

Acquisition of traveler information and its effects on travel choices: evidence from a Seattle-area travel diary survey

April 7, 2003

Sean Peirce
Volpe National Transportation
Systems Center
DTS-42
55 Broadway
Cambridge, MA 02142
617-494-3156
peirce@volpe.dot.gov

Jane Lappin
Volpe National Transportation
Systems Center
DTS-42
55 Broadway
Cambridge, MA 02142
617-494-3692
lappin@volpe.dot.gov

KEYWORDS

traveler information, travel behavior, Intelligent Transportation Systems, Advanced Traveler Information Systems, diary

ABSTRACT

Advanced Traveler Information Systems offer the promise of better informed travel decisions and more efficient use of transportation infrastructure. However, no firm consensus has emerged as to how travelers decide to access information, or how they actually incorporate this information into their travel choices. This paper is designed to complement existing research in this area with results from a large-scale survey of travelers in the Seattle area. The paper focuses on how characteristics of the traveler and of the trip itself influence these choices.

The analysis reveals that Seattle-area travelers seek information on a narrow share of their daily travel – just over 3 percent of respondents’ recorded trip segments involved information usage, with radio traffic reports the most common source. The decision to seek information does not seem to be strongly influenced by traditional demographics such as sex or income, but is correlated with employment status, internet usage, and experience with congestion. Trip characteristics are also influential, with travelers much more prone to seek information where (1) information is likely to be available for the route or mode in question, (2) the trip is arrival-time sensitive, and (3) there is a great deal of variability or uncertainty about the travel time. Thus, a typical traveler is about 20 times more likely to seek information on a peak-period, 25-mile commute trip to work than on an off-peak shopping trip. However, studies of ATIS usage should not limit themselves to commute trips, since other time-sensitive trips, such as those to the airport and to medical appointments, also exhibit above-average levels of information acquisition.

If expanding ATIS use beyond this narrow segment of trips is a public policy goal, this will require increasing the benefits of ATIS and/or reducing the costs of access. In light of our earlier research on travelers’ ATIS enhancement priorities, this implies that improvements in fundamental data quality – in particular, more frequent updates and greater geographical coverage – will be most useful. These improvements would broaden the range of trips on which travelers would perceive information acquisition to have a favorable benefit-cost profile.

Travelers’ response to the information they receive is complex, and their reactions in real-world settings are not easily modeled. This paper does confirm results from earlier work, such as the fact that information acquisition rarely leads to a shift in travel modes. In contrast to some studies, however, it also indicates that changes in route are more common than changes in departure time and that personal characteristics, such as gender, do not have a strong influence on this decision. The most common response is to make no travel-related change at all in response to the information received, suggesting that many travelers may be seeking “serenity” or “peace of mind” benefits. This is a phenomenon we plan to explore in more detail with the next wave of the survey.

INTRODUCTION

Drawing on a large-scale survey of over 3000 Seattle-area residents, this paper analyzes the use of traveler information sources and examines the impacts of information acquisition on travel behavior. For the purposes of this paper, traveler information is defined broadly, encompassing both conventional forms of information like radio traffic reports, as well as Advanced Traveler Information Systems (ATIS). ATIS, for its part, comprises a wide range of telecommunications services designed to provide travelers with frequent, customizable updates on traffic and transit conditions. Examples of ATIS services available in the Seattle area include websites with information on regional traffic congestion and video displays at transit stations showing updated bus arrival times.

Whether high-tech or low-tech, these traveler information services are all designed to help travelers make better-informed travel choices and thus to improve the operation of the transportation system. For example, a driver who learns of heavy congestion on his usual route may decide to change his departure time, alter his route, or switch to another mode of transport; in some cases, just having information about current conditions can also help reduce the stress of traveling.

However, the ability of traveler information to fulfill any of these goals depends on a number of factors, including the quality of the information provided, the characteristics of the user and of the particular trip, and the broader regional context (Lappin 2000). Moreover, the ability of ATIS and traveler information to improve the performance of transportation networks depends crucially on user habits, particularly the user response to information. How often do travelers actually consult information of any sort? Are they likely to change their travel patterns in response to the information they receive? If so, what sorts of changes are most typical? And to what extent are all of these things influenced by the *personal characteristics of the traveler* and the *nature of the trip* itself? This paper addresses these questions through an analysis of detailed personal travel diary data collected in the Seattle area during 2000.

DATA SOURCE

Since 1989, the Metropolitan Planning Organization for the Seattle region – the Puget Sound Regional Council (PSRC) – has been gathering information about household-based regional travel patterns using a panel survey design. Every one or two years, all members of a random sample of approximately 1,700 households complete a 48-hour travel diary, recording all of their trips taken over this period, including details such as the purpose and destination of the trip, the mode of transport used, and departure and arrival times. Each wave of the survey thus provides a snapshot of the Seattle region's travel activity, and the successive waves over time provide one of the only sources of

longitudinal data about local travel behavior in the US. The sample itself is stratified by commute mode and county of residence, and includes an intentional oversample for transit riders and carpoolers (in order to generate sufficient sample sizes to conduct analysis on these groups). As households leave the panel, for example after moving out of the area, they are replaced with similar household so as to maintain a roughly equal sample achievement from one wave of the survey to the next.

For the Wave 9 survey administration in 2000, two supplements were added to the travel diaries. The first was a questionnaire on respondents' awareness of ATIS sources and their personal attitudes toward local travel and advanced technologies. Results from this survey were presented in an earlier paper on awareness and use of traveler information sources (Peirce and Lappin 2003). The second supplement was an extension of the travel diary, which asked about the traveler information sources consulted on each trip and, where applicable, how the information was used to plan or modify the trip. This is the first time that the PSRC survey collected information on ATIS use at the level of the individual trip. This data enables us to conduct more detailed analyses of the effects of information on tripmaking behavior.

LITERATURE REVIEW

Of course, a great deal of research has already been done in this area, examining the impact of traveler information on travel decisions such as timing, mode choice, and routing. Previous surveys have found that over half of travelers will make a change to their travel route or departure time after accessing information over the radio, television, or telephone (Khattak et al. 1999), and that this proportion can be even higher for website users (Yim and Miller 2000). There is also some evidence from simulated trials that pre-trip information can indeed reduce the variability (if not so much the average duration) of the commute trip, and that travelers accessing pre-trip information are likely to reap the greatest benefit by shifting their departure time rather than by changing their route (Shah et al. 2001). Research has also delved into even more specific topics. In the area of route choice, for example, it has been found that variable-message signs are more likely to divert drivers from a non-freeway to a freeway rather than vice versa (Hato et al. 1995) and that behavioral inertia plays a part in drivers' choice of route in response to ATIS (Srinivasan and Mahmassani 2000).

All of these research efforts have contributed to the base of knowledge on travelers' response to information, yet no overarching consensus has emerged. That is to say, we are still quite far from being able "to accurately predict, for a [variable-message sign] displaying a particular message at a particular location in a particular network, what the effect on individual travelers or on overall network conditions will be" (Bottom and Lappin 2001). Part of this is due to limitations in the available data, as much of this research has relied on stated preference survey questions and small-scale trials (Bottom

and Lappin 2001), thus limiting its broader applicability. The research efforts employing empirical data (such as Shah et al. 2001) have generally used computer modeling and simulations; as such, they may not capture all the nuances of human behavior in real-world situations, such as the possibilities for re-arranging one's daily schedule or the ability to make small-scale adjustments to one's route using un-modeled surface streets. Additionally, it has been noted that the literature in this area has had a somewhat disproportionate focus on automobile trips, commute-to-work trips, and en route information (Khattak et al. 1999), meaning that relatively less is known about public transit trips, non-commute trips, and the use of pre-trip information, all of which are important components of travel behavior.

