## Title

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## Publication Date

2004-02-01

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**California PATH Working Paper**
**UCB-ITS-PWP-2004-4**

This work was performed as part of the California PATH Program of the University of California, in cooperation with the State of California Business, Transportation, and Housing Agency, Department of Transportation; and the United States Department Transportation, Federal Highway Administration.



Report for Task Order 4102

February 2004

ISSN 1055-1417

# TRAVELER RESPONSE TO NEW DYNAMIC INFORMATION SOURCES: ANALYZING CORRIDOR AND AREA-WIDE BEHAVIORAL SURVEYS

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March 2002

**KEYWORDS:** Traveler behavior, Advanced Traveler Information Systems, travel demand, survey research

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# Traveler Response to New Dynamic Information Sources: Analyzing Corridor and Area-Wide Behavioral Surveys

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**ABSTRACT**—Intelligent Transportation Systems present a well-known innovation opportunity to address urban congestion and allow greater access to transportation networks. New sources of travel information are emerging rapidly and they are likely to significantly impact traveler decisions and transportation network performance. To assess the value and impact of these new sources, this paper develops a comprehensive conceptual model based on information processing and traveler response. Specifically, the model accounts for the effect of information source, content and quality on information access and travel behavior. The paper presents empirical evidence from several behavioral surveys conducted in the San Francisco Bay Area between 1995-1999. The surveys used innovative methods to study the response of the whole population, response of people more inclined to use information technology (early adopters), and traveler decision-making in high-benefit incident situations. The conceptual model helps us integrate and interpret empirical findings from the surveys. We discuss the issues of access to new and conventional technologies and services, their current market penetration levels, switching behavior regarding new information sources/information service providers, desired information content and willingness to pay for dynamic information. The opportunities and limitations of new technologies and the implications for future technology implementations are discussed.

## INTRODUCTION

Continuing transportation problems such as congestion and pollution and recent developments in advanced traveler information systems (ATIS) raise interesting questions about the effect these innovations will have on travelers. In particular, we wish to know if the new technologies will help people plan for their travel and allow them to travel faster and at lower cost.

There are two sets of developments that can offer partial answers to such questions. One is the development of models that characterize how people make their travel decisions and use dynamic travel information. The other is the growing body of empirical evidence regarding traveler decisions and the impacts of new and improved information systems acquired through federally sponsored field operational tests.

One such test is TravInfo, which is a regional traveler information system in the San Francisco Bay Area. Its goal is to broadly disseminate accurate, comprehensive, timely, and reliable information about traffic and multi-modal travel options to the public. The TravInfo Field Test officially began operation in September 1996 and ended in September 1998, when it started a transitional phase to full deployment as an integral part of the Bay Area transportation infrastructure (*1*). To evaluate TravInfo effectiveness, significant resources were devoted to designing surveys and to collecting behavioral data. The surveys were based on a contemporary understanding of traveler behavior and the factors that might influence it, including dynamic information. In the several years over which the data was collected, this conceptual model has gradually been refined.

Our purpose in this paper is to review what we have learnt from TravInfo about the behavioral impact of ATIS, and to situate those results within the conceptual model that has developed during the research. The ultimate aim is to use the model and the results to help guide future implementation and research efforts regarding advanced traveler information systems.

## BACKGROUND

Table 1 summarizes selected ATIS studies that are not directly related to TravInfo evaluation (*2, 3, 4, 5, 6, 7, 8, 9, 10, 11*). Though small sample sizes limit the ability to generalize from many of these studies, they provide a glimpse of how ATIS can be relevant to travelers. They indicate that travelers' choices depend on their 1) information, experience and knowledge, 2) their own attributes (e.g., age, gender, and risk-behavior), 3) cognition, attitudes and preferences, and 4) opportunities and constraints in time and space. While the literature is insightful, several gaps are apparent. The key ones are the need for a comprehensive behavioral model and the lack of revealed preference data particularly for emerging information sources. The reason for this is that much of ATIS technologies are in their early stages of development and are not yet widely available, thus they cannot be studied empirically. Furthermore, the findings regarding willingness to pay for travel information are mixed. Stated preference questions, especially for exploring willingness to pay, can be substituted in some cases, despite concerns about their validity. Finally, the specific content demanded by travelers needs more attention. Few studies combine knowledge from revealed choice data with stated preference data to find the true information needs of end users (*12, 13*).

The TravInfo assessment sought data in a number of areas including the importance of delays and congestion to traveler behavior in the short term; attributes of alternative routes and modes; attributes of individual travelers; the efficacy of various media, including new media such as the Internet, in delivering travel information; and willingness to pay for travel information. Funded by the U.S. Department of Transportation as one of the sixteen field operational tests in 1993, TravInfo provides free information about traffic conditions and multi-modal travel options. The TravInfo test location encompassed nine Bay Area counties with a population of approximately six and half million people (Figure 1). TravInfo served the nine counties' diverse, multi-modal transportation network traveled by single-occupancy vehicles, high-occupancy vehicles such as vanpools and buses, other motorized vehicles and bicycles, as well as light rail, rapid rail, commuter rail, cable cars, and ferries.

TravInfo's operational core, the regional Traveler Information Center (TIC), collected and processed information for dissemination directly to the public and to information service providers. Since September 1996, TIC has disseminated traveler information to the public through the Traveler Advisory Telephone System and to information service providers through a Landline Data Server. The Field Operational Test of this system took place from July 1996 to August 1998. During the field test, three information vendors relied exclusively on TravInfo to disseminate traveler information through their traffic Web sites.

