non-commuter attributes, modal split and demographic profiles. The 1998 sample was compared with the 1995 sample in order to determine the similarities and differences between the two.

Commuters and Non-Commuter Split:

In the first wave (pre-TravInfo or 1995 survey) survey, the sample was composed of 67.1% commuters and 32.9% non-commuters (Table 2a). The sample reflects 1995 Bay Area working and non-working household profiles with an average of 1.4 workers per working household. The split between the commuters and non-commuters was 65/35 based on the 1995 census of Bay Area working and non-working households.

In the second wave (post-TravInfo or 1998 survey) survey, the sample was composed of 69.6% commuters and 30.4% non-commuters who either work at home or do not have regular employment (Table 2b). Commuters were defined by the frequency of weekly trips, i.e., those respondents who made three or more trips to work or school. Data on the 1998 commuter/non-commuter split were not available to compare. Despite this, the commuter and non-commuter split in 1998 is very similar to the split in 1995.

Table 2a. Commuter and Non-commuter Split in the 1995 Survey

	Commuters	%	Non-commuters	%	
Personal vehicle users	575	85.7	289	87.8	862
Transit users	96	14.3	40	12.2	136
Total	671	100	329	100	1,000

Table 2b. Commuter and Non-commuter Split in the 1998 Survey

	Commuters	%	Non-commuters	%	
Personal vehicle users	598	85.9	254	83.6	852
Transit users	98	14.1	50	16.4	148
Total	696	100	304	100	1,000

Modal Split

The 1995 survey showed that 86.4% of the sample drove alone or carpooled and 13.6% took transit to work or to their most frequent destination while in 1998, 85.9% of the sample drove alone or carpooled and 14.1% took transit. Table 3a shows the relative frequencies of respondents' primary transportation modes to work or most frequent destinations in November 1995. Table 3b shows the relative frequencies of respondents' primary transportation modes to work or most frequent destinations in November 1998.

The 1995 or 1998 census report on the Bay Area modal split was not available at the time of the Broad Area survey data analysis. However, the data were compared with the 1990 Census and surveys recently conducted by Rides (Rides, 1995) and the San Francisco Chronicle. The comparison shows that transit riders in the 1995 and 1998 surveys may be somewhat over represented and rideshare may be under-represented in the Broad Area survey (Yim, et al, 1996).

Table 3a. Modal Split between Commuters and Non-commuters in 1995

Mode	Commuters n=671		Non-commuters n=329		Total responses N=1000	
	n	%	n	%	n	%
Personal Vehicle Users:	**575**	**85.7**	**289**	**87.8**	**864**	**86.4**
Drive alone	533	79.4	277	84.2	810	81.0
Motorcycle	8	1.2	0	0	8	8.0
Carpool	34	5.1	12	3.7	46	4.6
Transit Users:	**96**	**14.3**	**40**	**12.2**	**136**	**13.6**
Transit	55	8.2	26	7.9	81	8.1
Combination (Park & ride)	41	6.1	14	4.3	55	5.5

N=total number of responses n=number of responses by subgroups

Table 3b. Modal Split between Commuters and Non-commuters in 1998

Mode	Commuters n=696		Non-commuters n=304		Total responses N=1000	
	n	%	n	%	n	%
Personal Vehicle Users:	**598**	**85.9**	**254**	**83.5**	**852**	**85.2**
Drive alone	538	77.3	239	78.6	777	77.7
Motorcycle	5	0.7	1	0.3	6	0.6
Carpool	55	7.9	14	4.6	69	6.9
Transit Users:	**98**	**14.1**	**50**	**16.4**	**148**	**14.8**
Transit	57	8.2	25	8.2	82	8.2
Combination (Park & ride)	41	5.9	25	8.2	66	6.6

N=total number of responses n=number of responses by subgroups

Flexible time to arrive at work

Having the flexibility to arrive at work will affect commuters' travel behavior. In both the 1995 and 1998 surveys, we asked commuters whether they could have a flexible time to arrive at work. About half of the survey participants indicated that they could arrive at work at different time. The 1995 survey showed that 50.5% (318 of 630 respondents) had flexible arrival time while 50.9% (307 of 603 respondents) had flexible arrival time in the 1998 survey.

Primary Route

Both the 1995 and 1998 surveys show that the primary route of the majority of the survey participants was the freeway. In 1995, 44.3% of the participants said their primary route was the freeway while 50.7% said in 1998. In 1995, 39.5% of participants said their primary route was surface streets while 32.8% said that in 1998. Of the total participants, 16.2% traveled both freeway and surface streets equally in 1995 while 16.5% did in 1998.

Demographic Characteristics

Demographic profiles of the sample serve two purposes: to test the representativeness of the actual population and to identify the relationships between the population and its travel behavior characteristics. In looking at the household income characteristics of the sample, it appears that in the 1995 survey, the upper income group over $100,000 is over-represented and the lower income group, less than $25,000, is under-represented while the 1998 survey shows that both age groups are slightly under-represented, as shown in Table 3.3.

Correspondingly, the 1995 survey shows that the age group between 18 and 34 is somewhat under-represented while the age group over 35 is somewhat over-represented (Table 3.4). The On the other hand, the age group distribution in the 1998 survey seems fairly well representative of the Bay Area driving population based on the 1995 census data (Table 3.4).

In order to correct response biases, the survey data were weighted (sample balancing) according to the census demographic profiles of the Bay Area population. The P-STAT algorithm was used to compare weighted and unweighted data. The comparative analysis suggested that sample balancing would not significantly affect the overall conclusions of the survey results. Therefore, the findings presented in this paper are based on unweighted data. When the data were weighted by Bay Area household income, the distribution was similar to the distribution using unweighted data.

The age distributions of the 1995 and 1998 samples were compared using the ANOVA test. The test showed that the means of age groups were similar between the 1995 and 1998 samples at the 95% significance level.

Table 4. Household Income Distribution in the San Francisco Bay Area
(1995 and 1998 surveys)

Household Income	1995 sample households responded in % n=746	1995 census households in % N=2.3 million	1998 sample households responded in % n=762
<25K	14.1	25.5	14.2
25-50K	22.5	31.6	47.0
50-100K	39.0	32.2	30.5
>100K	24.4	10.7	8.3
	100	100	100

254 people did not respond to the question about their household income in the 1995 survey.
238 people did not respond to the question about their household income in the 1998 survey.

Table 5. Age Distribution of the San Francisco Bay Area Population
(1995 and 1998 surveys)

Age group	1995 sample in % n= 787	1995 census in % N=4,173,570	1998 sample in % n=931
18-24	8.8	11.5	10.1
25-34	17.2	23.1	21.1
35-44	25.9	23.6	23.0
45-54	19.9	16.7	21.2
55-64	11,1	10.3	11.9
65+	17.1	14.8	12.7
	100	100	100

213 people did not respond to the question about their age in the 1995 survey.
69 people did not respond to the question about their age in the 1998 survey.

4 SURVEY RESULTS OF THE 1995 AND 1998 BROAD AREA SURVEYS

This section of the paper describes responses to survey questions pertaining to: 1) the acquisition of traffic information, 2) the traveler response to information, 3) the perception of the information quality and the perceived benefits, and 4) the preference for information content and delivery. The first- and second- wave survey results are presented to assess changes in travel behavior and travelers' opinions on and attitudes toward traveler information.

Acquisition of Traffic Information

To estimate the level of traffic/transit information acquisition among Bay Area travelers, the Broad Area surveys were concerned with: 1) how many people listen to traffic reports, 2) how frequently they listen, 3) when they normally listen to information and 4) what source of information they generally use.

As shown in the 1995 survey, the 1998 survey showed that a vast majority of travelers listen to traffic reports, at least when they expected a traffic problem. Over one third of Bay Area travelers listened to traffic reports regularly in both surveys. Based on our surveys, three types of travelers could be identified, those who: 1) use traffic information on a regular basis, 2) use information under special circumstances and 3) never listen to traffic information. The relative distribution among the different user groups in 1995 and in 1998 is shown in Table 6.

