SECTION **3**

DEMAND AND DESIRE FOR TTI

3.1 EMPIRICAL EVIDENCE CONCERNING THE DEMAND FOR TRAVELER INFORMATION

The evidence on consumer preferences and valuations for public transit information comes from a broad spectrum of research, ranging from qualitative studies to quantitative research based on stated-preference and revealed-preference data. Aspects of customer acceptance for ITS consumer products and services have been studied by U.S. DOT's ITS Joint Program Office since the early 1990s. A major focus of this research was on ATISs, including information for existing and potential transit customers. Evaluations have been conducted of transit information–oriented deployments as part of federally supported field operational tests, the Metropolitan Model Deployment Initiative (MMDI) projects, and local transit ITS deployments. Customer satisfaction information from the MMDI programs in Phoenix, San Antonio, and Seattle was reviewed for this project, as was customer research from other local ITS deployments in the United States and Europe.

3.1.1 Interest in Advanced Traveler Information

It is readily apparent that, while many urban residents express strong dissatisfaction with traffic delays and other traffic problems, many people view those types of irritations quite fatalistically. In focus groups composed of members of the general population, commuting horror stories were heard many times, but the stories were accompanied by a belief that these experiences are an inevitable adjunct to urban living, that nothing much can be done about them, and that it is not worth getting agitated about. "There's death, taxes, and traffic," one person said early in the qualitative research.

These attitudes help to explain why, despite complaining about individual bad situations, the national surveys have shown relatively high levels of overall satisfaction with transportation system performance and a slight belief that things are improving. They also explain why people generally do not appear to be highly motivated to seek sources of traffic and travel information that are currently available to them. Many cities have websites and telephone information services that provide more detailed and up-to-date traffic information than is available from broadcast radio and television stations (the most popular source of information). These newer resources are becoming more sought after or used as time goes by. However, the broadcast media have a considerable advantage of providing very easy and immediate ("one stop") access and do not require the user's full attention. As a result, the various private-sector interests involved in generating, processing, and retailing new forms of traffic information have had difficulty in developing business models to date that make money from anything but the long-standing, brief radio/television broadcast slots and public-sector contracts (*1*). The dissatisfaction expressed with daily travel delays does not automatically translate into streams of revenue from ATIS users. Traffic and travel information has not proved so far to drive the demand for other ATIS products, and a self-sustaining business model for this information is lacking in the United States (*2*). However, as of December 2002, every state in the union has at least one Internet site that provides information on traffic conditions (and can be accessed through the National Traffic and Road Closure Information Internet site at www.fhwa.dot.gov/trafficinfo/#TRFF).

This level of apathy among the public at large does not mean that advanced traveler information has no constituency or that it will not ultimately succeed in proving its worth. There are groups of users that have been identified and surveyed who are strongly enthusiastic about this type of information. They tend to be, as might perhaps be expected, younger, better educated, and better paid than most of the population. They are more "wired" to high-technology devices. They tend to include more males than females. Information about these users is discussed in Section 3.2.2.

Moreover, recent evidence suggests that awareness of ATIS resources is growing, more strongly through the Internet than through telephone information services. As access to the Internet increases markedly, so do people's expectations of the types of information and assistance available to them. Many new users of web-based traveler information say that they went looking for it, expecting it to be there but not knowing where to look other than by using a general search engine. The most informative and popular websites, such as the one provided by the Washington State DOT showing the Seattle-region traffic conditions (www.wsdot.wa.gov/pugetsoundtraffic/), have shown a healthy growth in "hits" and have received very positive feedback from users (*3*).

It is expected that such awareness and usage will continue to grow, driven in part by increased Internet access and use and in part by public awareness of the next (critical) generation of in-vehicle navigation devices, ones that will be able to receive and process real-time traffic information. While the demand for the current generation of static devices, which are available in an increasing number of automobiles, has not been particularly strong, the automakers are hoping to drive demand by supply-side decisions.

3.1.2 Interest in Transit Information

While the subject of this subsection so far has been mostly about traffic information, many of the observations have strong transit parallels. Research on transit information is sparser than on traffic information, but many of the same attitudes can be discerned. Some of the observations presented here were derived from transit-oriented ATIS focus groups in New York City and the Bay Area and from surveying transit information and website users in Seattle and the Bay Area (*4, 5*).

Many bus delays are caused by traffic conditions, and to some extent this helps create the same mixture of customer fatalism and tolerance evident in the discussions of traffic problems. There is an initial skepticism that more or better information can do much to resolve the major sources of dissatisfaction with particular transit experiences. But when the general complaints about transit services have been voiced, it is possible to get people to concentrate on information specifically, and six consistent themes emerge:

1. Customers would like timely and honest explanations of delays when systems fail to operate as they should.
2. Information materials that are currently provided about transit services are not sufficiently detailed for their purpose.
3. Telephone information systems using human operators inevitably attract complaints about the variable quality of the service.
4. More and more transit systems are providing itinerary planning assistance via agency websites and wireless devices.
5. Interest is growing in real-time transit information, and more agencies are providing this type of information.
6. There is evidence that transit information innovations may appeal most strongly to the customers least attached to transit—the choice riders.

3.1.2.1 Explanations of Delays

People have a strong general interest in being given a timely and honest explanation and assessment of the situation when systems are not operating as they should be. This is a concern evident across all forms of public transportation, not just urban transit. Air travel delays and cancellations and the airlines' provision of information to their customers have always been debated (*6*). Passengers can understand such things as weather-related problems, equipment problems, traffic-control problems, and even crew scheduling problems. To varying degrees, they may be somewhat tolerant of these situations. However, they find it much harder to understand and forgive information deficiencies in these circumstances. Experience has taught many frequent flyers to be very distrustful about the information they are given, both because of inadequacies in the airlines' communications systems and because they perceive the information to be slanted in favor of passenger retention concerns (*7*). They know that service disruptions are a fact of life for air travelers, but they expect to be kept accurately informed about the situation so that they can make intelligent decisions about their best courses of action.

One study of the information preferences of public transportation users (both intercity and local) in the Northeast Corridor found that passengers consider information about delays to be important and that passengers tend to value en route information more highly than pre-trip information (*8*). Specifically, 83% of rail transit passengers surveyed rated en route information about train delays to be "somewhat important" or "very important," while 65% said the same of pre-trip delay information. Bus transit passengers held very similar views, with 85% viewing en route information about bus delays as at least "somewhat" important, and 65% saying the same for pre-trip information.

Most research on transit information provision has found that, as with other forms of transportation, even when travelers are unable or unwilling to make changes in their travel as a result of learning about problems, they feel that they still benefit just from knowing about the situation and having been given the option to change, to inform others of a delayed arrival, and so on.