## METHODOLOGY

A number of surveys of travelers and system users were conducted between November 1995 and November 1998 in order to evaluate the TravInfo system. Although existing sources of dynamic information, including commercial radio and television reports for traffic and transit information, were not formally part of the TravInfo system, the use of these sources by travelers was also considered in the TravInfo assessment surveys. The behavioral evaluation consisted of focus groups, surveys, and observation of system usage. The overall evaluation strategy was to study response of the whole population, response of people more inclined to use information technology (early adopters), and traveler decision-making in high-benefit incident situations.

In the surveys, which were developed from an earlier version of the conceptual model discussed below, respondents were asked about their perceived uncertainty, incident delays, travel times and costs, revealed choices and stated willingness to pay for information. The surveys were meant to provide a better understanding of traveler response to dynamic information. A series of telephone surveys were conducted before, during, and after the field test. These included: two Broad Area surveys (BAS1 and BAS2) conducted before and after the field operational tests (*14, 15*); four waves of surveys (Target) focusing on incidents on a heavily used freeway segment (*16*); and two surveys of callers to the TravInfo Traveler Advisory Telephone System (TATS) (*17, 18*). In addition, a web-based online survey was conducted of users of TravInfo information through web sites maintained by private Information Service Providers (ISP) (*19, 20*). In addition to the surveys, six focus-group meetings were held during the field test to assess consumer preferences for different types of traveler information sources (*21*).

The key elements of the conceptual structure developed during the design and evaluation of the TravInfo surveys are illustrated in Figure 2. The figure describes a series of decisions that comprise traveler response to a spatial and travel context. The traveler must make several fundamental decisions including whether or not to take a trip, destination, mode, route, and departure time. Accessibility decisions that are presumably higher-level choices include vehicle ownership and proximity between work and home. In a repetitive travel situation, such as going

to work or traveling to buy groceries, earlier choices, experiences and information provide the context for the current decision problem. With new sources of static and dynamic travel information, gathering that information itself can initiate further decisions about whether to search for information, which information sources to use, and which access point(s) to use (computers, hand-held devices, radio, television, telephone, etc.). The emergence of new information sources makes the information access decision complex and interesting.

In keeping with contemporary theories of consumer behavior, we see the decision process as consisting of four steps: recognizing a need for a decision based on risk or uncertainty, gathering information (including perceptions), making a decision to undertake a certain action, and evaluating the outcome of the decision. The evaluation may contribute experience and may motivate the traveler to seek additional information. Over time, the evaluation may also lead to changes in attitudes and preferences. Each of the traveler decisions discussed above displays these phases, and for each of those decisions, certain types of information may be more useful and relevant.

Many travel decisions are informed with static information that the traveler remembers from prior experiences, for example information about the transportation network. Dynamic information about the spatial distribution of activities and changing conditions in transportation networks (e.g., due to peak demands or capacity-reducing incidents) adds complexity to the fundamental travel decisions. Incident information may motivate commuters to search for and select new routes and modes and reduce their travel time. Dynamic information may be acquired before a trip starts or while en route.

The source, content and quality of available information are key elements in traveler decision-making. The source is characterized by the type of device and its ability to convey information verbally and/or visually. Travelers are increasingly purchasing new products (e.g. in-vehicle systems) and services such as cell phones, and using them to receive travel and related information. Information content is characterized by whether it is historical, real-time or predictive, its level of detail, whether it is descriptive, advisory or compulsory, and whether the information is quantitative or qualitative. Information quality is characterized by its accuracy, temporal and spatial specificity, consistency, future validity, timeliness and relevance.

Availability of dynamic information to a traveler depends on the sources the traveler chooses to access. Information sources include direct visual observation of traffic (when in traffic), radio, television (including cable subscription), telephone (including cellular telephones, hand-held devices, pagers and personal digital assistants), computer at home and work (with Internet access), and in-vehicle navigation devices. Of course travelers need to be aware of these information sources and services before they can access them or purchase a service.

Variables that can influence the source(s) of travel information a person chooses to access include the perceived accuracy and reliability of information sources, the level of travel time uncertainty the user is willing to tolerate, trip characteristics, and socio-economic attributes. Individuals may be more likely to pay for travel information received from specific sources, especially when 1) travel time uncertainty is high, e.g., if incident induced congestion occurs frequently, 2) the dynamic information is available to a selected few individuals, e.g. if only a few individuals know about an incident (then they may be able to divert to relatively uncongested alternate routes, while uninformed drivers remain on the congested route) and 3) the perceived benefits of information use (e.g., travel time savings and anxiety reduction) exceed the perceived costs of information acquisition.

Decision makers obtain the maximum amount of pertinent information from available sources, while minimizing their search costs. Individuals collect information on alternatives and their attributes, and in doing so they must make decisions about what information to access, how to access it and how to use the information obtained. Individuals use "heuristics" or rules to convert incoming information into perceived attributes of alternatives. As they make a decision, travelers go through a cognitive process, which aggregates the perceived attribute levels (such as travel time and travel cost in a mode choice decision) into a function that is then maximized. In practical terms, travelers are likely to access information sources that provide accurate, timely, relevant information that will help them make decisions that minimize travel cost and time and incorporate other attributes that may be valued (e.g. scenery). Access to information may also help travelers overcome behavioral inertia by encouraging them to switch routes and departure times.

In addition to providing information for future decisions, the evaluation step may lead to an iterative decision process during the current trip, with the traveler returning to decisions that have already been "made" based on certain outcomes. For instance, information about the usual route might indicate that the route has unexpected congestion. This may in turn lead the traveler to reconsider the route, the departure time, or both. Such iterations may continue while the traveler is en route as new information becomes available, so that the process of making en route decisions is structurally similar to pre-trip decisions. Of course, the type of travel decision to be made and the location of the traveler at the time the decision (i.e., home, work, shopping, en route) will also determine which sources of information are available and relevant.