Regular users are defined as those who acquire information every time or most of the time when they travel. Occasional users are those who use information some of the time when they travel or only when they are expecting a traffic problem. (For consistency of terminology, those who commute to work in their personal vehicles are called "commuter drivers" and those who do not commute to work but use personal vehicles are called "non-commuter drivers.")

Table 6. Traveler Category by Acquisition of Traffic Information in 1995 and in 1998

Information user category	1995 survey N=1000 In %	1998 survey N=1000 In %
Regular users	35.7	32.5
Occasional users	38.4	33.9
Non-users	25.9	33.6

Two hypotheses were tested with the 1995 and 1998 data. The first hypothesis was that commuters tend to acquire traffic information more frequently than non-commuters and the second hypothesis was that personal vehicle users tend to rely on traffic information more often than transit users. In both surveys, the cross tabulation indicated that commuters listen to traffic reports more frequently than do non-commuters (t-test of proportions at the 95% significance level) for both transit and drivers, but no significant difference was found between personal vehicle users and transit users (t-test of proportions at the 95% confidence level).

Both the 1995 and 1998 surveys showed that more commuters tune into radio traffic reports en route than before leaving home or leaving for home. Commuter drivers who listen to *both* pre-trip and en route traffic reports are also more likely to change their commute habits than those who listen to traffic reports either pre-trip or en route only (t-test of means, significant at the 95% confidence level). Note that the percentages shown in Table 7 are not mutually exclusive. The surveys showed that more people obtained traffic information in 1998 than in 1995.

Table 7. Commuters Tune in to Radio Traffic Reports in 1995 and 1998

	1995 survey in % n=1000	1998 survey in % n=1000
Obtaining traffic reports before departure	20.2	30.2
Obtaining traffic information en route	33.4	47.6

Another hypothesis tested was that freeway drivers listen to traffic reports more often than those whose route is solely over surface streets. The cross-tabulation suggests that the acquisition of traffic information is closely associated with the primary travel route (t-test of means, significant at the 95% confidence level). Figures 1a and 1b show the relationship between the use of information and freeway/surface streets. Both 1995 and 1998 surveys show that over 40% of travelers whose primary route is freeway listen to traffic reports regularly while about 25% of travelers who travel surface streets listen to traffic reports. Roughly 30% of freeway and surface street travelers obtain traffic information when they expect traffic problems. Over 20% of freeway travelers do not listen to traffic reports at all while about 40% of surface street travelers never listen to traffic reports. As expected, more commuters travel on freeways than do non-commuters.

Figure 1a. Information Seekers and Freeway/Surface Street Driving 1995 Survey

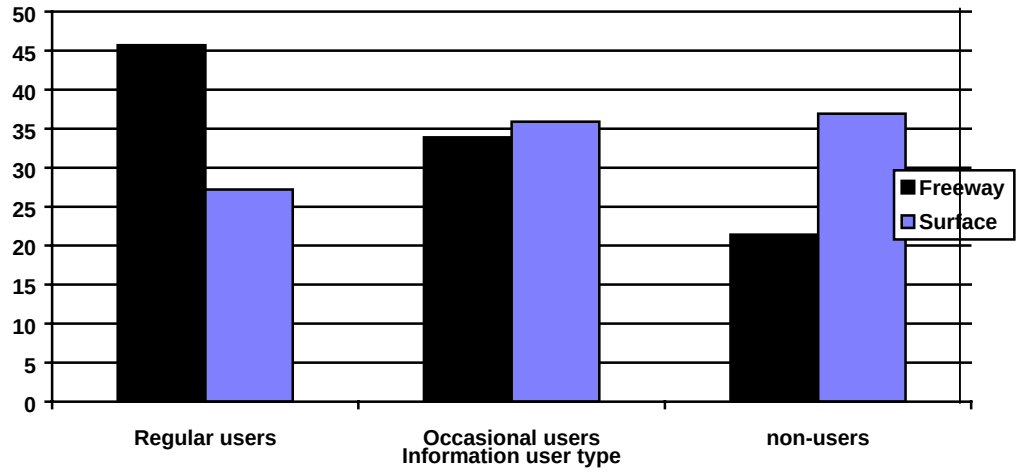
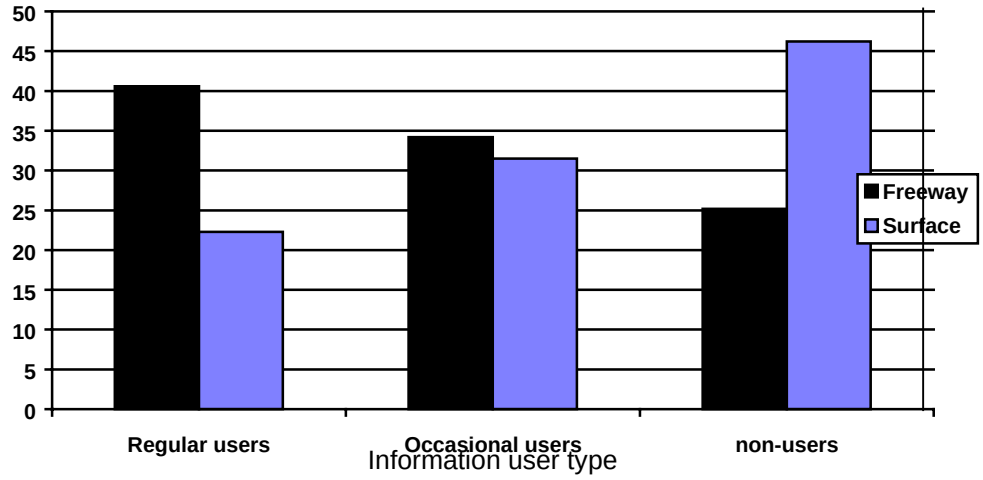


Figure 1b. Information Seekers and Freeway/Surface Street Driving 1998 Survey



Means for Acquiring Traffic Information

Until this day, commercial radio or television has been the primary source of traffic information in the Bay Area. The two major ISPs, Metro Networks and Shadow Broadcast Services, provide traffic data to radio and television stations in exchange for advertisement slots. (In June 1999, these two ISPs merged to provide radio traffic information.) The data are collected directly from their own airborne sources and the CHP CAD. Over 60 Bay Area radio and four television stations broadcast Bay Area traffic conditions in 10 to 15 minute intervals during the morning peak hours. Only a few stations disseminate traffic information during afternoon peak and off-peak hours. From the end-user perspective, TravInfo is advantageous since it can provide more current and accurate traveler information on demand than radio or television broadcasting.

Although Bay Area travelers are generally satisfied with radio-television traffic reports, a need for improved traveler information was apparent for two basic reasons: 1) timely dissemination of traffic conditions and multi-modal travel options, and 2) reporting of consistent information throughout the Bay Area (Yim, et al, 1994). With radio or television reporting, listeners may

have to wait until information is disseminated during the designated time. Delays of information can be as long as 15 minutes depending on when the information was disseminated and obtained. By the time the information reaches listeners, it is often irrelevant to their planned trips. Broadcast traffic reports are also inconsistent among stations. Many stations prioritize information provided by Metro or Shadow. Radio and television stations focus on major freeways and bridges, they rarely cover specific routes as reporting is aimed at covering the entire Bay Area in a half-minute time slot.

In 1995, two commercial telephone sources, Fastline and Bay Line, were available for traffic and weather information. Fastline provided Bay Area traffic information at the sub regional level, North Bay, East Bay, Peninsula, and South Bay. Fastline was connected to City Line, the free telephone information service for weather and Bay Area events. Bay Line, part of radio station KKSF, provided region wide traffic coverage over the telephone, along with weather information. In addition, GTE Mobilnet and Cellular One had offered traffic information service features over the cellular telephone. Transit telephone information was available through individual transit operators.