3.1.2.2 Insufficiently Detailed Information Materials

According to transit riders, the information materials that are currently provided about transit services (e.g., maps or schedules, whether displayed at stops, in printed pocket form, or on the web) are not sufficiently detailed for their purposes. The maps do not show all of the road names along the bus routes, for example, or the locations of the individual stops. The schedules do not show the times at all of the stops. The information displayed at individual stops—when it is there at all—is not tailored to help the rider easily answer his or her main questions: "Which routes go from this particular stop? From nearby stops? Where do those routes go? When will the next bus be here?" Or, more succinctly, "How do I get to X from here?"

A qualitative survey of transit users in the Sacramento and San Jose areas examined the areas of transit information judged to be most in need of improvement (*9*). Topping the list of most needing to be improved was the transit route map, with 23% of respondents listing the map as their first choice for improvement. Information on waiting times, hours of operation, and frequency of service were also near the top of the list; while information on fares, walking time to the stations, and seat availability were judged to be less in need of improvement. This "ranking" of the importance of specific types of transit information is reflected in extensive customer research conducted in London regarding TTI over the past 10 years.

3.1.2.3 Variable Quality of Customer Service and Telephone Information Systems

Telephone information systems using human operators inevitably attract complaints about the variable quality of the service. Some operators are very knowledgeable and helpful, but others appear to require a series of questions to obtain the required information; however, talking with a human being often is preferred to listening to a recording.

Telephone menuing systems currently elicit a "love-hate" relationship from their users. Few people profess to like the general "depersonalization" of the telephone, but occasionally admit grudgingly that, despite long menu chains, there are ways to use these systems to get to the desired information quite quickly, if the information is there. The greatest customer dissatisfaction arises from having to wait and navigate through long menus only to find that the service does not answer the current question and does not have the option of diverting to human assistance.

3.1.2.4 Itinerary Planning Assistance via Agency Websites and Wireless Devices

As documented in Section 3.1.1, the last few years have seen a rapid growth in the number of transit systems providing information on the Internet, via wireless devices (e.g., mobile telephones and PDAs), and via electronic signage (e.g., DMSs at stops/stations). Most transit websites provide static information—schedules, system maps, route maps, system policies—and fare information that was previously published by the agency in hardcopy form. Many transit websites now provide itinerary planning, and several provide real-time information (e.g., Denver's Regional Transportation District and Portland's Tri-Met). Transit websites have been the subject of several current and recent projects, including the following:

- *Trip Planning State of the Practice* (*10*);
- *TCRP Report 84: e-Transit: Electronic Business Strategies for Public Transportation, Volume 4: Advanced Features of Transit Websites* (*11*);
- *Public Transport Information Web Sites—How to Get It Right: A Best Practice Guide* (*12*);
- *TCRP Synthesis 43: Effective Use of Transit Websites* (*13*); and
- *Features of Traffic and Transit Internet Sites* (*14*).

When users' opinions have been solicited about transit websites, the responses indicate an interest in itinerary planning assistance. For example, in research conducted on Seattle's King County Metro website in 2000, a large number of respondents indicated that their most pressing need was to get more assistance in planning complex trips to unfamiliar areas. Passengers asked for more detailed maps of bus routes and the neighborhoods the routes serve or, better still, door-to-door itinerary planning (*3*). Since the 2000 survey, the website (tripplanner.metrokc.gov/) provides detailed itinerary planning, as shown in Figure 1.

Users unfamiliar with a transit system do not want to have to follow the cumbersome steps of first determining which routes are relevant to their proposed travel, then consulting individual route timetables in order to identify the schedules and (they hope) specific boarding and alighting points. Rather, users expect to be able to enter their trip origins and destinations, along with a preferred arrival or departure time, and then be presented with a choice of options meeting their criteria. The many transit agencies that now provide itinerary planning on the Internet have fulfilled this need. Not surprisingly, the more complex the transit network in terms of modes, routes, carriers, possible transfer points, and fares, the more valuable this type of assistance becomes.

3.1.2.5 Increasing Interest in Real-Time Transit Information

Opinions about the value of providing real-time transit information show that the interest is growing now that more agencies are providing this type of information. For frequent bus or train services, few focus group respondents initially see much advantage, in the abstract, of having real-time vehicle arrival information available at stops. Greater potential benefits are seen with longer headway services, particularly at night and on weekends. Where such systems have been piloted, most users say they find the information helpful and regard the displays as a sensible use of transit agency funds.

In London, a survey that was carried out when the Countdown system was initiated in 1994 indicated that there was strong interest in the real-time arrival information being provided at bus stops equipped with electronic Countdown signs. The relevant findings of this survey included the following (*15*):