Even if travelers do not make or change travel decisions based on the information they acquire, they may perceive an "intrinsic information value" in terms of reduction in anxiety and frustration when faced with congested travel conditions. It may prove productive to model such anxiety reduction as a "decision to be satisfied with one's current travel choices." Information systems may also help travelers feel safer while traveling if their and their vehicles' condition can be communicated to others (e.g., family members, business associates or emergency response centers), though if the mode of information delivery distracts drivers it may increase collision risk.

The attitudes that people develop about the transportation network itself and desirability of particular travel modes influence what information travelers will seek or use. Travelers' attitudes and the information they acquire will have an effect on their ultimate travel decisions. Some of these attitudes and perceptions are based on prior experience, while others reflect social, cultural and psychological opinions and information that is not directly related to the transportation system (preference for private automobile, favorite information media, avoidance of "dangerous" neighborhoods, etc.). It is often assumed that preferences are pre-determined and do not depend on the alternatives, but they change slowly over time in response to experience, travel information and other changes in the traveler's circumstances.

Transportation system performance can thus be understood as the aggregate result of many individual traveler choices. In deploying ATIS, it is also important to understand user demographics so as to reach key users with information that is most likely to lead to effective travel choices.

## KEY RESULTS

The conceptual model suggests that people will collect information, make travel decisions, and then evaluate their decisions, which in turn may involve collecting further information. Survey

results from the TravInfo evaluation can shed light on such questions as which travelers will seek information, why they will choose to gather information, where they will get the information, and what decisions are influenced by the information that is gathered. The surveys that are the basis of the empirical findings presented below were intended to evaluate the impacts of the TravInfo project. Each survey targeted a different population, and reflected an evolving understanding of the factors influencing travel decisions in different situations. Table 3 presents key comparisons of behavioral patterns among these reports. Table 4 presents illustrative comparisons of sub-types of automobile commuters in the second Broad Area survey. Note that other statistically rigorous analyses that we have conducted cannot be presented here due to space limitations (e.g., *12, 13, 18*). The purpose here is to integrate the survey results, interpret them using a conceptual model and draw suggestive inferences regarding the impact of information on various types of travel decisions, and the contribution of different information sources to those decisions.

**Sources of Information**

The Broad Area surveys indicate that about two thirds of travelers receive some form of dynamic traffic information. These surveys also suggest that radio, and to a lesser extent, television, are the prevalent media through which travel information is received during the pre-trip stage. The Broad Area surveys show that Internet access to travel information did increase from 1995 to 1998, but the use of telephone for travel information remained essentially the same. The predominant change between the two phases of the Broad Area Study is that use of radio reports declined from 54% to 30% of the respondents. Telephone access to travel information was essentially constant as a source of pre-trip information. Internet use increased as a source of pre-trip information, from 1% to 4% (Table 3.1). Cell-phone use doubled from 1% to 2% as a source of en route information (Table 3.2). This suggests that new technologies (specifically cell phone and Internet) are the main growth market in acquisition of travel information. The potential for these two modes is further indicated by a more than ten-fold increase in cellular phone subscriptions, from nearly 4% in the first Broad Area survey to almost 57% in the second Broad Area survey. At the time of the second survey, 52% of respondents had Internet access either at home or at work or both. Clearly, there is great room for expansion in the use of these technologies for the delivery of travel information (Table 4.1).

**Type of information desired**

Higher propensity for seeking travel information as indicated in the second Broad Area survey was significantly related to respondents who took longer trips, faced unexpected congestion, were female, employed, and owned a cellular telephone (*22*). That survey also indicated that the most desirable types of information in order of desirability are:

1) Current traffic conditions, frequently updated.
2) Detailed information about alternate routes with compared travel time.
3) In-car navigational computer with a display showing roads and location of congestion.
4) Estimate of delay due to unexpected traffic congestion.
5) Estimate of time to get from origin to destination on various routes.
6) Interactively accessible information about traffic conditions at specific locations.
7) Detailed information about alternative modes including schedules and stops.
8) Automatic notification of unexpected traffic congestion.

Of the travelers surveyed in the Broad Area studies who did not receive traffic information, approximately half stated that their reason is that the reports do not cover the route that the traveler takes (Table 4.2). Radio coverage is the most common source of dynamic information, yet the coverage is sparse. The morning peak hours typically receive the greatest traffic information coverage, with only a few radio stations reporting traffic conditions during afternoon peak and off-peak hours. Also, radio reports ran no more than once every eight minutes, and only in half-minute segments. The area covered by traffic reports was limited to major freeways, and reporting was not consistent throughout the Bay Area and somewhat lacking in detail (*22*). The decline in radio as a source of dynamic travel information between the two Broad Area studies suggests that the relevance of travel information is very important to travelers, both in making the decision to acquire travel information, and in changing their actual travel decisions. Lack of alternate routes was also a significant consideration for travelers.

Though market penetration of TravInfo was relatively small (only 9% of respondents in the second Broad Area study were aware that it existed), new users were attracted both to the telephone system and to travel Web sites. Approximately one-third of phone callers and one-third of Web site visitors switched to TravInfo from radio/television reports. Other users who reported never listening to radio and television reports also began to use TravInfo, as did some users who continued to use radio reports and supplemented them with access to TravInfo. Those who switched were long freeway commuters and high-mileage drivers. Traffic Web site users perceived the quality of Web site information to be far superior to radio/television traffic reports. Maps and verbal descriptions of freeway speeds and the locations of incidents were considered valuable for making travel decisions. The focus group participants also preferred obtaining information over the phone or the Internet to tuning in to radio or television reports, despite the effort required on their part.