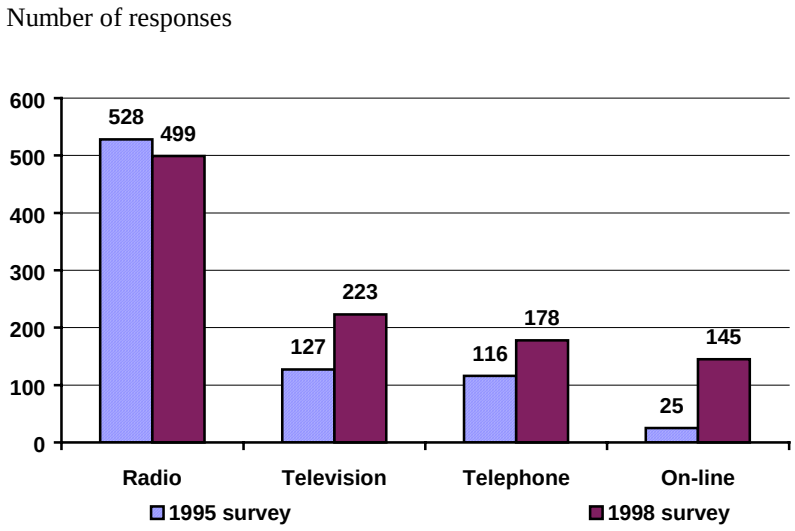
Since September 1996, TravInfo has been providing an interactive Traveler Advisory Telephone System (TATS) available through the landline telephone system by dialing 817-1717 and through Information Service Providers' traffic web sites. All travel-related information throughout the Bay Area is available through this single telephone number. TATS provides traffic information tailored to four sub regions, East Bay, North Bay, South Bay and Peninsula. At the start of the field test, the Bay Area had four area codes allowing any TATS caller to access TravInfo anywhere in the region without the need to dial an area code. During the field test, two of the four codes split and callers in regions defined by new area codes had to dial the area code first before the TravInfo access number. The Alameda County Transit (AC Transit), has adopted the 817-1717 number as the sole means of obtaining its information while all other transit agencies continue to utilize and advertise their own individual phone numbers in addition to the TravInfo number.

At home, people could receive traffic information from three primary sources: radio broadcast, television broadcast, and the telephone in 1995. Traffic and transit information from fax machines and on-line computers were also available through the employer transit use incentive program (initiated by the California Clean Air Act, Regulation 13). En route, travelers could acquire traffic reports mostly from in-vehicle radio broadcasts or the cellular telephone.

In 1998, Bay Area travelers could obtain traffic/transit information through TravInfo TATS and three web sites offered by ISPs. Several ISPs were developing traffic information services through personal digital assistants, in-vehicle devices, and cellular telephones with notification features.

Both the 1995 and 1998 surveys showed that radio broadcast was the predominant means of receiving traffic information, both before leaving home and while driving. Of those personal vehicle users who sought traffic information, there was a greater number of people who sought traffic information over the phone in 1998 than in 1995 and also in the case of the Internet. The increase in the Internet users in 1998 was significant.

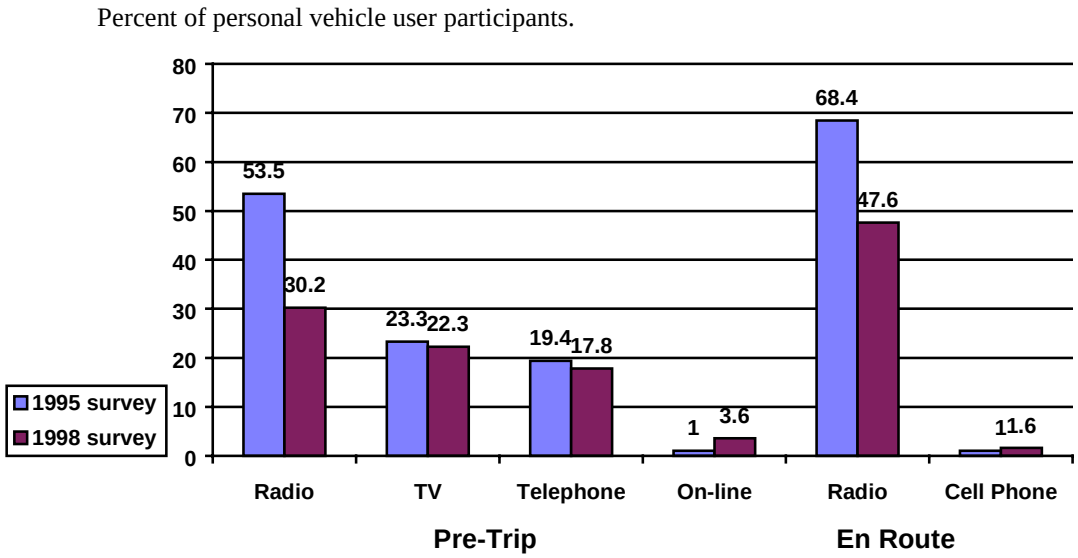
Figure 2. Means for Receiving Pre-Trip Traveler Information



Note: The numbers shown above are not mutually exclusive.

Figure 3 also indicates that among all drivers more people listen to radio reports en route than before leaving home or leaving for home. Of the radio traffic listeners, approximately half acquire both pre-trip and en route information, about 20% acquire pre-trip information only and 30% acquire en route information only.

Figure 3. Means of Receiving Pre-Trip and En Route Traffic Information



As mentioned before, both GTE Mobilnet and Cellular One offer traffic information. Both Metro Networks supplies information to GTE and Shadow Broadcast Services supplies information to Cellular One. In the 1995 survey, very few people sought traffic information over the cellular phone, only 6.1% of the cellular subscribers (19% of the total participants who have cellular phones or 1.1% of all drivers) ever called the cellular traffic information source. In the Bay Area, cellular call volume for traffic information has been constant over the past five years (Yim, et al, 1992) although subscription has gone up significantly. This is presumably due to the fact that drivers have to pay for the information, $1 a call, while the identical information can be obtained from commercial radio broadcasts. The SmarTraveler operational test in Boston however revealed that cellular call volume has increased dramatically when cellular traveler information has been offered free. Cellular phone users made up 45% of the total SmarTraveler callers and cellular calls comprised 61% of the total

calls (Multisystems, 1995). In 1998, the survey showed that one third of the calls made to TravInfo were from cellular phones (7 calls of the total 24 calls made to TravInfo).

Awareness of TravInfo in 1998

In the 1998 survey, we asked whether the respondents had heard of any transit or traffic information services in the Bay area that they can call on the telephone. Over half of them (53.6%) said they had heard of one. When asked whether they could recall the names or phone numbers of any of these service providers, only 1.3% (or 7 persons) of 536 respondents said that they could recall hearing about TravInfo. Most respondents recall hearing about transit agencies' (39.3%) and Caltrans' (10.6%) information services.

Then we asked have they heard of the telephone traffic and transit information service called TravInfo. This was among those who had heard of a telephone information service but did not mention of TravInfo voluntarily. Of 529 respondents (7 persons minus 536 respondents) who had heard of telephone information service, 12.3% (65 persons) said that they had heard of TravInfo. Overall 72 persons (7.2%) of the 1000 people surveyed had heard of TravInfo. It suggests that less than 10% of the Bay Area traveling population is aware of TravInfo (Table 8).

Table 8. Wareness and Usage of the TravInfo Traveler Advisory Telephone Service

1998 survey results	Number and %
Those who had ever heard of a telephone traffic/transit information service	536 (53.6%)
Those who were aware of TravInfo	72 (7.2% of the sample)
Those who had ever called TravInfo	18 (27.8% of those who were aware of TravInfo)

When asked how they first learned about TravInfo, one third of them said they got the information from radio followed by billboards or bus advertisement (Table 9). The TravInfo ad campaign did not include television, but some people heard of TravInfo through television

reporting during the BART strike and flooding. The survey participants said that the best media to advertise TravInfo is radio or television broadcasting.