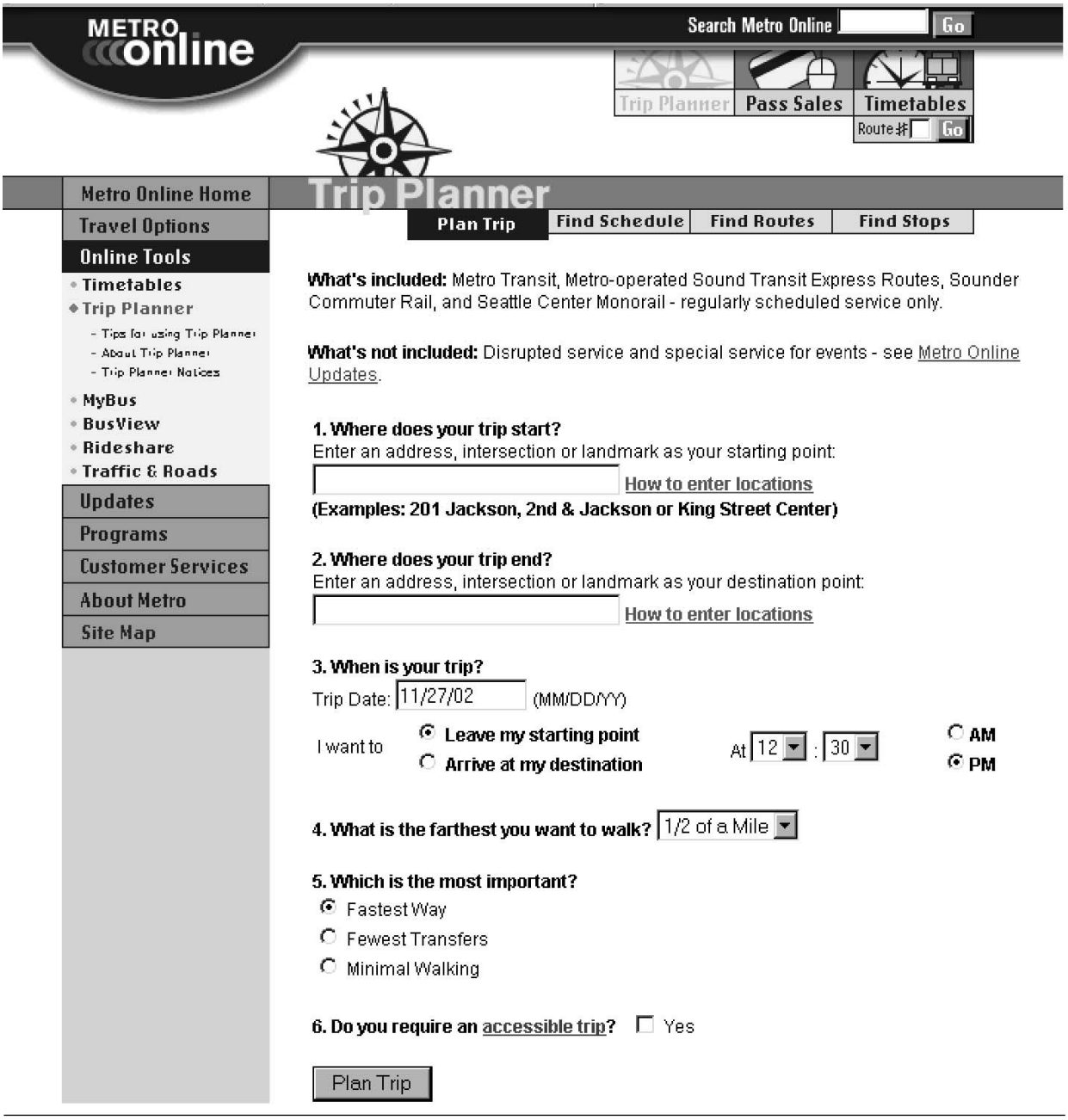


Figure 1. King County Metro's Trip Planner (December 2002).

- With real-time information displayed, passengers felt that waiting for the bus was more acceptable (89% of passengers).
- Passengers found that time seemed to pass more quickly when they knew how long their wait would be (83% of passengers).
- Passengers perceived a shorter waiting time (65% felt this was so).
- The actual bus service was perceived as being more reliable.
- Of those passengers traveling, waiting at night was perceived as being safer.
- Passengers' general feelings improved toward bus travel (68%), the particular operator (54%), and London Transport (45%).
- Almost all passengers (96%) said that countdown information is clear and easy to see and that they have no problem of any kind with the system.
- About 70% of passengers referred to the display when they arrived at the stop, about 90% looked at the sign

while they waited, and about 60% said they looked at the sign at least once a minute.

- Passengers approved of the three essential pieces of information provided (i.e., route number, destination, and waiting time); however, some baseline messages sent by Countdown controllers were not so well understood.
- There was strong overall customer support for the system—Countdown has been found to generate a minimum of 1.5% new revenue.

Also, it is worthwhile to mention that an extensive amount of market research continues to be conducted by London Buses to determine customer satisfaction with the Countdown system and the interest in future enhancements, such as providing real-time information away from the bus stop (e.g., on the Internet or on wireless devices) and the positioning of Countdown signs for best viewing. Key results of recent market research include the following findings.

- Results of 1,125 interviews with passengers waiting at 16 bus stops in northwest London included the following (*16*):
  - On a scale of 0 to 10,
    - Countdown achieved an overall usefulness rating of 7.1;
    - High-frequency stops achieved the best overall rating for usefulness at 7.5; and
    - Countdown was rated the least useful at low-frequency stops at 6.8.
  - Those respondents who had seen Countdown previously were more inclined to value its usefulness, which suggests a learning process.
  - The main reasons that Countdown was considered useful were because it gives arrival time information and it allows passengers to take alternative action.
- Results of seven group discussions in Shepherds Bush, Islington, and Bromley with regular, infrequent, and very infrequent bus users included the following (*17*):
  - Current bus users considered that it was most important to have off-system information available in their homes. Also important were points of interchange with other transport and in supermarkets.
  - There was the most interest in the availability of journey planning information rather than information relating to familiar or regular journeys. More interest was generated in static information than in real-time information.
  - Current bus users thought telephone and Teletext were the most readily acceptable means of communicating off-system bus information.
  - Customers would be prepared to pay a small fee for using any new application, but this fee should be kept to a minimum.

In June 2002, intercept surveys were conducted at four bus stop locations in Portland, Oregon, that have Transit Tracker real-time arrival information displays (*18*) (see Figure 2). The purpose of these surveys was to determine whether changes should be made to Transit Tracker and whether more

Figure 2. Portland Tri-Met Transit Tracker sign.

Transit Tracker displays would be a good value from the customers' perspective. Key survey results reveal that, at one bus stop, "100% of respondents said that they use Transit Tracker, either always (82%) or sometimes (18%)" (*19*). Further, the value that customers place on Transit Tracker was significant and is discussed is Section 3.4.

Several European transit systems have bus stop displays that indicate the amount of time until the next bus on a particular route will arrive. Researchers claim that people regard the waiting times as having decreased after the displays were introduced and that ridership has increased. However, in a survey conducted for *TCRP Synthesis 48: Real-Time Bus Arrival Information Systems* (*20*), many of the agencies indicated that it would be very difficult to ascertain whether ridership increases were solely due to the real-time bus arrival information; rather, it is usually a combination of factors that lead to an increase in ridership after such a system has been deployed. Specific findings from several of the European deployments of real-time information are discussed in Section 4.

3.1.2.6 Transit Information Innovations Appeal Most to Choice Riders

There is some intriguing—but as of yet, only fragmentary—evidence that transit information innovations may appeal most strongly to the customers least attached to transit—choice riders. In the customer satisfaction evaluation of the Seattle Metro TransitWatch real-time displays in bus terminals, there is a correlation between approval of TransitWatch and agreement with the opinion statement "As soon as I can, I'd like to switch to driving" (*21*). Two opposing hypotheses could be derived from this statement, if affirmed by further investigation: (1) that the value of information investments may be reduced by the fact that their appeal is to customers who will desert the mode anyway, and (2) that information investments may help transit to retain the very customers who are most likely to leave. In contrast, in a survey of non-transit users in rural areas across the United States (*22*), respondents showed the most interest in ITS strategies that could help them predict their travel experience: estimates of travel time, information on delays, and real-time bus arrival times. This interest in predictability was consistent with the experience respondents cited with general travel information. Here, the respondents appreciated advance notification of unusual conditions, including delays related to weather, accidents, or construction.

In summary, the initial impression regarding transit customer interest in information improvements is similar to that for traffic information, which provides an appearance of some indifference rather than of immediate and strong enthusiasm. However, based on more detailed research, it is clear that customer expectations are growing with experience (as on the traffic side).