**Changes to travel decisions in the presence of information**

One third to one half of users who acquired travel information made changes in their travel decisions (Table 3.3). The TATS and ISP studies revealed that users who actively seek information via telephone or Internet are more likely to change their travel behavior than travelers who relied on radio and television. The second Broad Area study data also suggests that this relationship exists (Table 4.1). However, people who are pre-disposed to changing their travel decisions may be more likely to seek out information from new sources due to simultaneity in their access and change decisions.

Among travelers who did change their behavior, altering their route was the most frequent change (Table 3.4). The second most common change was altering departure time. Few travelers changed to transit, mainly because they perceived it to be inconvenient and more time-consuming than driving, even in congested conditions.

The Broad Area studies also revealed that non-commuting drivers changed their travel habits more than commuting drivers, perhaps reflecting the flexibility inherent in non-work trips. Among commuting drivers, those who sought travel information at work were more likely to leave earlier or take an alternate route.

**Importance of information to travelers**

Results regarding the reasons that travelers valued information suggested that time savings and the opportunity to plan the trip differently were most important (Table 3.5). It will bear further investigation to determine whether this information has immediate significance or is implicated

in long-term changes to travel behavior (for example, deciding that a different route should be the "usual" one). An interesting result in this regard is the level of users who reported that travel information reduced their level of anxiety or stress. This percentage was much higher among Broad Area and Target study respondents than among telephone and Internet users. This is consistent with the observation that telephone and Internet users were more likely to seek information (since they had to be proactive in order to acquire it) and were more likely than the average user to change their travel decisions based on the information they received. This suggests that an important value of radio traffic reports is to help drivers feel in control of what is going on around them, perhaps because congestion that has an explanation is less stressful than congestion that is unexplained. Broad Area study respondents who acquired information via Internet or cell phone also appeared to be more likely to change their travel decisions than respondents who did not get information from those sources (Table 4.3).

**Willingness to pay for travel information**

Willingness to pay was investigated rigorously in the 1998 Broad Area survey (*14*) as well as in the TATS surveys (*17, 18*). In the Broad Area survey, the vast majority of those who already had electronic devices such as personal computers or Palm Pilots indicated that they would be willing to pay to subscribe to traffic information. Respondents were asked if they seek travel information, and, if so, about their willingness to pay for a hypothetical ATIS that provided: 1) Automatic notification of unexpected congestion on respondents' usual route, 2) Estimated time of delay from unexpected congestion on respondents' usual route, 3) Automatic alternate route planning around congestion, and 4) Estimated travel time on respondents' usual route and on any planned alternate routes. Sixty-six percent of the respondents sought travel information, and of these information seekers 71% (48.5 of the respondents) were willing to pay for ATIS. Those who preferred to pay on a per call basis were 37.1% of the respondents and they were willing to pay for ATIS as follows: $1.00, 21.7%; $0.75, 4.2%; $0.50, 6.8%; $0.25, 2.4%; $0.00, 2.0% (average $0.74 per call). Those who preferred to pay on a monthly basis were 11.0% of the respondents and they were willing to pay as follows: $7.00, 8.3%; $5.00, 1.7%; $3.00, 0.2%; $0.00, 0.8% (average $3.84 per month). Increased willingness to pay for ATIS was related to respondents who altered their trips in response to information and stated a greater desire for dynamic information. Males and younger respondents were more inclined to pay for the service.

The survey of TravInfo callers indicated that the average use of the system would decline if a service charge was initiated without further improving the service. Callers did express a willingness to pay if the service could be customized to suit their information needs. Consumer response to purchasing travel information services seemed cost-sensitive, but the demand for information was relatively inelastic for travelers making longer trips. Trip characteristics and personal attributes seemed to play an important role in information acquisition, use and willingness to pay. People who experience longer trips with greater travel time uncertainty and those who are younger and male seem to desire dynamic information. Higher willingness to pay for travel information received via telephone was associated with preference for customized travel information, longer trips, commuting, and listening to radio traffic reports. Fee-based information services are likely to be more successful in situations where the demand for information is relatively inelastic and improvement or customization of travel information is achievable.

## LIMITATIONS

The TravInfo evaluation revealed some important limitations of the system itself, and of the evaluation process. System limitations included a lack of marketing and low market penetration. Lack of marketing particularly hindered use of the telephone service. Web users found their way to the sites, perhaps because those users have a greater propensity to search for information and because web search engines make searches easier than for telephone users. Owing to low market penetration as revealed in the second Broad Area Study (conducted at the end of the field operational test) the system did not appear to have a significant influence on area-wide travel behavior.

The TravInfo system was further limited by a lack of knowledge of what consumers want. Many assumptions were used in the design of the telephone system regarding the kinds of information that people might find useful and the menu structure that might allow users to easily reach desired information. Similarly, information service providers developed their products with many assumptions regarding map displays, text language, menu options, and information content. It is not clear that these assumptions corresponded well to user needs.

The evaluation process also was limited by difficulties in sampling users and difficulties in drawing sound conclusions from the relatively small sample sizes. Sampling users of the system proved to be difficult. Because the majority (80%) of the traffic information line callers were repeat customers, the call intercept method did not work well. Some were intercepted repeatedly, which caused the study's sample size of traveler information seekers to shrink to one-third the size that was originally planned. Survey respondents on the Web sites were relatively few in number (334 respondents). Since the survey was conducted in an uncontrolled environment (a questionnaire incorporated into the Web sites), the degree of self-selection bias could not be determined.

The ability to quantify the long-term benefits of information technology is important. The data gathered during the TravInfo evaluation is a significant though small step in that direction. Public agencies do not have prototype models that would provide forecasting ability to accurately assess the long-term impact of traveler information technologies on travel behavior and transportation network performance. As a result, TravInfo's impacts were assessed qualitatively although quantitative measurements of both tangible and intangible benefits are desirable.