Our approach is thus to supplement all of this prior work by drawing on the PSRC survey's large, random sample of diary entries in order to measure levels of traveler information use, and to examine travelers' response to information. This methodology was specifically suggested by the authors of earlier research with the PSRC data: "In future data collection efforts, it may be informative to ask questions about information use for specific trips respondents report in their travel diaries. This will allow one ... to pinpoint specific situations in which travelers change their behavior" (Viswanathan et al. 2000). In short, this approach has several advantages:

- Inasmuch as the diary entries are records of actual trips taken under real-world conditions and constraints, they provide a valuable source of data to complement the existing stated-preference and simulation research;
- The PSRC survey is a large-scale, random sample of the Seattle-area population, potentially providing insights of greater generalizability;
- Rather than focusing the research on one type of trip or one source of information, the diary entries encompass all travel modes, trip purposes, and information media – in the proportions that they were actually employed.

At the same time, of course, it should be remembered that the 2-day diary period may not be fully representative of respondents' information use; in particular, the additional respondent burden associated with filling out the supplementary survey might have resulted in the underreporting of information use. Moreover, the extent to which findings from the Seattle area can be applied to other metropolitan areas – particularly those with different roadway networks, geographic conditions, and ATIS networks – is unclear. Even with these caveats, however, the entries in the travel diary provide valuable insights into the ways that traveler information is used to plan and modify trips, allowing us to add a new perspective to the knowledge in this field.

THE SAMPLE: WAVE 9 OF THE PSRC PERSONAL DAILY TRAVEL CHOICES SURVEY (2000)

A total of 3,262 individuals from 1,730 households were successfully recruited for Wave 9 of the PSRC survey in 2000. As mentioned above, the surveys they completed consisted of three parts: a personal survey on demographics, attitudes, and use of advanced technologies; the 2-day travel diary itself; and a supplemental diary for recording the details of any traveler information usage.

The respondents recorded a total of 25,688 trips in their personal travel diaries, reflecting an average of just under 8 trips per person during the 2-day diary recording period. The survey’s design is such that each one-way trip to another address, as well as each change of travel mode along the way, is recorded as one “trip.” The following table shows the most common trip purposes, though the figures are complicated by the fact that the most common purpose listed is the somewhat ambiguous catch-all category of “returning home” from a place other than work or school.¹

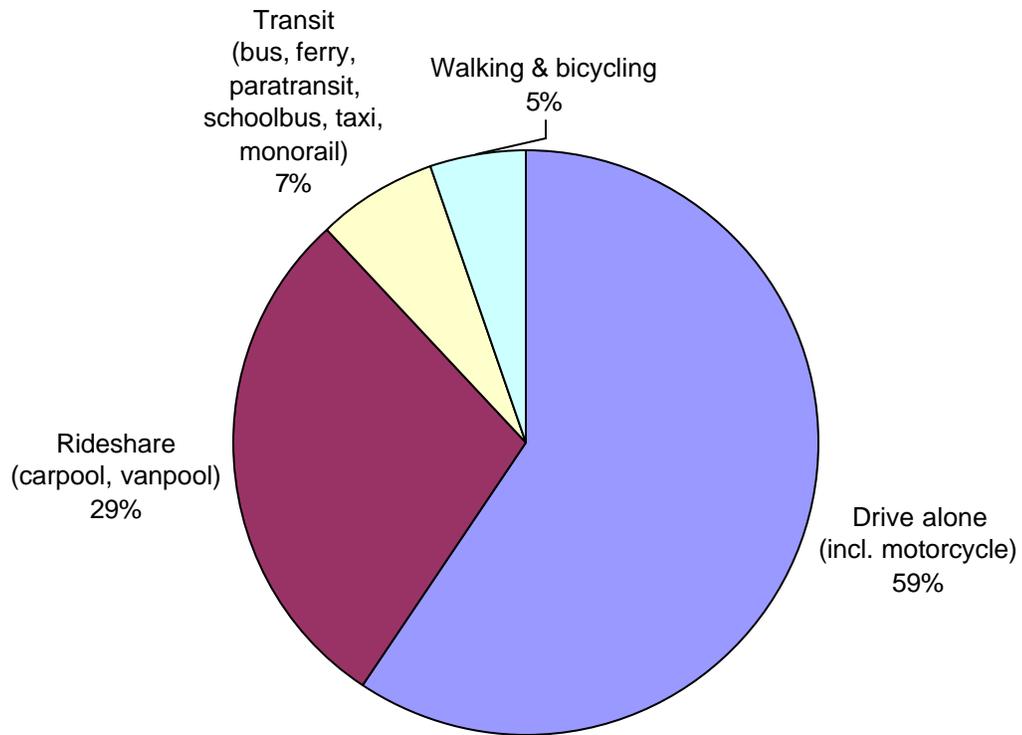
Figure 1. Distribution of trip purposes in the travel diaries

Purpose	Share of trips recorded
Returning home (<i>other than</i> from work or school)	23%
Commuting to/from work	20%
Errands, including picking up or dropping off others	13%
Shopping	8%
Other work-related travel (e.g. client visits, deliveries)	6%
Recreation/personal	5%
Dining/coffee	4%
Taking child to/from school or lesson	4%
Commute to/from school or college	3%
Medical appointment	2%

The median trip duration was 15 minutes and the median trip distance was 4.1 miles, reflecting the preponderance of short, local trips in the diary entries. The following chart shows the distribution of trips by mode of transport. However, it should be noted that this may not accurately reflect actual mode shares in the Seattle area because of the survey’s practice of over-sampling households using transit and rideshare modes. Respondents may tend to underreport short walking trips out of a belief that these are not “real” trips, thus depressing the figures for walking.

¹ The table also excludes trips where the purpose is unclear, such as trips labeled “going to another travel mode” or “other appointment.”

Figure 2. Distribution of diary trips by mode of transport



FINDINGS FROM THE TRAVEL DIARY

As mentioned above, the records of these 25,688 trips also include information about whether or not the respondent consulted any source of traveler information in order to plan or modify the trip. In cases where information was used, these records include details about which sources were consulted, what the motivation for seeking the information was, what information was gathered, and how the respondent reacted to the information. These data allow us to address a number of fundamental questions about information acquisition, such as how often information is typically used and how often travelers make changes in response to information. By combining this diary data with other information about the respondents, we can also address a more complex set of questions centered on how personal factors (e.g. demographics) and trip-related factors (e.g. travel mode) affect information acquisition and the response to information.

How often do people consult traveler information? Which sources are most commonly used?

The diary entries indicate that respondents used some form of traveler information on 3.2 percent of their total trips. This includes all sources – broadcast traffic reports, websites, telephone alerts, cable TV stations, and so on. (This figure would be slightly higher if our denominator were trip *chains* or *circuits* rather than individual trip segments. A single website visit, for instance, might help a traveler plan a multi-leg trip home from work that includes stops for errands. Most respondents would however have listed the website visit as associated with the first leg of the trip only; the survey did not include explicit instructions for these situations.)

When we look across the whole of the 2-day diary period, about 12 percent of all respondents consulted traveler information at least once during this period. This is roughly consistent with respondents' self-reported use of traveler information sources on another portion of the questionnaire, where about 18 percent indicated that they consult an information source 5 times per week or more (Peirce and Lappin 2003).