3.2 FRAMEWORK FOR UNDERSTANDING INFORMATION WANTED BY TRANSIT TRAVELERS

In July 2000, Transport Direct—a major U.K. transportation initiative—was announced "to provide the U.K. with a travel information service that can present the public with the opportunity to compare travel options across public and private transport modes" (*23*). As part of this initiative, a comprehensive compendium of research literature and information was compiled to provide the basis for understanding travelers' needs for information, in addition to 12 other topics associated with building such an ATIS. The 13 topics areas are as follows (*23*):

1. Consumer demand for information;
2. Information requirements of the end user;
3. Embracing walk, cycle, and car information;
4. Importance of awareness and marketing;
5. Effects of information on behavior (see Section 3.3);
6. Willingness to pay for information;
7. Importance of partnership and buy-in;
8. Making the business case;
9. Media and presentation formats;
10. Feasibility of including retailing with information;
11. Technical standards and technological solutions;
12. Integration of real-time systems into travel information systems; and
13. Interpreting integration and distinguishing it from coordination.

While the U.K. markets for public transit and TTI are decidedly different than those in the United States, this categorization of key topics provides a solid framework to examine the issues associated with determining the demand for improved TTI. In Subsection 3.2, the demand for TTI will be reviewed in terms of topics: Topics 1, 2, 5, and 6 from the list above. These topics represent the critical elements that should be used in determining what information is desired by existing and potential transit customers.

Before discussing issues associated with demand in each of these topics, it is important to summarize the general demand for TTI, which was initially discussed in Section 3.1 (*24, 25*):

> Transit customers seek to lower the trip time uncertainty they commonly experience with transit. They want information that increases their control over time and travel decisions. Evaluation findings indicate that transit customers want ATIS services that provide real-time information both pre-trip and en route, good quality user interface, and convenient access to detailed system information.
>
> Conditions that suggest high demand for ATIS transit services appear to be related to the complexity of the transit network and services, the age of the transit rider population, and the level of technological sophistication of the ridership.

Younger riders expect transit information to be as easily accessed as that provided by any market-based service. Their expectations are probably conditioned by the current service economy and by information available on the Internet. Technologically sophisticated riders are aware of many of the tools available for tracking cars and buses and can easily imagine the personal benefits of real-time transit status information, in addition to the other services that advanced media can provide.

3.2.1 Consumer Demand for Information

Demand for TTI must be determined before such a service is even considered. "The general public is not well informed concerning traffic and traveler information and its potential. An insufficiently developed user understanding of traffic and traveler information limits the demand" (*26*). Research conducted for Transport Direct assessed consumer demand for information "to understand how people make use of an information service and how in turn its design can be enhanced both in terms of information content and interface" (*27*). This research highlighted seven specific issues associated with demand that should be factored into a demand assessment:

1. Demand will vary depending upon the mode for which information is being sought;
2. Demand will vary if the TTI service represents more than one mode;
3. Acceptable and maximum levels of demand must be defined;
4. There is a difference between active and passive acquisition of information;
5. There is a distinct difference between providing itinerary planning services and information or guidance on mode choice;
6. Demand for TTI services in the absence of any services is different than demand for TTI services when others services may be available; and
7. TTI features and formats will affect demand.

While all of these factors are important in determining the demand for TTI, two of these warrant further discussion in terms of how to improve TTI.

The first factor is that active and passive acquisition of information (i.e., pull/request and push/alert, respectively) must be fully understood in order to understand the demand for TTI. Several transit agencies now provide "rider alerts" that notify a transit customer of any changes to his or her typical bus route. For example, King County Metro in Seattle provides King County Alert!; users of this e-mail service can select from three options in this system to receive an alert tailored to the user's specific needs:

- **General alerts with no route-specific information**—If the user wants information about changes in multiple bus routes but prefers to limit the number of e-mails he or she receives, this is the best option. He or she will be alerted to service disruptions and advised to check the website for the most current information.
- **"Lite" alerts regarding specific bus routes**—If the user wants information about changes in a specific bus route and has reliable web access, this is the best option. The messages he or she receives will contain a few details and a link to the website for the latest details posted on the Internet.
- **Detailed alerts regarding specific bus routes**—If the user prefers to receive detailed, route-specific e-mail messages, this is the best option. Each message he or she receives will contain detailed information about a specific route.

This type of passive or push/alert information is provided free of charge, depending on the media used for receipt. (If information is received via a mobile telephone, there may be cellular provider charges associated with receiving data.)

Active information requires that the user makes an effort to seek out the information and usually needs to continually refresh the information if it is real-time (*28*). An example of active information acquisition is a passenger sending a text message indicating a specific bus stop via mobile telephone to a telephone number in order to receive a text message that indicates within 30 sec the actual arrival time of the next bus. This real-time TTI service was launched in the U.K.'s Leicestershire County in October 2002 (*29*).

Another example of active information acquisition is receiving the arrival time of the next buses at particular bus stops in Seattle, Washington (www.mybus.org). Yet another example is receiving trip-planning information in the form of text messages from London Transport (*30*). The demand for these two types of information acquisition is quite different, as is the content and medium of providing the information (*31*).

The second factor is that the distinction between itinerary planning and information on a specific mode will drive the demand for TTI. Services that provide information on a specific mode have been evaluated more often than itinerary-planning services using multiple modes since multimodal information services offering itinerary planning have not yet been widely deployed (*32*). In the U.K., a recent survey found that 32% of the general public "often find themselves in a situation when they don't know what is the best means of transport to their destination." Of this group of people, 93% indicated they were likely to use a "single enquiry service giving information about all methods of making a journey" to make decisions regarding the best travel method. In part, demand is likely to be dependent on the extent to which modal alternatives are considered viable when compared with the primary (and default) mode (*33, 34*).

3.2.2 Information Requirements of the End User

Public transit users are a diverse group of people with different demographics, and meeting their needs for informa-

tion can be challenging. Meeting the needs of individuals can be quite different than meeting the needs of the traveling public. Thus, categorizing individuals is a crucial first step in developing information requirements for TTI services. Several categorizations of end users have been identified in ATIS market research conducted over the last several years. First, the MMDI (*35*) project evaluations categorized overall ATIS customers (not just transit travelers) as follows (*36*):

- **Control seekers**—more likely to be budget conscious, to plan ahead, and to want to be accessible at all times. Characterized by very high use of technology and gadgets (including mobile devices).
- **Web heads**—have a high use of computers and the Internet at home and at work. Usage of mobile devices is low to moderate.
- **Low-tech, pre-trip information seekers**—more likely to make changes in travel patterns as a result of obtaining traveler information.
- **Mellow techies**—low usage of traveler information, but high usage of computers and the Internet.

There is no doubt that these categories could be used to define TTI users. Other categorizations include those identified in research conducted by London Buses Limited (*37*). This research yielded three categories of information users: phobics, lovers, and pragmatists.