## CONCLUSIONS

Understanding traveler response to new technologies is at the core of understanding which innovative traveler information systems will be successful. Based on a conceptual model and TravInfo empirical results, this paper indicates that about two-thirds of the respondents from the Bay Area population use dynamic information either regularly or occasionally. They use a variety of information sources to obtain travel information during the pre-trip as well as en route stages, with cellular phones and the Internet representing important future growth markets; their use increased substantially during the TravInfo test. The main reason cited by those not seeking dynamic information was that it was not relevant to their travel patterns.

Dynamic information seekers who called TravInfo TATS or accessed dynamic information on the Internet were more inclined to change their travel decisions compared with Broad Area respondents as a whole, as expected. However, possible simultaneity between technology access and travel decisions among this population needs to be investigated further. Those who changed travel plans due to dynamic information were more inclined to change

routes and then departure times. Mode changes and trip cancellations were rare, as expected. Saving travel time and help with travel planning were the key perceived benefits of dynamic information. Interestingly, reduction in anxiety was also cited by many respondents as a perceived benefit. Respondents demanded good quality information and some were willing to pay for premium information services. While the new information services and media seem to suffer from a lack of publicity, they appeal to information seekers and early adopters.

Empirical evidence suggests that information helps travelers switch routes and departure time. The potential for information benefits is perhaps higher in unexpected/incident situations. A third of the Target survey respondents changed their travel decisions in response to the incident. While this is a significant number in terms of demand reduction due to information, perhaps the full benefits of dynamic information are not realized because the quality of information available in just such situations is relatively low. Simulation studies are needed to shed more light on network level effects. New information media can focus on variables that are sensitive to travel time uncertainty in order to improve the quality of information in high-uncertainty situations.

There seems to be significant (latent) demand for personalized information services that would allow users to retrieve information when needed, to the point where a significant number of Bay Area travelers stated they would be willing to pay either on a per-call basis or a monthly subscription fee for a customizable service. However, the new information must be superior to the information that can be obtained for free through radio or television or other Internet outlets and services. The benefits from new information technologies may be limited due to competition with existing information sources such as the radio and television (but these benefits are likely to improve incrementally over time).

While travel time savings are a key benefit travelers expect to receive from travel information, a niche area requiring further research is information leading to a reduction in stress and frustration (and perhaps avoidance of unsafe situations). If new information systems can address the anxiety reduction issue (and safety, including two-way communications), then they might effectively compete with, and surpass, the existing information sources. At present, though, ATIS technologies that are penetrating the market seem to be more of a safety problem than a solution. As drivers who use new technologies en route increase, the need to assess safety impacts also increases, e.g. a significant portion of those driving passenger vehicles on US roadways talk on hand-held cell phones, which is a source of driver distraction.

In terms of ATIS implementations, this work suggests that we should continue to encourage the collection and dissemination of quality information, especially in incident situations, on primary and alternate routes through various sources. Given that some people are willing to pay for dynamic information, we should encourage a greater private sector role in the collection, processing and dissemination of real-time travel information.

Compared to other cities, San Francisco is somewhat unique in terms of population, openness to new technologies and geography. The travel information impacts investigated in this study are context-specific and may not generalize to other cities. Clearly there is a need to integrate the field test results from other cities. A meta-analysis of existing research can provide transportation planners and decision-makers with stimulus and strategies for further deployment.

**ACKNOWLEDGMENT**— This work was performed as part of the collaboration between the California PATH Program at the University of California, California Department of Transportation and Metropolitan Transportation Commission.

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**TABLE 1: Selected ATIS behavioral studies (Y indicates a "yes")**

| Author | Key Findings | Topics Addressed in Study | | | | Approach | |
|---|---|---|---|---|---|---|---|
| | | Willing-ness to Pay for Info | Traveler Behavior under ATIS | Content of Info to Provide | Other Than Auto Commuters Examined | Method | Location and Sample |
| Abdel-Aty *et al.1997* (2) | Info has significant effect on route choice. Travel time not dominant choice criterion. ATIS has great potential. Gender, age, freeway use, length, variation in time affect route choice. | | Y | | | Phone and mail back surveys (2 models) | N = 564 (phone), N = 143 (mail) |
| Adler & Blue 1998 (3) | Conceptual model of choices, cognition, spatial knowledge, travel preferences & attitudes. | | Y | | | Suggests AI methods | |
| Englisher *et al.* 1996 (4) | 61% SmarTraveler users have cell phones, long commutes on roads 75%+ covered by info, 67% on work trips, more calls from work than to work. 50% very unlikely to pay $2.50/mo., none pay $10, 30% pay $.10/call for pre-trip info. | Y | Y | | Y (no specific analysis) | Survey of perceptions of SmarTraveler users and non-users | Boston N = 452 follow-ups, 547 users, 1920 non-users |
| Khattak & Khattak 1998 (5) | En-route diversions affected by availability & knowledge of alt. routes, travel time, amount of delay, & info source | | Y | | | Survey of peak auto commuters | Chicago (n=700) and SF (n=3238) |
| Khattak *et al.* 1996 (6) | Travelers may change behavior in response to long delays and with info, especially if it's prescriptive | | Y | Y | | SP & RP Survey | Golden Gate N = 586 |
| Mahmassani & Liu 1999 (7) | Males more likely to switch departure time due to info, older not. Late arrival causes more route change than early, as does unreliable info. | | Y | | | Lab experiment with travel simulator | N = 45 |
| Mannering *et al.* 1994 (8) | More route changes on work to home trips. 26% sometimes change route. Males, higher earners, more familiar, more likely to change. Females change more based on pre-trip. Inertia present. | | Y | | | Survey of I-5 commuters | Seattle N = 3893 |
| Mehndiratta et al 1999 (9) | Interest in travel information reflects influence of many variables. Distinct sub-populations of travelers have different information needs and expectations. | | Y | Y | | Panel Survey | Seattle N = 2000 |