On the recorded trips using some form of traveler information, the most common sources of information were broadcast traffic reports. En-route radio was the top source listed, having been consulted on 56 percent of the trips where information was consulted. The other top sources were pre-trip radio (22 percent of information-using trips), TV news broadcasts (13 percent), traffic websites (6 percent), and transit websites (6 percent).

How frequently do people make changes to their trip in response to information? What are the most common changes?

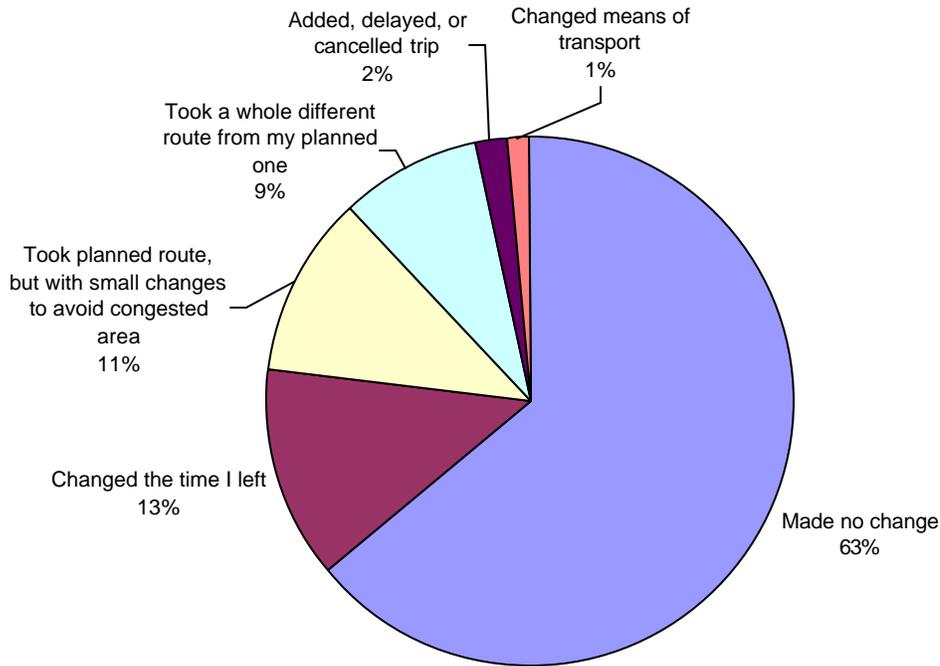
As shown in Figure 3, about 37 percent of the information-using trips also involved some resultant change in travel behavior. Although we are not aware of any other studies measuring this question in precisely the same way, this 37 percent figure does seem consistent with some earlier research. One stated-preference survey found that about 35 percent of respondents sometimes change their travel plans as a result of an information report (Khattak et al. 1999), while a study of *SmarTraveler*® users in the Boston area (Lappin et al. 1994) found that about 30 percent changed their travel behavior “frequently” in response to information. However, this latter study also found that 96 percent changed their trips “occasionally,” and research in Chicago found that 85 percent of motorists said that they alter their behavior after hearing a traffic report (Lappin et al. 1994). Obviously, much of this variation is driven by differences in the respondent populations, their decision-making contexts, and the types of information available to them, as well as by differences in the research methodologies employed. Our expectation is that the PSRC diary data should provide a fairly reliable estimate of the

prevalence of information-related travel changes, because it draws on a random sample and is based on an analysis of actual trips taken.

Overall, then, trips that were changed in some way as a result of traveler information represent just over 1 percent of all trips recorded in the diaries – i.e., 37 percent of the 3.2 percent, for a total of about 1.1 percent. Among these changed trips, the most typical changes are changing departure time (13 percent) and making small changes to one's route (11 percent). Only rarely do people change travel mode as a result of the information (1 percent). The fact that very few trips involved a choice to switch modes is consistent with other research indicating that traveler information generally has no more than a modest effect on mode choice (Yim and Miller 2000).

While the travel diary data indicate that travelers decide *not* to make a travel change on about two-thirds of the trips on which information is consulted, the structure of the diary unfortunately does not allow us to conduct any further analysis of why this is so. Based on our experience with ATIS, however, we believe that the reasons for this phenomenon are varied. In many cases, there is simply no reason to deviate from one's plans – there are no reported travel delays, or the delays reported are so minor as not to warrant a change. In other cases, the traveler may wish to change but cannot do so because there are no (feasible) alternative modes or routes. The traveler may also have limited knowledge of alternatives and/or an unwillingness to deviate from the routine. It is also possible for the traveler to react to the information in a way that does not involve an actual travel change, for example by calling ahead to say that he will be late, or by simply enjoying the peace of mind that comes with having additional information on travel conditions.

Figure 3. Changes in travel in response to traveler information (N=801 trips)



What are the most common motivations for seeking out information? For making changes to a trip based on the information obtained?

By far, respondents' top three motivations for seeking information were: that they anticipated traffic congestion (52 percent), that they wanted to be sure of arriving on time (47 percent), and that they wanted to get to their destination as fast as possible (34 percent). These value of these statistics is somewhat limited by the possibilities for different semantic interpretations. For example, a respondent who was concerned about getting caught in traffic and thus being late for work might well have checked any one of the three as her motivation. We can however confirm that other motivations, such as concern about bad weather or wanting to learn more about an incident, are relatively less common (5 percent each).

For those who made a change to their travel plans based on the information they received, we also asked what *specific* information was obtained that led to the decision to make a change. While some respondents reported incidents and accidents along their route (17 percent of those who adjusted their travel plans), the most common response was that "nothing special happened, it was just traffic congestion" (41 percent).

When it comes to the broader motivation for making changes in response to information, a plurality (43 percent) of those respondents who made a change said that they did so in order to reduce their trip time. Others said they were primarily looking for more predictable travel time (13 percent), less stressful travel conditions (12 percent), or safer conditions (6 percent). Again, there is the possibility for respondents to have differing interpretation of each of these pre-coded responses. (As might be expected, though, the proportion seeking greater predictability and safety is even higher amongst those who say that they sought information due to bad weather, though the sample size for this observation is quite small.)

Figure 4. Why did you consult travel information for this trip?