Table 9. Information Sources to Learn about and Advertise TravInfo TATS

1998 survey, N=72

Source	Learned about TravInfo in %	The best place for TravInfo to advertise
Television	15.3	36.1
Radio	31.9	44.4
Billboard	22.2	2.8
Internet/web page	2.8	2.8
Word-of-mouth	6.9	-
Employer program	1.4	-
Newspaper	12.5	9.7
Not sure	6.9	4.2

Of those who had heard of TravInfo, 25% (18 of 72 people) had used the TravInfo information service. About 40% of those who had tried TravInfo said that they called TravInfo more than one to two times a week. Of the 18 TravInfo users, 50% requested both pre-trip and en route traffic information.

The 1998 survey suggests that TravInfo callers are repeat users. Of the TravInfo users, nearly 40% said that they were using it more than a year and another 40% said they were using TravInfo longer than three months (Table 10). The survey also suggested that new customers were relatively small. Only about 10% of the users used TavInfo less than a month.

Table 10. Months of TravInfo TATS Usage by Patrons

How long have you been using TravInfo? (N=18)

Months	%
One year/more	38.9
6-12 months	16.7
3-6 months	22.2
1-3 months	5.6
< 1 month	11.6
Not sure	5.6

Of the 72 persons who are aware of TravInfo, over two thirds (76.4%) have not called TravInfo. When asked about the primary reasons for not calling TravInfo, the participants indicated that traffic reports rarely cover the routes that they take and there are no alternative routes that they can take.

The 1998 survey showed that 56.6% of the sample owned a cellular phone (Table 11). Of the 1998 survey sample, 37.7% usually had a cellular phone while traveling, in 1995, 19.4% of the sample usually had a cellular phone while traveling. In 1998, 7 persons called TravInfo using the cellular phone.

Table 11. Subscription to the Cellular Phone Service and Usage of TravInfo TATS

1998 Survey Results

	Number and %
Own a cellular phone	566 (56.6% of the sample)
Usually have a cellular phone while traveling	377 (37.7% of the sample)
Called TravInfo using cellular phone	7 (35% of those who ever called TravInfo)

The question of how TravInfo callers felt that they changed their call behavior of obtaining TravInfo information; whether they called more or less frequently, or about the same. Of the 18 TravInfo users, 55.6% said about the same, 16.7% said that they call more frequently, 22.6% said less frequently, and 5.6% said they stopped calling altogether. The reasons for calling TravInfo more frequently were that they became increasingly reliant on TravInfo and the perception that TravInfo information became more accurate and reliable. The reasons for calling TravInfo less frequently that were there was no benefit resulting from calling TravInfo and that callers changed the needs of traffic information.

As mentioned earlier, three ISPs offered independent website traffic information using the TravInfo database. In 1998, 68.3 % of the sample had access to the Internet (Table 12). Of the sample taken in the 1998 survey, 14.5% retrieved traffic information on-line (Table 13). Only 2.5% retrieved information via on-line in 1995. Interestingly the 1998 survey showed that more people retrieved information before leaving home than leaving for home.

Table 12. Access to the Internet in the 1998 Survey

Location	Number N=1000	%
At home only	208	20.8
At work only	136	13.6
Both	339	33.9
Total	683	68.3

Table 13. Obtaining traffic reports via Internet

	Number N=1000	%
Before leaving home only	64	64.0
Before leaving for home only	44	44.0
Both before leaving home and for home	37	37.0
Total	145 (21.2% of those who have PC or 14.5% of the sample)	14.5

Perceptions of Traveler Information

How public perceptions of traveler information have changed over time? To assess public perceptions of the quality of traffic reports in 1995 and 1998, we asked participants to rate the quality of traffic information with respect to its usefulness on a scale of 1 to 5, 1 being poor and 5 being excellent.

In both the 1995 and 1998 surveys, user satisfaction with traffic reports was high, a significant proportion of the respondents perceive the quality of traveler information as excellent or good on usefulness. Tables 14a and 14b illustrate the level of satisfaction on the usefulness of traffic information disseminated by different media among commuters who normally use personal vehicles in the 1995 and 1998 surveys. In the 1995 survey, over 60% of commuter drivers responded that radio and television broadcasts are highly useful. In the 1998 survey, they responded that they could get most useful information over the telephone. This

perceptual change may be due to the fact that the information commuters get over the telephone is more useful than radio reports because telephone information provides sub regional specific traffic information.

Table 14a. Rating on Information Media in 1995

Rating	Radio in % n =197	Television in % n = 90	Telephone in % n=51
Excellent	39.1	38.1	27.7
Good	27.4	27.0	34.9
Total	66.5	65.1	62.6

Table 14b. Rating on Information Media in 1998

Rating	Radio in % n =302	Television in % n = 223	Telephone in % n=178	Internet in % n=36
Excellent	23.5	20.2	24.2	22.2
Good	26.8	25.6	31.5	25.0
Total	50.3	46.0	56.2	47.2

Benefits of Traffic Information

Traffic reports may benefit travelers in a number of ways. In addition to travel timesavings, the intangible benefits include reduced anxiety, increased knowledge of travel options, increased reliability (particularly in arrival at the destination and the accuracy of information), enhanced ability to avoid congestion, and reduced possibility of getting lost. The perceived benefits of traveler information will influence individual travelers' choices whether or not to acquire information and then modify their travel behavior (Yim and Koo, 1998).

The participants were asked to respond to the following benefit categories: a) saves travel time, b) reduces stress/anxiety, and c) informed travel planning (change departure time, take mass transit, cancel the trip altogether, and inform delays). For the 1995 and 1998 surveys, the participants who use traffic information were asked to state the single biggest benefit that they perceived from getting traffic reports.

Table 15. Perceived Benefits of Traveler Information in 1995 and in 1998

	1995 survey in % (n=431)	1998 survey in % (n=658)
Saves travel time	20.5	23.3
Reduces stress/anxiety	17.7	22.5
Informed travel planning	35.4	48.6
Other	5.5	-
Not sure	20.9	5.6

Although the benefit categories of travel time savings and reduction of anxiety are related to trip planning, the benefit category of the ability to make informed travel decisions covers broader benefit categories including decisions taken to avoid traffic congestion, such as trip cancellation. Therefore, we asked respondents to react to specific benefits under the ability to make informed travel decisions (Tables 15 and 16). Over 60% said that the benefit of traffic information is to allow travelers to find an alternate route in order to avoid traffic jams.

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Table 16. Informed Travel Planning 1998

Travel planning category	Responses in % (n=320)
Helps to change departure time	19.1
Helps to take mass transit	1.3
Helps to cancel the trip altogether	1.6
Allows to call and tell someone for late arrival	14.4
Allows to find an alternate route and avoid traffic jams	62.5
Not sure	1.2

Reasons for Not Acquiring Traffic Information

Approximately one third of the survey participants are classified in the non-user group. Among the key reasons cited for not listening to traffic reports are the unavailability of alternate routes and inadequate geographic coverage (Table 17). Nearly 60% in the 1995 survey and 50% in the 1998 survey said that the key reason is that traffic reports rarely cover their routes. Other reasons include "not being able to understand traffic reports" and "do not usually listen to the radio or television." Transit and personal vehicle users cited similar responses. The hypothesis is that when personalized traffic information services become available with TravInfo through Traveler Advisory Telephone System (TATS) and ISPs, the expanded geographic coverage (including surface streets) and real time traffic information will attract those who currently do not acquire traffic information.