| Author | Key Findings | Topics Addressed in Study | | | | Approach | |
|---|---|---|---|---|---|---|---|
| | | Willing-ness to Pay for Info | Traveler Behavior under ATIS | Content of Info to Provide | Other Than Auto Commuters Examined | Method | Location and Sample |
| Mehndiratta et al. 2000 (10) | Drivers prefer more frequent information updates & coverage of major arterials. Prospects for self-sustaining ATIS services are unclear. | | Y | Y | | Survey of TravInfo callers—Web + Mail | Bay Area, CA N=69 |
| Polydoropoulou *et al.* 1996 (11) | Expected delay, alt. rte. travel time, congestion level, and info quality (predictive and prescriptive best) increase route changes. | | Y | Y | | SP & RP Survey of automobile commuters | Golden Gate N = 1492 |

**TABLE 2:** TravInfo Evaluation Surveys. Field Operational Test Dates: July 1996 to August 1998

| | **Broad Area (Baseline)** | **Broad Area (Final)** | **Target Area Phase 1** | **Target Area Phase 2** | **TATS[a] (Wave 1)** | **TATS (Wave 2)** | **ISP Customers** |
|---|---|---|---|---|---|---|---|
| **Abbreviation** | BAS 1 | BAS 2 | Target 1 | Target 2 | TATS 1 | TATS 2 | ISP |
| **Date(s)** | 11/1995 | 11/1998 | 7/1997 | 3/1998 | 4/1997 | 3/1999 | 9/1998 – 3/1999 |
| **Goal** | Baseline traveler behavior | impact of TravInfo on travelers | Changes in travel behavior over time | Changes in travel behavior over time | Effectiveness of TATS in informing callers | Effectiveness of TATS in informing callers | Effects of web site use on travel behavior |
| **Target Population** | Bay Area Households | Bay Area Households | Morning commuters on selected freeway segment | Morning commuters on selected freeway segment | Callers to TATS | Callers to TATS | Users of Web Site |
| **Survey Selection** | Random Digit Dialing | Random Digit Dialing | License Plate Survey | License Plate Survey | Random call interception | Random call interception | Self-selecting |
| **Method** | Telephone Interview | Telephone Interview | Telephone Interview | Telephone Interview | Telephone Interview | Telephone Interview | Online Questionnaire |
| **Sample Size** | 1000 | 1000 | 105 Northbound<br>107 Southbound | 80 Northbound<br>80 Southbound | 421 | 421 | 334 |
| **References** | 14 | 15 | 16 | | 17, 18 | 17, 18 | 19, 20 |

[a] TATS is the Traveler Advisory Telephone System
[b] Abbreviation used to refer to this survey in the text

**TABLE 3:** Results from Multiple TravInfo Surveys —automobile users

| | BAS1 | BAS2 | Target1 | TATS 1 | TATS 2 | ISP |
|---|---|---|---|---|---|---|
| **3.1 Source from which electronic travel information was obtained (pre-trip)** | | | | | | |
| | N=864 | N=852 | N=212 | N=173 | N=158 | N=334 |
| Radio | 54% | 30% | 56% | n.a. | n.a. | n.a. |
| Television | 23% | 22% | | n.a. | n.a. | n.a. |
| Telephone | 19% | 18% | n.a. | 69% | 53% | n.a. |
| Internet | 1% | 4% | n.a. | n.a. | n.a. | 100% |
| **3.2 Source from which electronic travel information was obtained (en route)** | | | | | | |
| | N=864 | N=852 | N=212 | N=173 | N=158 | n.a. |
| Radio | 68% | 48% | 45% | n.a. | n.a. | n.a. |
| Cell Phone | 1% | 2% | n.a. | 31% | 47% | n.a. |
| **3.3 Travelers who changed plans due to electronic travel information** [a] | | | | | | |
| | N=550 | N=598 | N=212 | N=173 | N=158 | N=334 |
| Any Change | 30% | 34% | 15% | 47% | 56% | 84% |
| No Change | 70% | 66% | 85% | 53% | 44% | 16% |
| **3.4 Types of travel decision changes (travelers who changed plans—multiple response permitted)** [b] | | | | | | |
| | N=343 | N=317 | N=32 | N=173 | N=158 | N=334 |
| Departure Time | 44% | 44% | 25% | 16% | 13% | 37% |
| Route | 71% | 71% | 69% | 33% | 29% | ~50% |
| Mode | 10% | 10% | 13% | 1% | 11% | 1% |
| Cancel Trip | 10% | 2% | 3% | 4% | 6% | 7% |
| **3.5 Perceived benefits from dynamic travel information (multiple response permitted)** [b] | | | | | | |
| | N=431 | N=658 | N=210 | N=173 | N=158 | N=334 |
| Saves Time | 21% | 23% | 18% | 36% | 31% | 10% |
| Reduces Anxiety | 18% | 22% | 24% | 18% | 4% | 5% |
| Travel Plan | 35% | 49% | 24% | 39% | 53% | 24% |
| Other/Unsure | 26% | 6% | 34% | 8% | 12% | 27% |
| General Benefit | n.a. | n.a. | n.a. | n.a. | n.a. | 34% |

[a] Broad Area studies only considered auto commuters who received pre-trip information.