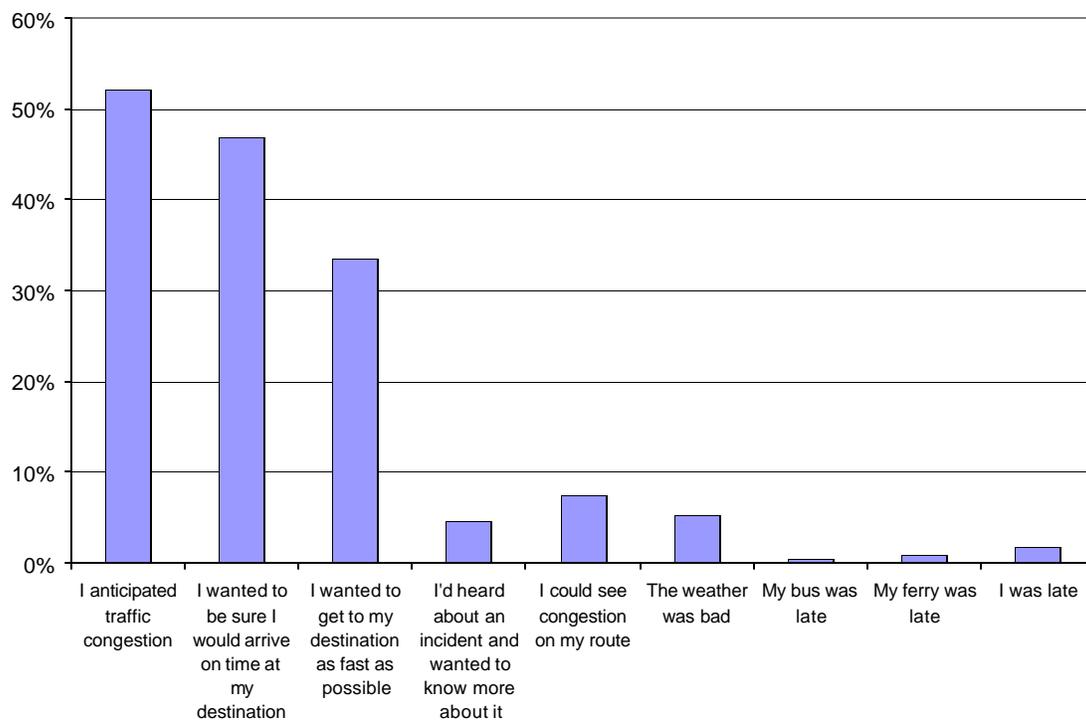
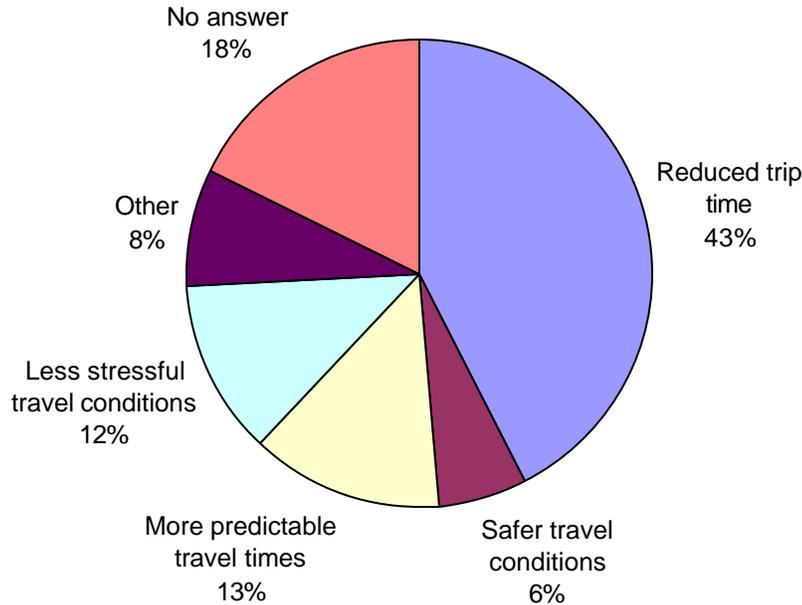


Figure 5. (If you made a change to the trip after consulting information) What primary benefit were you seeking when you made a change to your trip?



How does information use vary with demographics and trip-related factors? How does the type of trip modification made (e.g. change in route, timing, mode) vary with these factors?

Gender: The overall percentage of respondents consulting information at least once during the 2-day diary period was just about the same for both genders, at 12 percent. However, on a trip-by-trip basis, men used traveler information slightly more often than women did. The diary entries show that men consulted information on 3.6 percent of their trips, versus 2.7 percent for women, a small but significant difference ($p < .001$). Otherwise, there were few differences, although users of travel information *websites* were more likely to be men, and women were more likely to consult information pre-trip rather than en route. (Both of these differences were also significant at the 5 percent level.)

With regard to travel changes made as a result of information, there were again almost no gender-related differences; men and women were equally likely to make changes such as delaying their departure or seeking an alternate route. This is somewhat in contrast to earlier findings of gender-related differences in the use of ATIS (Shofer and Koppelman 1997). There was, however, one noticeable difference in the stated *motivation* for making a change, with women more likely to say that they were seeking “more predictable travel conditions” and men more likely to say that they were seeking

“reduced trip time.”

Age and employment status: Use of traveler information generally rises with age, peaking among those in late middle age and then falling off amongst those over 65. With this kind of pattern, we would expect that age is to some extent a proxy for employment status and thus a need to travel during peak periods. Indeed the rate of information usage is substantially higher for full-time workers (4.3% of trips) than for retired people (1.6%) or full-time students (0.9%). No clear patterns emerged when we looked at the response to the information acquired, except that younger respondents (those in the 15-17 and 18-24 age groups) were more likely than average to change their departure time, while those in older age groups tended to leave their plans unchanged. This could be related to age-related attitudinal or lifestyle differences, but it could also simply reflect a different mix of trip types – younger travelers make proportionately more school trips and visits to friends and family.

Other demographics: Interestingly, household income does not seem to have a strong effect on reported information usage. However, several other identifiable (and overlapping) demographic groups had above-average levels of traveler information use. Among salaried employees, for example, 17 percent had consulted at least one traveler information source during the 2-day diary period, compared to 12 percent of respondents overall. Likewise, workplace internet users (16 percent), regular commuters (15 percent), subscribers to fee-based internet information services (15 percent) and subscribers to free online services (19 percent) were all above average on this measure. This accords with our earlier work with the PSRC dataset which found that employed commuters and internet users were more likely to be users of traveler information (Peirce and Lappin 2003).

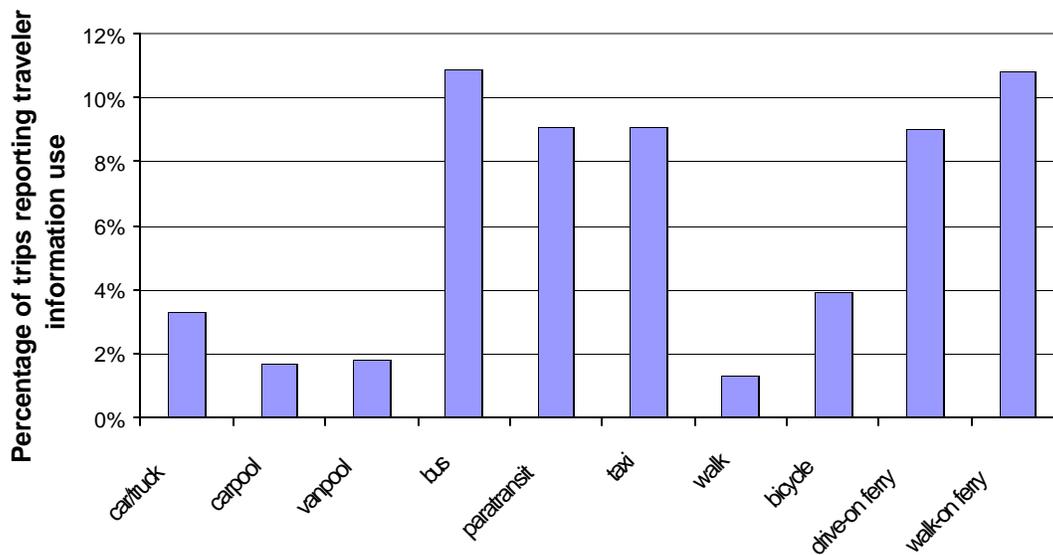
This is particularly true for commuters who say that they typically encounter an unexpected delay on their route at least once a week: 21 percent of respondents in this category consulted information at least once during the 2-day diary period, again compared to the overall average of 12 percent. This relatively high level of information-seeking suggests two things. First, as would be expected, personal experience with congestion is an important determinant of information usage. Second, the extent of *unexpected* delays may be of particular importance because of the role of uncertainty as a driver of information acquisition. Indeed, recent simulation research has found that “variability of travel times is the key attribute” in determining whether pre-trip traffic information will be of value to the traveler (Jung et al. 2002). In other words, ATIS is of most use when traffic conditions are not only congested, but unpredictably so.