No matter which categorization is used, there are other factors that will lead to determining information requirements. Based both on survey research evidence and on detailed consideration of transit travel mechanics and characteristics, a number of different factors can be identified that help determine the types of information that might be desired by transit travelers. Such factors include the following:

- **Stage of the journey.** The type of information needed depends on whether the passenger is planning a trip, is currently en route, or has arrived at an intermediate or final destination.
- **Familiarity with the system.** Tourists and visitors with little knowledge of either the city or its transit system have different needs than locals, even those locals who are only occasional riders. Frequent riders need less information on system policies and services, but are likely to seek out more detailed information on current operations.
- **Trip frequency.** For an infrequent or unfamiliar trip, travelers need more in the way of itinerary planning and basic service information than they do for a commute trip.
- **Nature or purpose of the trip.** The type of trip determines passengers' flexibility with respect to timing, rerouting, making intermediate stops, and so forth. When schedules are tight, such as on business-related trips, travelers may demand more specific, up-to-date information than they would for a weekend shopping trip. And when times and destinations are flexible, passengers will tend to want more information on their alternatives.
- **Accessibility requirements.** These requirements include accommodation for passengers with disabilities as well as provisions for passengers with luggage (*38*) or heavy parcels. Station access—for example, information on the storage of cars and bicycles at stations—is very important for travelers who anticipate driving or cycling to the station.
- **Safety concerns.** For some passengers, knowing where to wait for the train or bus safely, which stations are unattended at night, and so on, are key considerations.
- **Comfort with complexity and technology.** The travelers' level of comfort with complexity will determine whether they would prefer, for example, to receive a single, simplified route to their destinations or more detailed information about all the possible options. Their comfort with technology will also dictate the media through which they prefer to receive the information.
- **Lifestyle and demographics.** The demographics of the user (e.g., income, automobile availability, etc.), the availability of multiple modes, the monetary value of time savings, and personal attitudes toward schedule planning and delays all affect the type of information desired.

Figure 3 represents these eight factors in two main categories: (1) those that are driven by the nature of the journey itself, and (2) those that are driven by the personal characteristics and wishes of the person desiring the information. In addition to these factors, characteristics of the information should be considered as well in determining what kind of TTI is needed or desired by users. These characteristics should include the following (*39*):

- Accuracy—correct information;
- Timeliness—current information, received in time to permit travel changes;
- Reliability—source of information is comprehensive and consistent in quality;
- Costs—both one-time and recurrent;
- Level and personalization of decision guidance—information that is sufficiently detailed and personalized;
- Ease of access of the specific information needed—time required to access information and necessary level of attention; and
- Perceived safety implications—information that protects the user from an insecure or unsafe situation.

The evaluation of TransitWatch, which was conducted as part of the Seattle MMDI evaluation, sought information on how the system could be improved among other customer satisfaction factors. (TransitWatch was the name given to the

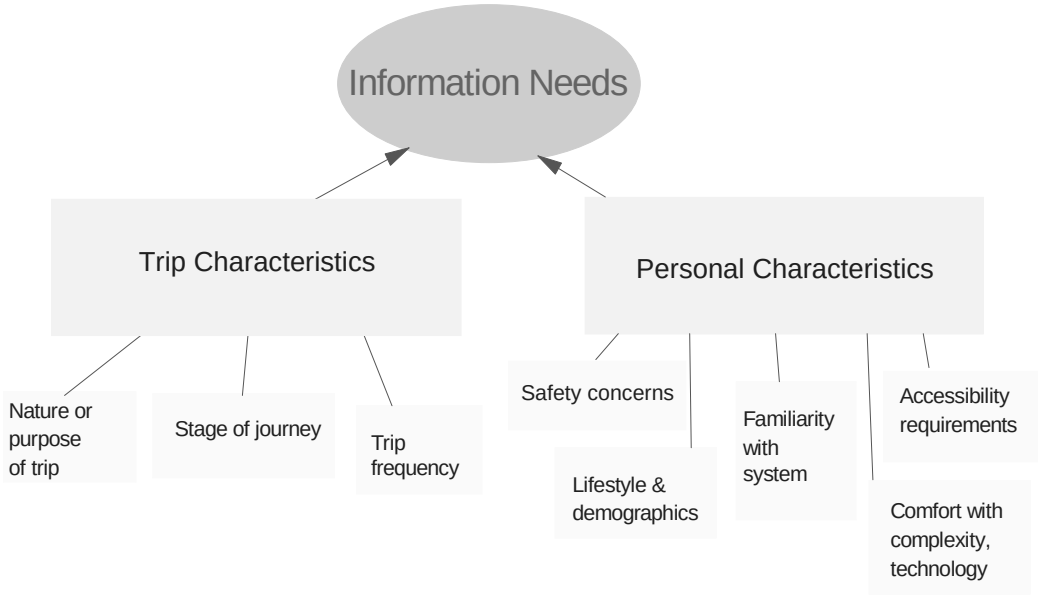
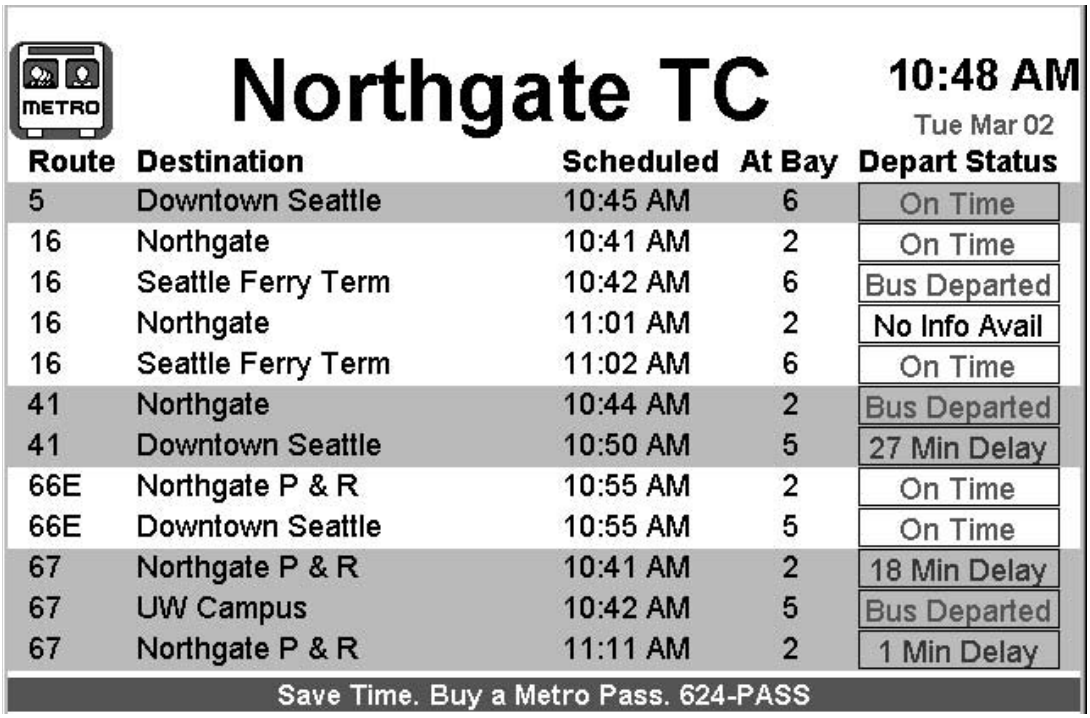


Figure 3. Factors affecting transit passengers' information needs.

video monitors located at the Bellevue and Northgate Transit Centers in the Seattle area that display real-time transit information on arrival times and bus bay locations [see Figure 4].) Those survey respondents who had suggestions about improvements "mentioned improved accuracy the most often" (*40*).