Table 17. Reasons for Not Acquiring Traffic Information

Question: Why don't you get traffic or travel reports from radio, television, or over the telephone? (Asked as an open-ended question)

Reasons	1995 Survey Commuters/non-commuters & personal vehicle/transit users (n=269)	1998 Survey Commuters /non-commuters & personal vehicle /transit users (n=342)
Do not usually listen to the radio or television	17.7 %	18.4%
Traffic reports rarely cover the routes I take	54.4	47.4
No alternate routes available	5.4	16.7
Traffic reports are unreliable	1.9	7.6
Cannot understand the traffic reports	2.3	1.2
Not sure/DK	5.0	8.2
Refused/NA	13.1	0.6

Changes in Travel Behavior

This section reports on the 1995 and 1998 survey results with respect to changes in travel behavior as a result of obtaining pre-trip or en route traveler information. We were concerned with travelers' specific decision whether to change departure time, shift mode, take an alternate route, or to cancel the trip altogether based on traffic information.

The 1998 survey in the Bay Area showed that approximately 15% of motorists on average modified their travel behavior each day, 13% were based on radio traffic information and 2% was for reasons not related to traffic reports. Of those who learned about traffic problems on their planned routes from the radio, about 25% changed their travel behavior. In most cases, people tend to take an alternate route or change their departure time. The impact on mode shift from driving to taking transit was minimal (less than 1% of those who learned about traffic problems from the radio). In the 1995 survey, similar results were found. Approximately 15% of the participants on average modified their travel behavior each day.

Changes in Travel Behavior

The 1995 survey showed that about half of commuter drivers who listen to traffic reports changed their travel habits as a result of obtaining traffic information while over two thirds of commuter drivers who listen to traffic reports changed their travel behavior in the 1998 survey.

Both 1995 and 1998 surveys suggest that proportionally more non-commuter drivers changed their travel habits than did commuter drivers (t-test of means, at the 95% confidence level); the reason may be that their schedules are more flexible. According to the survey, more non-commuter drivers tend to make travel decisions before leaving home than commuters; more commuter drivers seem to make their travel decisions en route than non-commuters. The surveys also suggest that people who listen to traffic reports *both* before leaving home and en route are more likely to change their travel habits than those who listen to only pre-trip or en route reports (Pearson Chi-Square ^{test}, at the 95% confidence level).

To assess the behavioral characteristics of travelers, survey participants were asked the last time they changed their travel because of a traffic report, how did they change with regards to departure time, route choice, mode shift, and trip cancellation. The 1998 survey showed that over half (53%) of drivers who obtained traffic information changed their travel behavior based on traffic reports while one third (29.7%) of drivers changed their travel behavior based

on traffic reports in 1995, a significant increase in travel change (Table 18). Similar to the 1995 survey, the 1998 survey also showed that most people took an alternate route and changed their departure time.

Table 18. Travel Changes Based on Traffic Information among Personal Vehicle Users Who Obtained Traffic Information

Travel change	1995 survey Personal vehicle users n=469	1998 survey personal vehicle users n=420
Pre-trip changes	24.2%	32.2%
En route changes	27.5	24.5
Both pre-trip & en route changes	48.3	43.3

Table 19. Travel Changes Based on Pre-trip Traffic Information among Commuters/Non-commuters and Personal Vehicle/Transit Users

Travel category	1995 n=343	%	1998 n=317	%
Left earlier than originally planned and took an alternate route	89	**25.9**	92	**29.0**
Left earlier than originally planned but took the usual route	17	5.0	34	10.6
Left later than originally planned and took an alternate route	31	9.0	27	8.5
Left later than originally planned but took the usual route	16	4.7	23	7.3
Left at the usual time but took an alternate route	119	**34.7**	105	**33.1**
Left at the usual time but changed the mode	15	4.4	16	5.1
Left earlier than originally planned and changed the mode	12	3.5	10	3.2
Left later than originally planned and changed the mode	8	2.3	4	1.3
Canceled the trip altogether	36	10.5	6	1.9

As shown in Table 19, both surveys suggest that the greatest effects of travel information are on route choice. A majority of commuter drivers who changed their travel behavior said they took an alternate route the last time they heard of a traffic problem while only very few people said they changed their method of travel (commonly referred to as mode). This suggests that people are least likely to shift their method of travel from drive alone to transit (Figures 4 and 5). In making departure time choices, more people choose to leave early rather than late and more transit users in proportion seem to leave early than do personal vehicle users (Figure 6).

Figure 4. Travel Method and Route Changes Based on Pre-Trip Traffic Information (1995 and 1998 surveys)

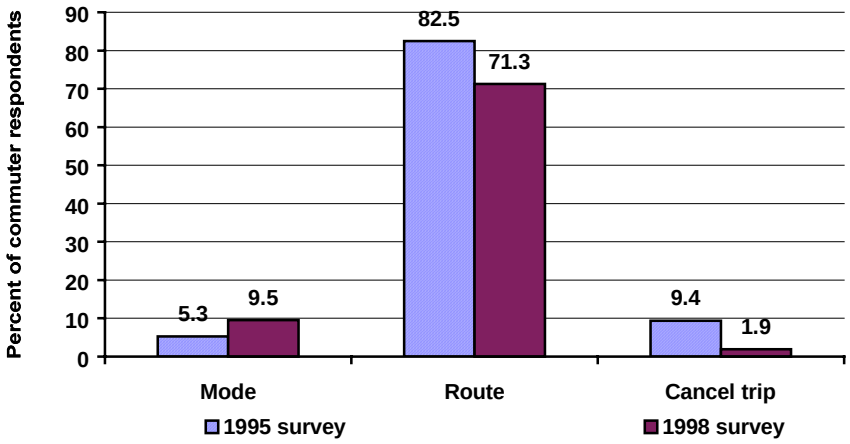


Figure 5. Travel Method and Route Changes Based on En Route Traffic Information (1995 and 1998 surveys)

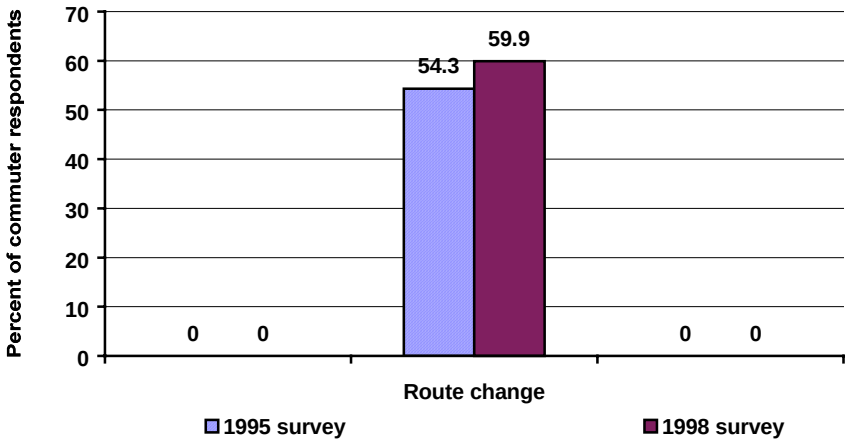
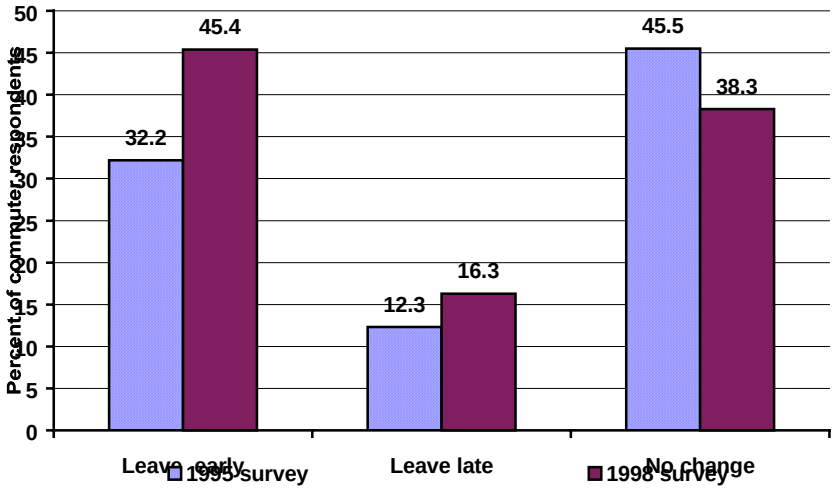

Percent of commuter respondents
70
60
50
40
30
20
10
0
59.9
54.3
0
0
0
0
Route change
1995 survey
1998 survey

Figure 6. Departure Time Changes Based on Traffic Information (1995 and 1998 surveys)



The respondents were also asked about their most recent experience in en route diversion as a result of the traffic reports that they heard while driving. When asked how they changed their route after learning about a traffic problem, commuters' route choice patterns in 1995 and 1998 were similar. Over 40% of commuters responded that they took surface streets (43.9% in 1995; 42.1% in 1998), about 20% (23.9%) took a different freeway, and 30% (32.2%) took a combination of different freeways and surface streets (Table 20). Proportionally, more commuters tend to take an alternate route than do non-commuters.