Travel mode: Trips on public transit were associated with higher than average rates of information acquisition. For example, respondents consulted information on 11 percent of their bus trips, versus 3 percent for car trips. Much of this difference was due to

travelers consulting conventional paper transit schedules before departing. When schedules are excluded, transit trips have about the same information use levels as driving trips. Travelers on bus trips were, however, more likely to say that they were seeking more predictable travel conditions rather than simply reduced travel time. This could be related to the nature of transit trips, where things like schedule changes, late buses, and missed connections create a level of uncertainty for travelers that arguably exceeds that of driving trips. In any event, variability and uncertainty again seem to be important motivations for information acquisition.

On bus trips, travelers were also more likely to respond to the information received by changing their departure *time* rather than their *route*. This makes sense when one considers that, compared to motorists, transit passengers generally have fewer opportunities to change their route, particularly after they have started their journey. This translates into a strong preference for pre-trip information: overall, about 87 percent of the information related to bus trips was accessed pre-trip only, compared to 26 percent for car trips.

Figure 6. Reported use of traveler information, by mode of transport



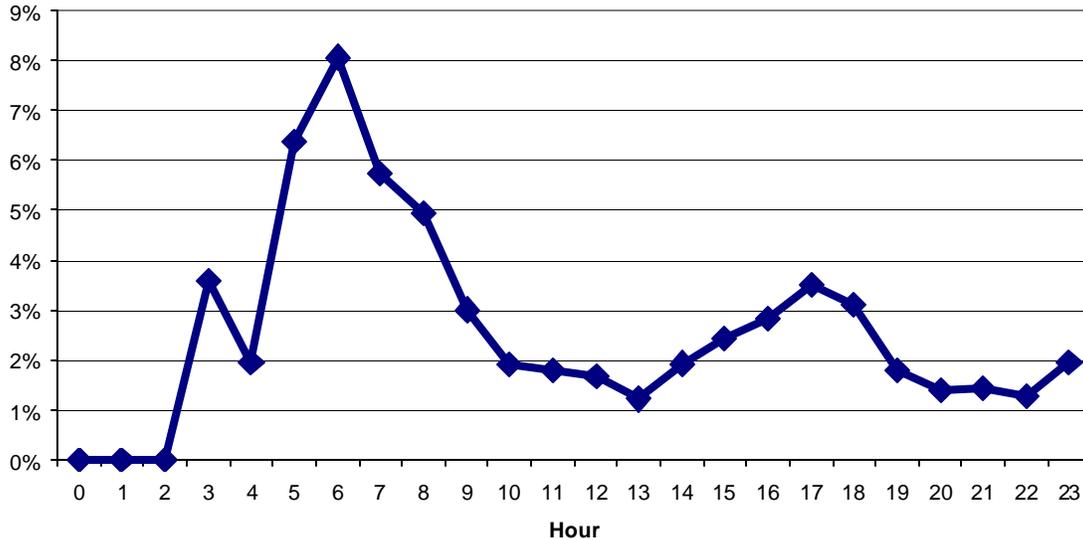
Trip purpose: The types of trips where traveler information was most frequently acquired were: linked work trips (10 percent of such trips also had recorded information use), trips to another travel mode (9 percent), and commute trips to work (7 percent). People making work-related trips (i.e., commute trips to or from work, plus other work-related travel) were more likely to list reduced trip time as their main motivation, while those making trips for dining and shopping were more likely to list less stressful travel conditions.

In terms of the behavioral response, people on work-related trips were more likely to make *no* travel change as a result of the information they acquired. This seems somewhat at odds with their motivation to reduce trip times, but this may have something to do with the habitual, familiar nature of commute trips. We have found in focus groups that commuters draw on their experience and tend to trust their own first-hand assessment of conditions more than the information from broadcast traffic reports (LaScola et al. 1998). In many cases, they will check the reports as part of their commuting routine, but only to confirm that there have not been any accidents or other anomalies on their route.

Time of day: Looking at trips by time of departure, we find that the highest levels of information use are for trips starting between 6 and 7 AM. During this hour, 8 percent of all trips made use of information. Presumably, usage peaks in the morning as commuters consult information to plan their trips so as not to be late for work, or needlessly early (Wunderlich et al. 2001).

There are, however, significant variations across information media, with usage of radio reports more common in the morning and usage of websites more common in the afternoon. The median departure time for a trip on which a radio report was consulted prior to departure was 8:28 AM, versus 5:13 PM for trips where a traffic website was consulted. An analysis of the Puget Sound Traffic website (Cluett 2000) also found that website usage peaks during the afternoon rush hour – for while relatively few travelers access the internet at home before leaving on their morning commute, many more do access the internet from the workplace in order to plan their trip home. Since radio usage is more common than website usage, the overall figures peak in the morning as shown in Figure 7.

Figure 7. Percentage of trips using any form of traveler information, by time of departure



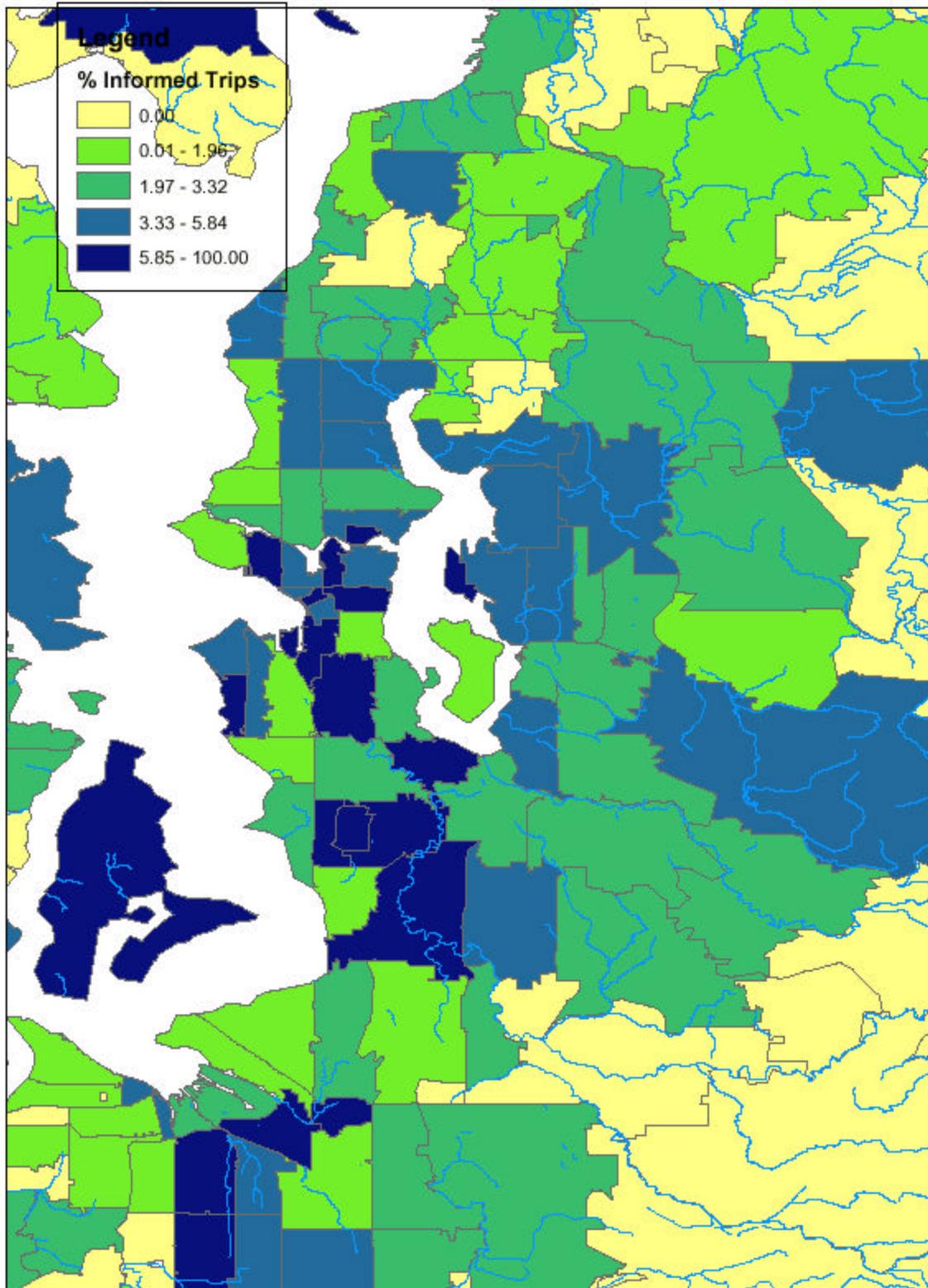
Distance and duration: The propensity to use information tends to rise with the distance and duration of the trip. Respondents reported using information on just 1 percent of trips under 10 minutes, compared to 10 percent of trips over 40 minutes in length. Likewise, about 9 percent of trips of over 15 miles made use of information, versus only 1 percent of trips of 3 miles or less. Of course, distance and duration serve to some extent as proxies for exposure to congestion, variability, and travel by freeways rather than local streets. The diary data also show that trip distance and duration seem to have some modest effects on travelers’ response to information, with people on shorter trips more likely than average to change their departure time, and people on longer trips more likely than average to change their route. Presumably, longer trips afford more possibilities for changing routes.