Further, in a web-based transit ATIS evaluation, survey respondents sought the following improvements (*41*):

- Real-time transit information on web, by phone, at bus stops, and on monitors at malls and office parks near major transit centers;
- More sophisticated and detailed web interfaces;
- Point-to-point itineraries;
- Point-to-point itineraries for multimodal trips;
- Recommended trip times and routes for fastest travel;



Route	Destination	Scheduled	At Bay	Depart Status
5	Downtown Seattle	10:45 AM	6	On Time
16	Northgate	10:41 AM	2	On Time
16	Seattle Ferry Term	10:42 AM	6	Bus Departed
16	Northgate	11:01 AM	2	No Info Avail
16	Seattle Ferry Term	11:02 AM	6	On Time
41	Northgate	10:44 AM	2	Bus Departed
41	Downtown Seattle	10:50 AM	5	27 Min Delay
66E	Northgate P & R	10:55 AM	2	On Time
66E	Downtown Seattle	10:55 AM	5	On Time
67	Northgate P & R	10:41 AM	2	18 Min Delay
67	UW Campus	10:42 AM	5	Bus Departed
67	Northgate P & R	11:11 AM	2	1 Min Delay

Figure 4. Seattle TransitWatch® display.

- Detailed maps of routes, with stops, and transfer locations; and
- Secure on-line bus pass purchases.

It is interesting that many of these TTI improvements (with the exception of travel times) have been made around the country at various transit agencies since this evaluation was conducted, most notably in Denver; the San Francisco Bay area; New Jersey; and Washington, D.C.

3.2.3 Effects of Information on Behavior

Quantitative assessment of how the use of information changes travel behavior is still in its infancy, and analysis concerning transit information in particular is especially sparse. There is a little stated preference evidence resulting from direct survey questions about travel changes in response to information acquisition, but there are concerns about whether response biases lead to inaccuracies in such surveys (*42*). For example, in a survey about commuter usage of information designed for the Puget Sound Regional Council, between 24% and 28% of bus and ferry commuters said that they were likely to change their departure time as a result of pre-trip information, 10% to 16% were likely to switch mode, and 11% to 14% were likely to change their routes. Also, mean concurrence with the statement "When waiting, I'm happier if I know when the bus will come" was +3.9 on a scale of −5.0 to +5.0 (this was the highest absolute mean score for any attitudinal statement asked).

Recent research on changes in behavior caused by information suggests that the number of travel alternatives beyond a traveler's primary travel choice drive the change in behavior. This behavior can change in the short-term, long-term, or both. Other research shows that TTI results in mixed and contrary effects on behavior. Most of the research conducted to measure changes in behavior primarily are for traffic information, so it is challenging to make assumptions about the effects of TTI on behavior. The small body of research, including *TCRP Synthesis 48* (*20*), shows that behavior may change for choice riders and that many systems say that TTI systems result in an increase in ridership. However, this resulting change in ridership cannot necessarily be quantified, even though agencies claim an increase.

3.2.4 Willingness to Pay for Information

Several of the previously cited sources indicate that while this subject has been mentioned in the research, the research on willingness for a user to pay for traveler information has yielded mixed messages. In the U.K., various surveys produced stated willingness-to-pay estimates ranging from 0.9 pence ($0.01) to 26 pence ($0.41) per trip. The most reliable of these surveys seems to indicate a valuation of about 9 pence ($0.14) per trip. Overall, the financial projections for London Transport (or Transport for London, as it is now called) indicated a revenue increase of about 1.5% on Countdown-equipped lines and showed the business case to be justified at consumer valuations of about 2 pence ($0.03) per trip and over. Likewise, Helsinki's Promise information program found user valuations to average about 6.5 Euro ($6.48) per month, or 50¢ per request.

It is possible that improved TTI will have to be supported by user fees or fare increases in a declining economy. Because no existing TTI services have a charge associated with them (except for a third-party charge, such as a mobile telephone charge for receiving or sending text messages), it is difficult to assess whether existing and potential transit customers will be willing to pay for improved TTI.

In one particular case in the greater Washington, D.C., area, a provider of traveler information discontinued its telephone-based service after 6 years in operation (its website is still in operation for the D.C. area) (*43*):

> Local governments spent $8 million on SmarTraveler, calling it an essential public service in a region plagued by traffic jams. The money was supposed to cover start-up costs until the private operator could turn a profit. Five other areas also invested millions in SmarTraveler, but all have abandoned it as a profit-making venture.

In 2000, an average of 12,000 phone calls were made per month to SmarTraveler in the D.C. region, which has a population of more than 5.4 million people. By the summer of 2002, the average number of monthly calls dropped to 5,000.

In this case, there was a combination of factors that led to the demise of this service in the D.C. area. First, system users were unwilling to pay for personalized services, such as e-mail or mobile device alerts. Second, users were demanding more detailed and reliable information, which was not being provided by the service because the technology infrastructure was not robust enough. Third, the ability to make a profit was hampered by a lack of advertising and other revenue. SmarTraveler is still in operation in several regions, including Boston and south Florida, because they are funded by public entities.

3.3 WHAT DO TRANSIT CUSTOMERS WANT TO KNOW?

On a practical level, the improved TTI wanted by existing and potential passengers varies most along three of the eight fundamental dimensions shown in Figure 3 (Section 3.2.2):

1. The **type of traveler,** and his or her level of familiarity with the transit service;
2. The **nature of the trip,** primarily in terms of what other travel options (or even nontravel substitutes) may be available to the traveler; and

3. The particular **stage of the journey** (location, point in time, or both) in planning or making the trip at which the information is being sought.

3.3.1 Type of Traveler

Regarding variation by the type of traveler, riders with trips that they make frequently often need little basic (or "static") information about the routes, schedules, transfers, and fares they might encounter in the course of their most customary journeys. It is important to remember, however, that even frequent transit customers may still need information in connection with trips they take infrequently.

On the other hand, very infrequent or neophyte riders may have significant needs for information just to find their way to the appropriate route and stop, to determine schedules and return trip options, to identify the appropriate fare, and so on. For these unfamiliar or less frequent trips, itinerary planning services—detailed, point-to-point directions generated by trip-planning and geographic information systems (GIS) software—can be especially useful. As described in detail in the previous section, such services can be provided via Internet websites, wireless devices, electronic signs at stops or stations, kiosks, or interaction with telephone operators.