Table 20. Route Choice Decisions based on Traveler Information

	1995 survey in % n=269	1998 survey in % n=278
Took surface streets	43.9	43.2
Took a different freeway	23.9	21.9
Took a different freeway and also surface streets	32.2	34.9

Reasons for Not Changing Travel Behavior

Regarding reasons for not changing travel behavior even though people listen to traffic reports, the 1998 survey respondents cited similar reasons as the 1995 respondents (Table 21).

The primary reasons for their not changing their behavior were the irrelevance of traffic information and unavailability of alternate routes. Among other reasons were "traffic usually clears" and "alternate routes take longer than the routes that they usually take." According to the survey, transit users were more afraid of getting lost than were the personal vehicle users (t-test at the 95% confidence level).

Table 21. Reasons for Not Changing Travel Behavior based on Traffic Information
Question: What is the main reason you haven't changed your commute or travel as a result of traffic reports? (Asked as an open-ended question)

	1995 survey Commuters/non-commuters & personal vehicle/ transit users (n=139)	1998 survey Commuters/non-commuters & personal vehicle/ transit users (n=184)
Traffic usually clears	17.3%	28.8%
No good alternative routes	29.5	39.7
Alternative routes take longer	12.2	12.5
Information not relevant or useful	28.1	14.1
Afraid of getting lost	4.3	0
Not sure/DK	8.6	4.9

Preferred Means of Receiving Traveler Information

TravInfo is expected to provide more and better information through a variety of means, including cable television, commercial FM radio and in-vehicle devices specifically tailored for those customers who desire personalized traveler information. To assess which medium is most favored by travelers for receiving travel information, the participants were asked to rate the currently and potentially available *media* on a scale of 1 to 5, 1 being not at all interested and 5 being very interested.

Across all user groups, radio broadcast is still the most favored medium to receive traffic information as compared to other media (Table 22). Both commuter drivers and commuter transit users expressed a moderate interest in an in-vehicle device. As expected, the respondents showed little interest in receiving information through either fax machine or on-

line computer. Commuter transit users rated on-line computer service somewhat higher than did other groups; the reason may be that they are more familiar with getting information through the employer transit information program. The percent of respondents who gave each medium the highest rating of 5 is shown in Table 23, as an indication of the number of people who are strongly interested in getting information through each medium.

Table 22. Desired Means for Receiving Traveler Information
("Very interested," a scale of 5, and "somewhat interested," a scale of 4, are shown)

Medium	1995 Survey Commuters/non-commuters & personal vehicle/ transit users (n=731)	1998 Survey Commuters/non-commuters & personal vehicle/ transit users (n=658)
Radio	66.1%	66.2%
Television	27.9	30.1
Telephone	17.2	14.0
Cellular phone	19.6	17.5
Fax machine	9.0	6.1
On-line computer	15.9	10
In-vehicle device	26.8	28.8

n= number of respondents

Table 23. Percent of Respondents Who Gave the Highest Rating
("Vary interested, a scale of 5, is shown)

Medium	1995 Survey driver n=554	1998 Survey n=658
Radio	43.9%	43.9%
Television	15.0	17.2
Telephone	10.4	8.5
Cellular phone	10.9	10.2
Fax machine	5.1	3.5
On-line computer	8.2	4.4
In-vehicle device	18.7	20.1

n= number of respondents

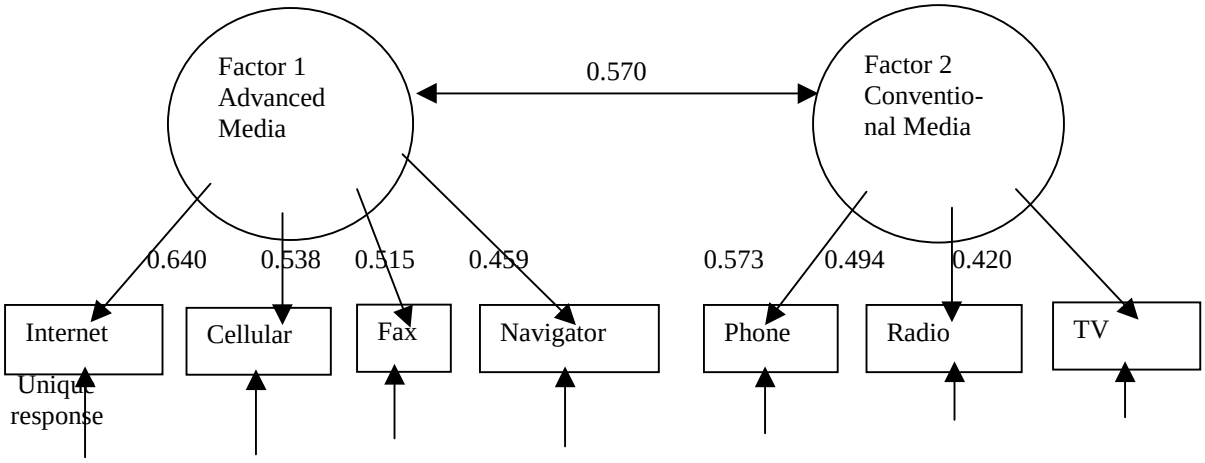
Factor Analysis for Information Media

With the 1995 and 1998 survey data, we performed factor analysis for the preferred media to obtain traveler information. With the 1995 data, factor solutions were not derived. However with the 1998 data, we were able to find factor solutions that could be identifiable with some meanings. The factor solutions suggest that two groups could be identified; one group of participants is interested in obtaining traffic information through advanced media (i.e., internet, cellular, fax, and navigator) and the other group is interested in obtaining information through conventional media (i.e., phone, radio, television). The correlation coefficient between Factor 1 (advanced media) and Factor 2 (conventional media) is 0.597 (Figure 7).

With the factor scores, we were interested in examining whether there is any difference between men and women being interested in obtaining traveler information from advanced or conventional media. One-way ANOVA was used to examine the difference in consumer preferences. The other question was whether there is any difference between people who attained higher education (greater or equal to college education) and people who did not attain higher education (less than college education) for their interest in obtaining traffic information from advanced and conventional media. After performing ANOVA procedures, we obtained the following results.

More educated women are likely to obtain traffic information from advanced media while no significant difference is found among men who received higher education and those who didn't receive higher education for obtaining traffic information either from advanced or conventional media. Such findings can be used to develop marketing strategies tailored to educated women who are likely to use advanced media for traffic information.

Figure 7. Factors and observed variables



Desired Traveler Information

The survey participants were asked to rate types of *traveler information* as to whether they would like to receive it in the future and how important it is to them to make informed travel decisions on a scale of 1 to 5, 1 being not at all desirable and 5 being highly desirable. Moderate variations were found in the relative importance rating. People who normally drive were however most interested in getting alternate route information followed by real-time traffic conditions. To them the least desired information was real-time transit service. Table 4.9a shows the stated preference based on the desirability in a descending order of interest among drivers and Table 4.9b shows among transit users. As expected, transit users were most interested in getting information about real-time transit services followed by information about alternate routes. Traffic information through in-vehicle devices was least interesting to transit users. The percent of respondents who gave each information type a rating of 5 is shown below, as an indication of the number of people who are strongly interested in getting each type of information.