Geography: We sorted the trip data by destination zip code, and then calculated the percentage of trips to each zip code on which the traveler consulted at least one information source. As the map (Figure 8) indicates, travelers tend to use information more often when their destination is in certain parts of the Puget Sound region. This includes downtown Seattle and environs, some areas south of the city near the airport, areas near bridge crossings, and places such as Vashon Island that are accessed by ferry. This pattern of information use accords with our expectations, since travelers should be more likely to consult information when traveling to a typically congested area such as downtown, or on an arrival time-sensitive trip such as one to the airport. Areas near bridges and ferry terminals are also key points where travelers can make route and timing decisions, so these are also likely locations for information use.

The geographic concentration of traveler information use appears to be quite strong. Although PSRC respondents recorded trips to a total of 222 zip codes, trips bound for just

25 of these zip codes accounted for nearly half of all of the recorded instances of traveler information usage. In fact, nearly 1 out of every 6 trips on which traveler information was consulted were *destined for just 5 zip codes*: two in downtown Seattle, one on Bainbridge Island, and two in the industrial areas near Sea-Tac airport. Again, this seems to reflect travelers' propensity to seek information on trips that are work-related and/or to typically congested areas. In the case of Bainbridge Island it reflects the extra level of contingency planning and coordination that is necessary for trips by ferry.

Figure 8. Percentage of trips using traveler information, by destination zip code



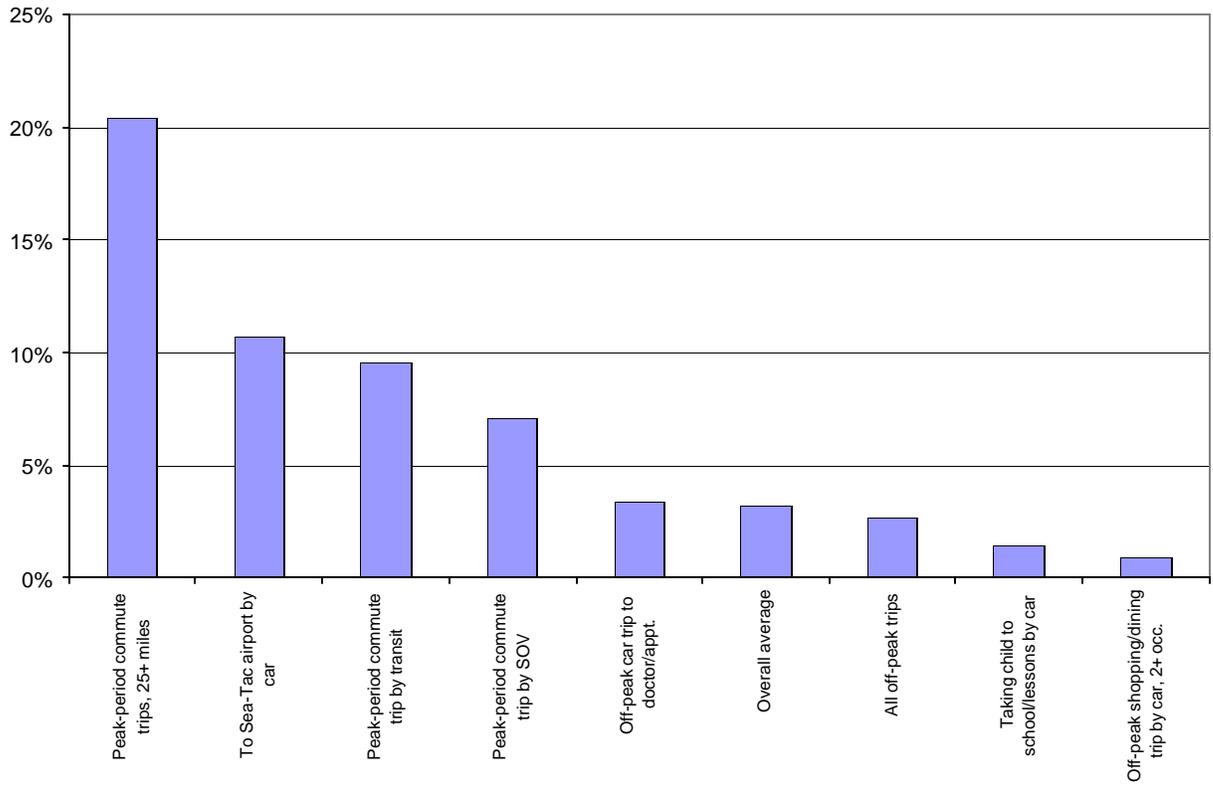
DISCUSSION

When evaluating traveler information systems, the rush-hour trip to or from work is often thought of as the typical or canonical trip – sometimes implicitly, sometimes as the explicit basis for a simulation model or survey question. As has been observed, however, the commute trip represents a relatively modest share of overall daily travel activity (BTS 1995). The PSRC diary data show that many people’s travel days are filled with short, non-work related trips, with commute trips to and from work accounting for only 20 percent of the total recorded trips. This figure is comparable to that recorded in the 1995 National Personal Travel Survey (BTS 1995). Furthermore, when we restrict the discussion to *peak-period* commute trips, the relevant share falls to about 11 percent of the trips recorded in the PSRC diaries².

Thus, the sort of peak-period commute trip that is so often discussed and modeled in ATIS research actually accounts for only about 1 out of 9 trip segments in the Seattle area. How do the levels of traveler information usage on other types of trips compare with the commute trip? In the following graph we have screened the diary data to focus in on a number of familiar or “typical” trips – such as a trip to the airport, or taking a child to school – where traveler information might also be used. We then ranked each of these typical trips in order of the frequency with which travelers consulted information on them. This is designed to give the reader a sense, for a range of recognizable trip types, of how trip-related factors such as time of day, purpose, and mode combine to affect the choice to seek information.