It is likely that both frequent and infrequent riders can take advantage of real-time information during their trips—for example, by making use of at-stop displays reporting vehicle arrival times. The primary distinction may simply be in the level of supporting navigational information that will be necessary.

3.3.2 Nature of the Trip

Regarding the nature of the trip, a traveler's information wants may depend on the available options for travel or his or her "degrees of freedom" for the trip. Information content and timeliness needs to be oriented toward the types of alternatives a traveler may consider at different stages of planning or making a transit trip. These types of available options are illustrated in Table 1. Choices of destination, mode, route, departure time, and even whether to take a trip illustrate the "degrees of freedom" available to the traveler. Moreover, those travelers with significant flexibility (or higher degrees of freedom) may need more information in order to make an informed travel decision. A traveler considering options in the time of travel or in the travel mode may a need a great deal of content, in a timely manner, at the point of decision. On the other hand, travelers with little or no travel options may not require the same quantity or detailed level of detail of information as those with greater flexibility.

A different version of this table, showing the relationship between travel characteristics and dissemination media, was produced for the FTA ATIS Human Factors Project discussed in Section 1.1, as shown in Table 2. Also, while information may have a significant effect on helping people make their travel decisions, the overwhelming evidence to date also suggests that both static and real-time information may have significant value to customers even when it does *not* lead to any changes in actual travel behavior. Information may have the effect of simply reducing the potential anxiety of the trip for the traveler. Examples include a passenger calling ahead to announce his or her late arrival, the traveler taking shelter from inclement weather until a time nearer to the

TABLE 1 Choices available to transit customers at various stages of their journeys

Stage of the journey	Type of choice					Information desired	Potential delivery platforms
	Go/no go?	Destination	Mode	Route	Departure time		
Before leaving home on a commute trip	Sometimes	Rarely	X	X	X	Updates on service disruptions, delays	Telephone, cable TV, Internet
Before leaving work for home	Rarely	Sometimes	X	X	X	Updates on service disruptions, delays	Internet, telephone
Before leaving on a trip for non-work purposes	X	Rarely	X	X	X	Point-to-point itinerary planning; operations updates	Telephone, cable TV, Internet
Rail station entry, before paying the fare	X	X	X	X	Rarely	Estimated travel times (including wait and transfer times) to potential destinations	In-station display
Station platform or bus stop	Rarely	X	Rarely	X	X	Vehicle arrival time	At-stop display
Intermediate transfer points	Rarely	X	Sometimes	X	X	Vehicle arrival times, routing information, transfer instructions	Kiosk, at-stop display

TABLE 2 Relationship between travel characteristics and dissemination media

	When / Where			What		How		
	Pre-Trip	Wayside	In Vehicle	Trip Planning	Real-time	Portable	Interactive	Custom
Printed Material	X	X	X	X		X		
Telephone	X			X	X		X	
Cellular Phone	X	X	X	X	X	X	X	
E-mail	X	X	X	X	X	X		X
Handheld Device	X	X	X	X	X	X	X	X
Internet Website	X			X	X		X	X
Kiosk	X	X	X	X	X		X	
Television	X				X			
Video Monitor		X			X			
Message Sign		X	X		X			
Annunciator		X	X		X			

bus's arrival, or the traveler who is just more satisfied with the system because the traveler felt he or she was given an honest and understandable explanation of a delay.

3.3.3 Stage of the Journey

Finally, and perhaps most importantly, information content requirements vary based on the stage of the traveler's journey. The very time consumed by making the trip means that conditions may change while en route, and information content and format need to change as a result. Before setting out, travelers who are planning a trip need information on available travel modes, the location of the nearest stop, and schedule information. Such information is often provided through printed schedules and their online equivalents, but can also be complemented with itinerary-planning services available over the phone or by accessing a website. Those travelers at the bus stop may be concerned about when the bus may arrive or even whether they are waiting for the right bus—information that can be provided by means of at-stop signs or monitors listing bus routes and estimated arrival times. Once on board, travelers may be concerned about the timing of a transfer connection, identifying the alighting stop, or how to get from there to the final destination. Automatic onboard annunciators can provide this kind of stop location and transfer information to passengers.

To identify traveler's information wants or needs, one must look at what information customers would like to know, when, why, and by what means. Tables 3 through 6 illustrate one means of categorizing the desired information. At various stages in their journeys, travelers may need different types of information in various formats. The elements in these tables suggest that people making occasional or infrequent transit trips may need more elementary orientation and navigation information than do regular customers, but both groups can also benefit from "real-time" information about current system performance. Those who travel frequently may have little need for navigation information, but a greater interest in learning about *variations from the expected performance* of the transit service.

3.4 EVIDENCE ABOUT HOW CUSTOMERS VALUE INFORMATION IMPROVEMENTS

As implied in Section 3.2.3, surveys about changes in behavior caused by TTI provide little direct evidence of consumer valuations of specific information enhancements. To find such evidence, other sources need to be reviewed (mostly from Europe). Many European projects (e.g., Italy's Telematics Technologies for Transport and Traffic in Turin) have attempted to quantify valuations through the use of both stated preferences and revealed preferences (i.e., changes in observed behavior).

Trials of the London Bus Countdown system (real-time bus arrival time information displayed on electronic signs at bus stops) provide some evidence on the reactions of transit users to information enhancements. With the Countdown system in place at bus stops along Route 18, mean perceived waiting time fell from 11.9 minutes to 8.6 minutes, and 65% of passengers felt that they waited a shorter time (even though actual waiting times did not change significantly) (*15*). The results of trials for other routes were less dramatic, but even so 21% to 24% of passengers felt that they were waiting less. Other customer surveys have shown that 89% of respondents state that waiting itself is more acceptable at stops equipped with Countdown.

TABLE 3 Sample information desired by transit customers: pre-trip

Occasional Trips	Both Occasional and Frequent Trips
What routes are near my home, work, and other key locations, and what destinations can I reach by transit from those points? Where is the closest stop or station? What are the schedules for the services that stop there? Can I go to an intermediate destination? Is a transfer required? When and how can I get back home? Do I have multiple route or transfer point choices to get to this particular destination? Which will get me there fastest, or most reliably, or with least hassle? When should I leave my trip origin location? How long will I have to wait for service? When will I arrive at my destination? What will the total trip time be, compared with other modes (e.g., walking, cycling, taxi, driving)? How do I get to the station or stop? Is parking available nearby? Are bike racks available? Will I be allowed to take my bicycle on the bus or train? How much will I pay? Overall, how much will it cost compared with other modes? Where and how do I pay? Do I need to use certain forms of payment? Will I be able to navigate the system in a wheelchair, or with a stroller or luggage? Which routes or boarding points will have the fewest obstacles (stairs, faregates with no luggage provision, etc.)? Is the system safe? Are there particular lines or areas to avoid?	Are there disruptions to the usual schedule? How are alternative modes or routes performing today? Can I improve my trip by leaving earlier or later, taking an alternate route or mode, or going first to an intermediate destination? What's the best way to get to the station today (e.g., by walking, driving, cycling)? What will the total trip time be when I travel today, compared with other modes (e.g., walking, cycling, taxi, driving)?