Table 24. Importance of the Type of Traveler Information

Information type	1995 Survey Commuters/non-commuters & personal vehicle/ transit users (n=731)	1995 Survey Commuters/non-commuters & personal vehicle/ transit users (n=658)
a) Current traffic conditions on radio or television that are updated every minute	53.1%	56.8%
b) Detailed information about alternate routes around congestion, including where to exit and what surface streets to take, with compared travel time	56.2	56.7
c) Information about traffic conditions at specific locations, which they could request over the telephone or on-line through their computer	37.6	35.6
d) An in-car navigational computer with a display showing highways and roads. The computer could show where congestion exists and map the fastest routes in terms of time around the congestion	49.8	54.3
e) Detailed information about mass transit alternatives to avoid congestion including up-to-the-minute bus, ferry, and train schedules and where to take them	35/2	29.5
f) An estimate of the time of delay on usual route from unexpected traffic congestion	Not included in the questionnaire	46.2
g) An estimate of the travel time to get from the point of departure to the point of arrival on usual route and any planned alternate routes	Not included in the questionnaire	46.0

Experience with Incident Conditions

How do people react to unexpected congestion? Our interest was to learn about how people reacted to a delay because of incidents (Koo and Yim, 1998a). Participants were asked: 1) whether or not they had experienced an unexpected congestion in the previous month because of an incident, 2) how they became aware of it, 3) what the cause of the congestion was, 4) how long they were delayed, and 5) what they did in response to the delay. Transit users were excluded in this survey because transit operators make en route decisions.

The 1995 survey showed that close to half of the drivers experienced a delay (49.0% of commuter drivers and 42.2% of non-commuter drivers). The median delay for commuters was 24 minutes and for non-commuters was 18 minutes. The 1998 survey suggested that two

thirds of drivers (66.7%) experienced a delay and the median delay for commuter drivers was 15 minutes.

A majority of those who experienced a delay said they became aware of it by *running into congestion while driving*; a small number of people said they learned of the problem from traffic information sources (Table 25). About half of commuter drivers (52.2%) and one quarter of non-commuter drivers (27%) who ran into congestion subsequently tuned in to a radio traffic report to learn more about the problem.

Table 25. Travelers first become aware of the traffic congestion

The last time you experienced unexpected traffic congestion, how did you first become aware of it?

Commuter drivers	1995 survey Personal vehicle users N=342	1998 survey Personal vehicle users N=749
En route		
Just ran into congestion while driving	81.6 %	89.9%
Radio report while driving	10.2	6.4
Pre-Trip		
Radio report before departure	1.8	1.8
Television report before departure	0.4	1.4
Called Caltrans	-	0.6
Heard from someone else	0.8	0.8
Internet	-	-
Other	-	-

Of the participants who encountered unexpected traffic congestion in the 1998 survey, 32.7% (of 742) listened to a radio traffic report after encountering congestion. Of those who listened to a traffic report (245 persons), 27.3% (67 persons of 245) perceived that the traffic report saved time while 71.4% thought it did not.

Using the cellular phone, one person called TravInfo 817-1717, two called GTE or Cellular One and two said they weren't sure.

Most of those who experienced a delay en route did nothing to avoid congestion; about 20% took an alternate route (Table 26). Four commuter drivers took transit when they learned of the problem before leaving home. Those commuter drivers who took an alternate route thought traffic reports substantially saved travel time, with the average reported savings being 17 minutes.

Table 26. Traveler Response to Congestion

Reaction to an incident	1995 survey Personal vehicle users N=352	%	1998 survey Personal vehicle users N=749	%
Did nothing	261	74.2	599	80.0
Took an alternate route	65	18.5	130	17.4
Took mass transit	6	1.7	-	-
Changed departure time	5	1.4	12	1.6
Made an intermediate stop	6	1.7	5	0.6
Eliminated an intermediate stop	9	2.6	-	-
Cancelled the trip altogether	-		3	0.4

Both surveys indicated that accidents were the primary cause of congestion, followed by roadway construction and bad weather. More commuter drivers experienced a weather impact on congestion than non-commuter drivers (t-test of proportions, at the 95% confidence level).

The Effects of Market Penetration of Medium on Information Acquisition

The communications technology has played a significant role in transportation. With new media, a wide range of advanced traveler information systems is being tested and deployed in the marketplace. A conjecture was that certain media are more effective in disseminating information and influencing individual travel decisions than others. Several Bay Area traveler information media were examined and compared, including web sites, digital cellular telephones, hand-held personal digital assistants, and in-vehicle devices. The study suggests that the more the advanced or sophisticated interactive media was used for disseminating

information, the greater was the influence on travel changes. Table 27 shows that the market penetration of advanced media in 1998.

Table 27. Market penetration of medium in 1998

Medium	San Francisco Bay Area in %	Seattle Metropolitan Area in %
Subscription to cable TV	76.4	69.0
Personal computer at home/at work	71.6	68.0
Internet/online access	52.0	34.0
Pager	46.0	12.0
Personal digital assistant	9.3	0.5
In-vehicle navigation unit	3.4	1.0
Cellular phone	56.6	41.0

The 1998 survey showed that nearly 20% of those who have access to the internet at home or work retrieve traffic information at least once a week while the 1995 survey showed that less than 1% of those who had internet access retrieve information through personal computer. Approximately half (48.1%) of the Internet information seekers access traffic information both at home and work. People retrieving Internet information only at home and only at work are somewhat evenly divided. The focus group study however showed that more people tend to access Internet information at work before leaving for home than before leaving for work (Yim, 1998). This is mainly because people are not interested in spending time for turning on and waiting for information to show up. It is much easier for people to retrieve information at work before turning off the computer.

TravInfo Comparison with TransCal and YATI Field Operational Test

Over the past several years, a wide range of Advanced Traveler Information Systems (ATIS) has been tested and in-vehicle navigation devices have been deployed in Japan and, to a lesser extent in the US and Europe. Recently, three field operational tests, TravInfo, TransCal, Yosemite Area ATIS, examined traveler response to different media. The TravInfo field test was in the San Francisco Bay Area for an urban setting. The TransCal field test was in a rural environment between the City of Sacramento and the City of Reno. The Yosemite Area ATIS field test was in a regional recreational area. All were federally funded projects and their test

sites were located in the state of California. Their project objectives were to test advanced traveler information systems, including kiosks, changeable message signs, personal digital assistant (PDA) units, in-vehicle navigation devices, and traveler advisory telephone systems. The results of these tests were compared with respect to different types of information technologies and to the extent traveler information influences travel behavior.

The studies showed that a greater number of people who obtained traveler information from the Traveler Advisory Telephone System changed their behavior than those who obtained information from the radio (Kurani, et al, 1997; Jovanis, et al, 1998). At least twice as many people who obtained information from the telephone service took an alternate route or changed their departure time when compared with those who acquired information from the radio (Table 28). Interestingly, the telephone service was also able to increase mode shift from personal vehicle to public transit in the Bay Area from less than 1% to over 5%. This is a significant change in the use of public transit as a result of the telephone information system ($p < .05$).

Likewise, the user surveys indicated that information disseminated through web sites, kiosks, Personal Digital Assistants or In-vehicle devices had a greater impact on travel behavior than information disseminated through radio broadcasts or the telephone (Jovanis, el at, 1998). As shown in the study of the Boston Metropolitan Area, the Bay Area and TransCal telephone information service was able to attract those who were seeking information en route. Over 30% of the Bay Area traveler calls were made from vehicles via cellular phone (60% of the Boston Area calls were made via cell phone).