² We defined “peak” broadly, including any trip that started between 7 and 9:30 a.m. or between 4 and 7 p.m.

Figure 9. Percentage of trips on which traveler information was consulted, by type of trip



As Figure 9 shows, respondents' levels of information usage vary in ways that are consistent with our foregoing findings. For example, respondents used information more often on peak-period trips than on off-peak trips. And even among off-peak car trips, there is a clear difference between dining/shopping trips and the more time-sensitive trips to a doctor's appointment. Respondents used information on 3 percent of the latter, compared to less than 1 percent of the former. Trips to the airport, which are presumably among the most time-sensitive of all trips (and often less familiar), also show comparatively high levels of information acquisition – indeed they are the only non-work trips to rival commute trips in this respect.

As for the conventional peak-period commute trip, not surprisingly we find that information usage is higher than average for these trips. This is particularly true for public transit trips where again the figures are inflated somewhat by the use of paper schedules. But trip distance and duration seem to be key factors: trips over 25 miles showed exceptionally high levels of information use. We posit that longer trips not only involve more variability and potential exposure to congestion, but are also more likely to include freeway travel³, where (at least in the Seattle area) traffic information coverage is most comprehensive.

Regression models

While the above discussion provides an overview of how trip-related characteristics affect the propensity to consult traveler information, it is not able to fully disentangle the *independent* effects of factors such as trip duration and mode. We thus turned to regression analysis, estimating binary-choice logit models in which the dependent variable was the choice to consult (or not consult) traveler information for a particular trip. The range of independent variables tested included the trip purpose; trip mode; trip start time, duration, and distance; the destination city (for example, Seattle vs. elsewhere); the traveler's gender, age, and employment status; and whether the traveler had a current bus pass and/or driver's license.

Despite testing numerous combinations of these independent variables, none of the models we estimated showed any real predictive power; the adjusted R-squared values were in the 0.09 range at most. The same was true for models where the dependent variable was the choice to alter (or not alter) one's travel plans in response to information obtained, again based on a wide range of trip-related and personal variables. It thus appears that the array of potential explanatory variables in our survey data is just not sufficient to model these rather complex decisions with any degree of predictive power.

More broadly, research on ATIS choices is not yet as highly developed as areas such as mode choice, where researchers have spent decades refining models of travel behavior

³ The diary data include the origin and destination for each trip, but not the exact route taken.

choices. On the contrary, ATIS research is a relatively new field and the nature of ATIS itself is still changing rapidly. Many of conclusions that have been drawn about travelers' decisions regarding ATIS (including those in this paper) are potentially quite context-specific (Bottom and Lappin 2001). In the near term, then, one promising avenue of research is not so much the development of a reliable model of the decision to use ATIS, but rather the *identification* of the relevant explanatory variables that would ultimately go into such a model. Presumably, these would be drawn from a mix of personal attitudes, demographics, and trip characteristics, and we believe the foregoing sections have highlighted some promising avenues. They would likely also encompass a number of variables describing the regional travel context, such as congestion and variability levels. The goal would be to learn which variables are most important in predicting travelers' use and response to ATIS, as well as how best to measure them, so that future data-gathering efforts can contribute to the development of sophisticated models along the lines of those that currently exist to model mode choice, route choice, and departure time choice.

CONCLUSIONS

Seattle-area travelers have a wide and growing selection of local traveler information services at their disposal – traffic and transit websites, broadcast traffic reports on TV and radio, variable message signs on the freeways, even personalized e-mail alerts. Our goal was to use our large set of trip-level data to study the usage of these sources and to assess how characteristics of the *traveler* and of the *trip* itself affect the choice to acquire information and the behavioral response to that information.

Overall, we find that use of traveler information sources remains fairly modest, with about 12 percent of respondents seeking out any traveler information over the course of their 2-day travel diary period, with the most common source of information being radio traffic reports. Looking across all of the diaries, respondents consulted information on just over 3 percent of their recorded trip segments.

We posit that these relatively low figures are due to a number of factors. First, people can only access those ATIS sources with which they are familiar, yet local ATIS service providers have had limited marketing efforts, and public awareness tends to be low. Our earlier work in Seattle found that consumer awareness levels for non-broadcast ATIS sources typically do not exceed 30 percent, even for the most well-known traffic websites (Peirce and Lappin 2003). Second, even when aware of information sources, many people hold fatalistic attitudes about traffic and are skeptical of the ability of information to improve their travel experience (Mehndiratta et al. 2000b). Third, the structure of the survey itself may have depressed the information-use figure, because reporting information usage led to a greater respondent burden. Fourth, despite the wide range of

traveler information services, most sources still provide coverage only for freeways and a few key arterials, making them unhelpful for short trips taken on surface streets. Finally, as explained in the previous section, there are significant variations in the level of information-seeking behavior among people taking trips of different types. Information usage is highest for trips that take place during the peak congested periods and on those trips – such as to work, to the airport, or to a medical appointment – where the traveler needs to be sure of arriving on time. The diary data reflect the fact that such trips actually represent a fairly small share of total daily travel, keeping overall information usage fairly low despite the well-known traffic congestion problems in the Seattle area.

This last point also jibes with the observation that the benefits from ATIS tend to be concentrated in certain geographic areas and times of day. One simulation, for example, found that 25 percent of the potential trips in the highway network accounted for 78 percent of the economic benefits of ATIS use, and that certain trips actually would experience negative benefits from ATIS (Jung et al. 2002). Given this distribution of benefits, it is no surprise that we find that travelers tend to focus their information-gathering efforts on those trips that are likely to provide the greatest benefits. For while uncertainty about travel conditions is by nature uncertain, travelers appear to have an intuition about which trips are highly variable and thus where information acquisition would be of greatest value. For example, we find that travelers are about 20 times more likely to seek out information on a long-distance, peak-hour commute trip than on an off-peak shopping trip. The use of traveler information is also geographically concentrated, with a large fraction of information-using trips destined for just a handful of areas within the Puget Sound region.

Still, the decision to seek traveler information is a complex one, and as noted earlier there are not yet any tried-and-true models of this choice as there are for other transportation-related choices, such as mode choice. This analysis was designed to highlight the factors that seem most relevant to this choice, and it indicates that both personal factors and characteristics of the trip are influential. While traditional demographics such as sex and household income have only small effects on this choice, employment status does seem to matter, as do internet usage and habitual exposure to unexpected travel delays. With respect to the trip itself, the purpose, mode, distance, duration, time of day, and geographic destination of the trip all seem to affect this choice in ways that are consistent with our expectations. While regression analysis was not able to disentangle the individual effects of each of these interrelated factors, we suspect that many of these trip-related factors are ultimately related to a common set of underlying elements:

- the availability of traveler information for the route (or mode) in question, and the traveler's comfort and familiarity with accessing this information,
- the need for an on-time arrival, and
- the traveler's perception of the *variability* and *uncertainty* of the trip time.

Uncertainty is a broad concept that means different things to different people in different situations. An office-bound commuter might use ATIS to minimize the chances of arriving late for work, while someone planning a trip to an less-familiar part of the metropolitan area may wish to access ATIS in order to reduce his uncertainty about how long the trip might take (Jung et al. 2002). Our market segmentation of Seattle-area travelers also shows that certain groups within the population are particularly concerned about unsafe weather conditions and place a high value on information in these circumstances (Peirce and Lappin, forthcoming). In the transit context, we have seen that bus riders say that they seek information in order to increase the predictability of their journeys – in other words to minimize unpleasant surprises, more so than to reduce trip time per se.