TABLE 4 Sample information desired by transit customers: at station or stop

Occasional Trips	Both Occasional and Frequent Trips
What is the fare? What is the payment system? Do I need to use certain forms of payment? Will I save money by buying other than a single-ride fare? How will I recognize which bus or train is mine?	When will my train or bus get here? Which of the alternative trains or buses currently available here (e.g., different routes, express or local services) will get me there first? Will the next bus or train be less crowded than this one? When will it get here, and when will it get me to my destination? If my bus or train doesn't arrive here on time, should I continue to wait, switch to a different mode, or give up altogether?

TABLE 5 Sample information desired by transit customers: onboard or transferring

Occasional Trips	Both Occasional and Frequent Trips
If I have several transfer point options, how do they compare (travel times, reliability, personal safety, walking distance, comfort, etc.)?	What is causing this delay, and how long will it last?
How do I navigate at the transfer point or station?	When will my connecting train or bus arrive?
Do I need to pay to transfer? How do I obtain whatever I need to prove my transfer validity?	How do I navigate the station or system so as to minimize physical barriers?
When should I start getting ready to alight?	
Where should I position myself (on platforms, in vehicles, etc.) to make my trip most expeditiously (e.g., maximize my chance of a seat, minimize my connection time, etc.)?	

Passengers also claimed to have waited for a bus indicated at a Countdown stop when they would not have waited at a normal stop, in proportions ranging from 23% to 66%. Between 83% and 93% of interviewees felt that the Countdown system should be introduced on all London routes, and between 53% and 68% of respondents claimed that their attitude toward bus travel had improved as a result of the system.

Surveys of the users of Southampton's Stopwatch project (which provides bus arrival time information via variable message signs at bus stops) indicate that about 3% of riders, on net, plan to use the bus system more often as a result of having this information (*44*). Again, because this is only a stated preference response, it may be unreliable because of noncommitment bias, strategic bias, or other sources of response bias and error. However, it does seem to be supported by the results of other studies. For example, with the introduction of the Phoebus system in Brussels and Angoulème, increased ridership of about 5.8% was observed on bus lines equipped with real-time information about waiting times (*44*). This is consistent with other trials, such as that in Liverpool, in which ridership purportedly increased between 5% and 6% on lines equipped with at-stop displays. Other evidence on consumer response comes from Turin, which has seen a 3% shift in favor of public transport since the introduction of its Telematics Technologies for Transport and Traffic in Turin information system.

The Countdown and Phoebus projects also give some insight into the specific ways in which passengers use and respond to wait-time information. Countdown studies showed that about 90% of passengers look at the sign while waiting and about 60% look at the sign at least once per minute. With Phoebus, studies found that 2% of passengers go back home, 4% decide to walk, and 10% change mode as a result of the at-stop information. Other information relating to the value that customers place on improved TTI can be summarized as follows:

- In the Infopolis 1 project (*45*), users' responses to Countdown and Infobus (in Turin, Italy) indicated that the vast majority (more than 90%) said that they were

TABLE 6 Sample information desired by transit customers: at arrival station

Occasional Trips	Both Occasional and Frequent Trips
Where is my destination relative to the stop or station? What is the best way to get there?	Where are the elevators in this station? Where is the cabstand? The bus stop?
Where can I get a taxicab or make another intermodal connection?	
Can I reconfirm my return trip information?	
Is there an elevator to street level? Where can I exit to minimize physical barriers?	

either very satisfied or satisfied with the systems, while only 6% stated that they were not satisfied by the overall function of the systems.

- Infopolis 2 reported on a study that was carried out in France 6 months after the launch of the Digiplan device (*46*). The results provided included (*47*)
  - 50% of users of Digiplan used public transportation afterwards;
  - After consulting Digiplan, 3% of the users decided to use public transportation even though they had no definite intention of using it at the beginning; and
  - Similarly, after a first attempt at using the device (which was a "self-training" session), 8% of users took public transportation for a future trip, for which they again used the kiosk system.
- Customer satisfaction with TravInfo®—an ATIS providing information on traffic conditions and multimodal travel options to the public in the San Francisco Bay Area—was high (*48, 49*): 80% of users were repeat users of the service. Initially, during the field operation test, less than 1% of TravInfo callers asked to be rerouted to the transit menu after hearing about bad traffic conditions. After the field operational test, 5% were rerouted. Furthermore, 12.4% changed both departure time and route after making a call to Traveler Advisory Telephone System (TATS); 19.5% changed departure time; and 9.7% changed route only. High remarks were given to the system by 71.4% of users, while 41.9% thought that the system was better than radio or television.
- Surveys in Brussels show user satisfaction on Phoebus to be 90%. The systems are regarded as being very user-friendly, and display readability is felt to be excellent. The Brussels experience is that the use of public transportation on the lines equipped with these displays has increased by 6%.
- In Helsinki, 71% of the tram passengers and 83% of the bus passengers noticed the traveler information displays at their respective stops (*50*). The displays were regarded as useful by 66% of the tram passengers and 78% of the bus passengers. The most desirable features of the display were knowing the remaining wait time and knowing if the expected vehicle had already passed.
- In Glasgow, Bustime user feedback in surveys has been extremely positive. There is 98% acceptance, and 46% of users say that they would be encouraged to use the bus service more often because of the system (*51*).
- A survey that was carried out in 1997 and 1998 on the Timechecker system in Liverpool included the following results (*51*):
  - The Timechecker system led to a 5% increase in patronage on routes where Timechecker was installed;
  - 68% of passengers used Timechecker consistently;
  - The system claimed a 90% accuracy;
  - 85% of users believed that the use of Timechecker made waiting more acceptable; and
  - 87% felt that Timechecker gave a feeling of reassurance.

In an initial survey conducted about the Transit Tracker system, the results revealed the following (*52*):

- 73% reported that the bus was usually on time;
- 91% are satisfied or extremely satisfied with bus adherence to posted schedules;
- 97.3% feel secure while waiting at the bus stop during the day;
- 63.3% feel secure while waiting at the bus stop during the night; and
- 91% are satisfied or extremely satisfied with bus service.

Key findings from the aforementioned second survey of Transit Tracker users in Portland, Oregon (see Section 3.1.2) show that "passengers place a very high value on having Transit Tracker at their stop. Because of this, it is logical to assume that customer satisfaction will increase with the placement of more Transit Trackers throughout the system" (*53*).

Given the results of most of these surveys, which show that transit customers place a high value on TTI, particularly real-time information, one technique has been developed to predict "how customer satisfaction increases with the presence of the information system at bus stops and, in particular, with its performance" (*54*). This model could be used in the future to determine whether introducing real-time information at a transit stop or station would increase overall customer satisfaction with the transit service.

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