[b] Target, TATS and ISP report percentages of all users, Broad Area reports percentage of users who sought information.

n.a. – not available

**TABLE 4:** Results from Broad Area 1 Survey – Market for New Information Sources[a]

| | Internet Access | | Cell Phone | | Both | | Telephone (all auto commuters) | No Internet or Cell Phone |
|---|---|---|---|---|---|---|---|---|
| | Have | Use for Info | Have | Use for Info | Have | Use for Info | | |
| **4.1 Users who changed plans due to electronic travel information** | | | | | | | | |
| | N=475 | N=74 | N=257 | N=10 | N=213 | N=53 | N=598 | N=21 |
| Did not Acquire Information | 30.5% | n.a. | 27.2% | n.a. | 26.8% | n.a. | 31.3% | 33.3% |
| Got Information (from anywhere) | 69.5% | 100.0% | 72.8% | 100.0% | 73.2% | 100.0% | 68.7% | 66.7% |
| Changed Travel Plans due to information[b] | 47.4% | 68.9% | 51.8% | 100.0% | 53.1% | 66.0% | 47.0% | 42.9% |
| Changed Route | 26.5% | 43.2% | 29.6% | 60.0% | 30.0% | 39.6% | 26.3% | 23.8% |
| Changed Departure Time | 32.0% | 51.4% | 36.2% | 80.0% | 37.6% | 52.8% | 31.6% | 33.3% |
| Changed Mode | 1.5% | 4.1% | 1.9% | 10.0% | 2.3% | 5.7% | 1.3% | 0.0% |
| **4.2 Reasons for not seeking travel information (users who did not acquire travel information from any source)** | | | | | | | | |
| | N=145 | | N=70 | | N=57 | | N=187 | N=7 |
| Do Not Listen | 17.9% | n.a. | 15.7% | n.a. | 17.5% | n.a. | 16.7% | 14.3% |
| Info Not Relevant | 44.1% | n.a. | 50.0% | n.a. | 47.4% | n.a. | 41.4% | 57.1% |
| No Alternatives | 24.1% | n.a. | 22.9% | n.a. | 22.8% | n.a. | 22.7% | 14.3% |
| Unreliable | 7.6% | n.a. | 4.3% | n.a. | 5.3% | n.a. | 6.1% | 0.0% |
| Incomprehensible | 0.7% | n.a. | 1.4% | n.a. | 1.8% | n.a. | 0.5% | 0.0% |
| Not Sure / No Answer | 5.5% | n.a. | 5.7% | n.a. | 5.3% | n.a. | 7.1% | 14.3% |
| **4.3 Perceived benefit of travel information (from any source)** | | | | | | | | |
| | N=330 | N=74 | N=187 | N=10 | N=156 | N=53 | N=411 | N=14 |
| Saves Time | 23.3% | 21.6% | 24.6% | 20.0% | 24.4% | 15.1% | 22.9% | 14.3% |
| Reduces Anxiety | 25.2% | 33.8% | 26.2% | 10.0% | 27.6% | 26.4% | 24.6% | 28.6% |
| Travel Plan | 46.1% | 40.5% | 43.3% | 60.0% | 43.6% | 37.7% | 45.7% | 42.9% |
| Other / Unsure | 5.5% | 4.1% | 5.9% | 10.0% | 4.5% | 20.8% | 6.8% | 14.3% |

[a] Auto commuters only, N=598

[b] Pre-trip or en route changes (Table 3 reports pre-trip changes only)