Economic theory holds that consumers will use traveler information whenever the expected benefits of doing so – such as lessened anxiety and uncertainty, or outright time savings – exceed the costs. These “costs” are generally the time and inconvenience involved with accessing the information source rather than any out-of-pocket subscription fee. To this we might add the cost of potentially having a *worse* travel experience (in terms of arrival time and congestion delay) after seeking information than one would have had without it – a scenario that can occur more often than one might expect (Jung et al. 2002). In Seattle, we find that travelers find this benefit-cost ratio attractive only on a narrow sliver of their total travel: trips with a high degree of uncertainty and/or arrival-time sensitivity, for which information is likely to be available. A good example of this is how the propensity to seek information is higher for trips of longer distance and duration, because these are proxies for both exposure to congestion (and thus uncertainty) as well as for travel on the main highways where information is available.

Policymakers may well have an interest in increasing traveler information use, as a means of promoting better-informed travel choices and as a relatively inexpensive way of mitigating congestion. But increasing usage of information will require altering travelers’ benefit-cost equation. On the benefit side, this can involve increased public awareness of the potential benefits of ATIS, but will probably also need to take the form of significant increases in data quality. Research shows that the economic benefits of traffic ATIS are inversely related to the error rate of the system’s predictions about roadway travel times, with the average benefit falling to zero once the error reaches about 18 percent (Toppen and Wunderlich 2003). This implies that providing more *reliable* data would broaden the range of trips for which travelers could reasonably expect positive benefits from consulting ATIS, a finding that is consistent with users’ subjective evaluations of ATIS systems (Mehndiratta et al. 2000a). On the cost side, the costs of accessing information can be reduced by expanding the range of media in which information is available, and by providing customized services such as one-button access to a personalized report. Our earlier research on travelers’ ATIS enhancement priorities

suggests that, out of all these potential improvements, more frequent updates and coverage of more roads would be the most highly valued (Peirce and Lappin 2003). In the absence of any of these changes, however, information use is likely to be restricted to a narrow segment of trips.

With respect to the behavioral response to information that has been obtained, in this area we are even further from specifying a definitive model of how travelers make their choices. In part this is again due to the complexity of the decision. We are also limited by small sample sizes, for out of the over 25,000 recorded trip segments, only about 260 involved a traveler seeking information and then making a specific travel change in response to the information. This may indeed be the most important finding from our analysis, namely that an overwhelming majority of trips do not involve an information-related travel change of any kind.

Our analysis of these trips does however confirm some earlier results, such as the general observation that effects on mode choice appear to be minimal. In addition, we find that demographic factors do not seem to have a major effect on this choice and that trip-related factors influence it in ways that are consistent with our expectations. For example, changes of route are more common on longer trips, where more such opportunities present themselves, and transit passengers are more apt to change their time of departure rather than their routing. In contrast to some simulation-based studies (Jung et al. 2002), we also find that changes to route are slightly more common than changes to departure time.

One key question that remains largely unanswered is why the majority of travelers, particularly on work-related trips, do not change their trips at all after consulting information. One possibility is that no substantive information is available for the traveler's planned route, or that the information indicates that conditions are near-normal (whether congested or not). Another possibility is that even in the case of a major disruption, most travelers have, or at least feel that they have, no alternatives. In the next wave of the survey, we will ask respondents who consulted information whether any information was in fact available for their route. In cases where information was available and yet they made no change, we will ask them to distinguish between cases where they did not perceive the problem to be severe enough to warrant a change, versus cases where they made no change simply because there was no feasible alternative. The responses to these additional questions can then be matched up with demographic and trip-related factors to shed further light on this decision. Ongoing research with smaller groups of travelers can also explore certain topics in more detail, for example looking at route choice by studying how drivers react to unexpected delays.

ACKNOWLEDGEMENTS

This research was funded by the office of Dr. Joseph I. Peters, Intelligent Transportation Systems Joint Program Office, Federal Highway Administration. Grateful acknowledgement is also given to Neil Kilgren of the Puget Sound Regional Council.

REFERENCES

Bottom, J. and J. Lappin. 2001. Understanding and predicting traveler response to information: a literature review. Report for the Office of Metropolitan Planning, Federal Highway Administration.

Bureau of Transportation Statistics. *1995 NPTS Summary of Travel Trends*.

Cluett, C. 2000. Metropolitan Model Deployment Initiative: Seattle, Washington travelers' use of the WSDOT traffic conditions web site. Report for Federal Highway Administration, No. 13656.

Hato, E., et al. 1995. influence of traffic information on drivers' route choice. Proceedings of the 7th World Conference on Transportation Research, Sydney, Australia, 27-40.

Jung, S., et al. 2002. On-time reliability impacts of Advanced Traveler Information Services (ATIS), Volume II: Extensions and applicability of the simulated yoked study concept. Report for Federal Highway Administration, No. 13630

Khattak, A., et al. 1999. Does travel information influence commuter and non-commuter behavior? Results from the San Francisco Bay area TravInfo project. *Transportation Research Record* **1694**: 48-58.

Lappin, J. 2000. Advanced Traveler Information Service (ATIS): Who are ATIS customers? Report for Federal Highway Administration.

Lappin, J., et al. 1994. A market analysis of the commercial traffic information business. Report for the Office of Policy Development, Federal Highway Administration.

LaScola, L., et al. 1998. Unpublished focus group research.

Mehndiratta, S.R., et al. 2000. Users of a regional telephone-based traveler information system: a study of TravInfo users in the San Francisco Bay area, *Transportation* **27**: 391-417.

Mehndiratta, S.R., et al. 2000. Who are the likely users of ATIS? Evidence from the Seattle region. Transportation Research Board, 79th Annual Meeting.

Peirce, S., and J. Lappin. 2003. Evolving awareness, use, and opinions of Seattle region commuters concerning traveler information: findings from the Puget Sound Transportation Panel Survey, 1997 and 2000. Transportation Research Board 82nd Annual Meeting.

Peirce, S., and J. Lappin, forthcoming paper on Seattle-area ATIS market segmentation.

Shafer & Koppelman, TRB ~1995 (get exact citation).

Shah, V.P., et al. 2001. Time management impacts of pre-trip ATIS: findings from a Washington, DC case study. Transportation Research Board 80th Annual Meeting.

Shofer, J., and F. Koppelman. 1997. The ADVANCE project: formal evaluation of the targeted deployment. Report for Federal Highway Administration, No. 3328.

Srinivasan, K., and H.S. Mahmassani. 2000. Modeling inertia and compliance mechanisms in route choice behavior under real-time information. Transportation Research Board 79th Annual Meeting.

Toppen, A., and K. Wunderlich. 2003. Verifying qualitative benefits of online ATIS with modeling: Los Angeles case study. Draft report for Federal Highway Administration.

Viswanathan, K., et al. 2000. Use of traveler information in the Puget Sound Region: preliminary multivariate analysis. Transportation Research Record **1719**: 94-102.

Wunderlich, K., et al. 2001. On-time reliability impacts of Advanced Traveler Information Services (ATIS): Washington, DC, case study. Report for Federal Highway Administration, No. 13335.

Yim, Y.B., and M.A. Miller. 2000. Evaluation of the TravInfo Field Operational Test. California PATH Program, Institute of Transportation Studies, University of California, Berkeley.