Table 28. Changes in travel behavior related to information sources
TravInfo comparison with TransCal and Yosemite field operational tests in California

	TravInfo	TransCal	Yosemite
Changeable Message Sign			5%
Radio/television	24.5%		
Telephone system	47.7%	46%	
Web site	80.1%		48%
Kiosks			50%
Personal Digital Assistants		51%	
In-vehicle navigation device		81%	

Logistic Regression Models

A question is why do some people drive alone and others do not (share rides)?
With the Bay Area household data collected in November 1998, our interest was in building a binary logit model of mode choice. When using the binary logit modeling procedure, the following rules may apply. The dependent variable should be dichotomous. Independent variables can be interval level or categorical, but categorical variables should be dummy or indicator coded.

Consider mode choice as a dependent variable and recode it as a dummy variable; ride share, 1; otherwise, 0 (drive alone) because we are more interested in learning about what factors can explain why people choose to share rides.

The independent variables entered in the equation for model calibration were:

a) Auto-accessibility: the number of automobiles in a household divided by the number of licensed drivers in the household (continuous)
b) Commute or not: DUMMY - commute, 1; otherwise 0.
c) Income-expendable: household annual income divided by the number of persons in the household (continuous)
d) Miles driven/year: DUMMY- if greater than 10,000 miles driven per year, 1, otherwise, 0)
e) Travel distance: DUMMY – if greater than 15 miles, 1; otherwise,0.

f) Gender: DUMMY- if male, 1; female, 0.

g) Age: DUMMY – if age group is between 18-24, coded 1, otherwise 0. If age group between 45-54, coded 1, otherwise 0.

"Commute distance" is closely associated with "commute time;" "auto accessibility" is associated with "income" and "education." Some of the continuous variables such as 'travel distance" and "age" are treated as dummy because when recoded as dummy variables, models seem to perform better.

Using the binary logistic regression procedure of SPSS, the following results were obtained (Tables 28). The "variables in the equation" table shows the parameter estimates for the logistic regression model.

Table 29. Variables in the Equation - Binary Logit Model 1

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1	Auto accessibility	-.936	.407	5.300	1	.021	.392
	Commute or not	.871	.351	6.171	1	.013	2.390
	Miles driven/year	-1.195	.305	15.360	1	.000	.303
	Gender	.358	.276	1.678	1	.195	1.430
	Income-disposeable	-.016	.010	2.588	1	.108	.985
	Trip distance one-way	.734	.277	6.993	1	.008	2.082
	Age category 18-24	.690	.391	3.119	1	.077	1.994
	Age category 45-55	.712	.311	5.238	1	.022	2.038
	Constant	-2.057	.596	11.930	1	.001	.128

The coefficients (B) in Table 28 can be interpreted as follows:

1) The greater automobile accessibility at home, the less likely to share rides with other people.

2) Commuters are more likely to choose ride share.

3) The higher the miles driven per year, the less likely to share rides with other people.

4) Women are more likely to share rides than men. (Women are coded 1)

5) The higher the disposable income per capita (persons in a household), the less likely to share rides.

6) The longer the travel distance, the more likely to share rides.

7) The younger age group between 18-24 and older age group 45-55 are more likely to choose ride share than other age groups.

In logistic regression, we estimate the probability of an event occurring. Therefore, the probability of an event occurring (i.e., mode choice of driving alone) can be written as:

$$\text{Prob (Drive Alone)} = \frac{1}{1 + e^{-(B_0 + B_1X_1 + B_2X_2 + ... + B_pX_p)}}$$

Where

$B_0, B_1, B_2, ...B_p =$ coefficients estimated from data

$p =$ number of independent variables

$e =$ the base of the natural log (2.718)

Alternatively the logistic regression model can be written as (Table 30):

$$\text{Prob (Drive Alone)} = \frac{1}{1 + e^{-Z}}$$

Z = -1.784 – 1.182(auto/licensed drivers/HH) - 0.571 (age 45-54) – 0.562 (commute distance) + 0.19(income) + 0.903 (auto/licensed driver) –0.927 (commute)

Z = 1.582 + 1.261(1) - 0.571 (1) – 0.562 (1) + 0.19 $(1)^1$ + 0.903 (1) –0.927 (1) = 1.876

[Footnote 1 = Annual income per household member is $10,000]

$$\text{Estimated Prob (Drive Alone)} = \frac{1}{1 + e^{-(1.876)}} = 0.386$$

Based on this estimate, we can predict that the people in this group are likely to drive alone with the estimated probability of 0.39. The probability of not driving alone is 0.61 (that is 1-0.39).

Table 30. Variables in the Equation- Binary Logit Model 2

	B	S.E.	Wald	df	Sig.	Exp(B)
a) Miles driven/year	1.261	.302	17.504	1	.000	3.531
b) Age group 45-54	-.571	.299	3.632	1	.057	.566
c) Commute distance	-.562	.280	4.011	1	.045	.570
d) Income/person HH	.019	.010	4.982	1	.045	1.019
e) Auto/licensed drivers	.903	.396	5.195	1	.023	2.466
f) Commute or not	-.927	.344	7.248	1	.007	.396
Constant	1.580	.538	8.629	1	.003	4.853

5. CONCLUSIONS

The TravInfo Broad Area study provided basic knowledge of how Bay Area travelers acquire travel information and to what extent the information has influenced travel behavior. As part of the TravInfo evaluation, PATH conducted a baseline study of travel behavior among Bay Area households and studies of commuter behavior under major incidents.

The traveler response part of the evaluation provided invaluable information to the partners. The studies showed the extent to which people obtain traveler information and to what extent their travel behavior is influenced by traveler information.

The first wave Broad Area survey was conducted in November 1995, eight months prior to when TravInfo became operational. The second wave Broad Area survey was conducted in November 1998, three months after the field test was completed. Both surveys investigated the trip characteristics and travel behavior of Bay Area residents with traveler information. The findings of the two surveys, pre- and post-TravInfo field tests, are similar. It appears that there were no significant changes in information acquisition or travel behavior. The key findings of the surveys are that two thirds of Bay Area travelers surveyed in 1995 and 1998 acquire traffic information at least when they expect a traffic problem; the vast majority of them listen to radio traffic reports, more frequently en route than do before leaving home or leaving for home. Regular users and occasional users of traveler information are evenly divided.

The 1998 survey in the Bay Area showed that approximately 15% of motorists on average modified their travel behavior each day; of those who learned about traffic problems on their planned routes from the radio, about 25% changed their travel behavior. In most cases, people tend to take an alternate route or change their departure time. Travel information had little effect on mode shift, especially to mass transit from drive alone. Less than 1% of those who learned about traffic problems from the radio shifted mode from driving to public transit. In the 1995 survey, similar results were found. Approximately 15% of the participants on average modified their travel behavior each day.

Mode choice is closely related to auto ownership, income, gender, commute, miles driven, travel distance, and age group. The greater automobile accessibility at home, the less likely to share rides with other people. Commuters are more likely to choose ride share. The higher the miles driven per year, the less likely to share rides with other people. Women are more likely to share rides than men. The higher the disposable income per capita (persons in a household), the less likely to share rides. The longer the travel distance, the more likely to share rides. The younger age group between 18-24 and older age group 45-55 are more likely to choose ride share than other age groups.

A higher proportion of commuters drive on freeways than do non-commuters; the same proportion was found in the relative distribution of traffic information users. Freeway users acquire traffic information more often than those who use surface streets. This is due to the fact that traffic information covers mostly freeway driving conditions. The preferred means of receiving traveler information among the currently and potentially available media is still radio broadcast. Among commuters traveler information through an in-vehicle navigation device is seen as highly desirable.

It was expected that more people would seek traveler information in the 1998 survey because the content and delivery of traveler information services under TravInfo would improve. Furthermore, there may be an increase in the number of people who change their mode choice from drive alone to mass transit. The 1998 survey did not show significant overall changes in

the acquisition of traffic information, but significant changes were observed in travel behavior. More people modified their travel behavior in 1998 than did in 1995. Notable changes are also an increase in the use of traffic Web sites and the public perception of traffic information over the telephone as being more reliable.

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