n.a. – not applicable/not available

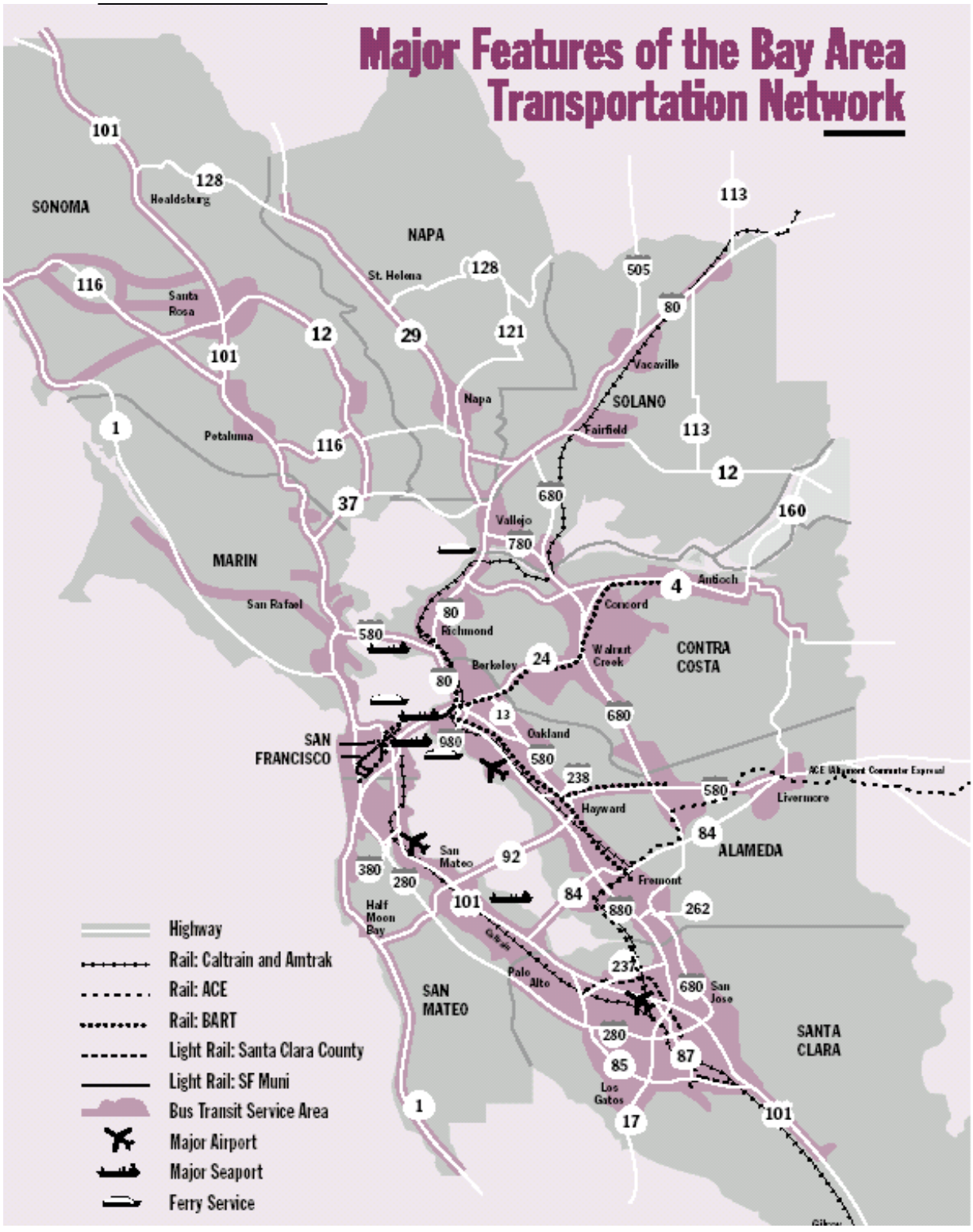


**FIGURE 1:** Bay Area Transportation Network (TravInfo Service Area) Source: Metropolitan Transportation Commission.

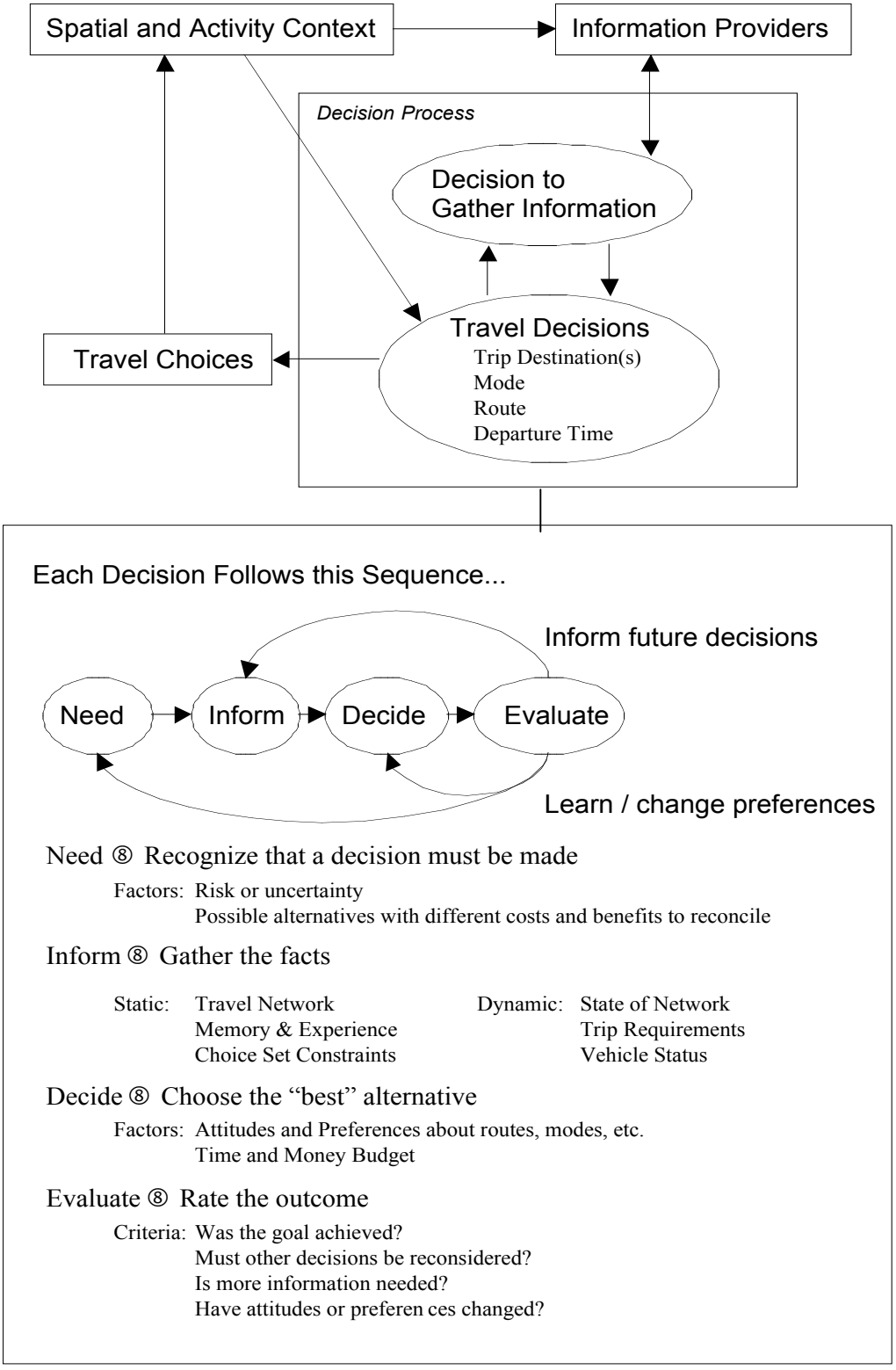


**FIGURE 2:** Conceptual model of traveler behavior