Assessing Users' Needs for Dynamic Ridesharing

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The findings of three user assessment methods that were used to gather information on commuter needs and preferences for the Bellevue Smart Traveler (BST) Traveler Information Center (TIC) are presented. The goal of the BST TIC is to reduce congestion in downtown Bellevue, Washington, by providing a new alternative to single-occupancy-vehicle commuting. The TIC's main function will be to help commuters form dynamic rideshare groups, in addition to providing traffic congestion and transit information. The current TIC design reflects the preferences and needs of its potential users as revealed by the assessment methods described. The strategy behind the development of the prototype BST TIC has been to (*a*) base its design on users' travel needs and (*b*) integrate existing technologies that enable an automated system to work efficiently and effectively. This prototype will be demonstrated and tested in a selected area of downtown Bellevue. Throughout the demonstration, researchers will solicit input from participants and, whenever possible, modify the BST prototype to meet their needs. The kind of user assessment presented is necessary for the design of efficient transportation information systems to appropriately meet the needs of commuters.

Much of the traffic congestion in urban centers can be attributed to large numbers of workers traveling in single-occupant vehicles (SOVs) to densely clustered downtown office buildings. A conventional method of dealing with this kind of congestion is to encourage high-occupancy-vehicle (HOV) commuting. However, this method has been unsuccessful at times, perhaps because of the flexibility, convenience, and other attractions of SOV travel, as well as commuters' lack of detailed knowledge of how to participate in HOV travel. For example, despite community and corporate efforts to encourage alternative travel in Bellevue, Washington, more than 80 percent of commuters travel in SOVs.

New approaches to HOV commuting may make it more attractive to current SOV commuters. One approach is to use innovative communication technology to provide commuters with the means to easily arrange for HOV commuting to and from their downtown office buildings. Bellevue Smart Traveler (BST) is a national intelligent vehicle highway system (IVHS) demonstration project developing such an approach. Under BST, a team of researchers at the University of Washington is working with the Bellevue Transportation Management Association (TMA) and with pager-service providers (PacTel, Tele-Page Northwest, and Seiko) to develop a prototype traveler information center (TIC), which is being implemented and tested in Bellevue Place, a downtown Bellevue office building. This center will integrate phone and paging technology to deliver three types of personal commuter information: (*a*) dynamic ridematching information, (*b*) up-to-the-minute traffic congestion information, and (*c*) transit information. A detailed description of the BST TIC design is given by Haselkorn et al. (*1*).

The research team began this project by conducting a survey of commuters traveling to and from the test site. They team also conducted telephone interviews and held focus group sessions. Results of the initial research are guiding the design and development of BST's information services.

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ASSESSMENT OF POTENTIAL USERS

To determine current commuting habits and needs, the team conducted a survey of employees at the test site, Bellevue Place. The survey gathered data on the employees' current knowledge and use of HOV modes, their information delivery preferences, and their general interest in the types of information that will be offered through the TIC. After results of the survey were analyzed, telephone interviews were conducted to elicit feedback regarding potential program features. Focus groups were then conducted with employees who did not participate in the survey to determine how well they would respond to a dynamic ridesharing program. This section presents the findings from each user assessment method and, on the basis of these findings, makes recommendations about user requirements for the planned traveler information center.

Survey Results

The survey sought to determine how knowledgeable the employees at the test site were about alternative HOV modes. From the results, it was determined how detailed the information that was provided should be. If the employees were already highly knowledgeable about alternative modes but were not using them, the task would then be to motivate them to do so (in addition to simply providing information). To help design the BST ridesharing program, employees were asked how important various ridesharing features would be in making their decision to join a ridesharing program. Determination of the importance of safety issues to the participants was a specific aim. The survey also determined how participants would prefer to sign up for a ridesharing program and how they would like to receive ridematch information.

About 1,200 surveys were distributed to 54 companies at Bellevue Place; 420 people from 45 companies responded. The data were analyzed using Statview 4.0 for the Macintosh. Frequencies were calculated for all variables for the total sample. Because a large group of survey respondents worked for a major hotel at the site, tests of significance were run to determine whether there were any statistically significant differences between respondents who

TABLE 1 Familiarity with HOV Modes

Item	Percent		
	Familiar with	Use	Unfamiliar with
Route number of most convenient bus to work	31.66	11.31	57.03
Departure time(s) of most convenient bus from work	29.15	—*	70.85
Departure time(s) of most convenient bus from home	28.39	—	71.61
Arrival time(s) of most convenient bus at work	28.89	—	71.11
Arrival time(s) of most convenient bus at home	28.14	—	71.86
Amount of fare needed to ride bus	36.27	—	63.73
Available carpooling/vanpooling programs	25.88	4.77	69.35
Park and Ride lot closest to your home	66.58	6.53	26.89
Location of nearest bus stop to work	51.00	11.31	37.69
Location of nearest bus stop to home	49.50	10.80	39.70

* Data not applicable.

worked for the hotel and those who did not. Gender and income differences were assessed with *t*-tests for interval data, Mann-Whitney tests for ordinal data, and χ^2 tests for nominal data. Results reported here are significant at an alpha level of 0.05. Because of the large number of variables analyzed, only variables that are relevant to user requirements and system features are reported.

Employees' Current Commuting Schedules

A total of 78 percent of the survey respondents reported arriving at Bellevue Place between 6 and 10 a.m., with nearly 60 percent arriving between 7 and 9 a.m. Approximately 77 percent reported usually leaving Bellevue Place between 3 and 7 p.m., with 53 percent leaving between 4 and 6 p.m. Respondents could vary the time they started work by an average of 21.21 min [standard deviation (SD) = 32.82, standard error (SE) = 1.7, median = 10.0] and the time they left work by an average of 27.39 min (SD = 35.85, SE = 1.9, median = 15.0).

Prior Knowledge of HOV Modes

Respondents indicated whether they were familiar with or used the items given in Table 1. More than half the respondents were unfamiliar with the route number of the most convenient bus to work, and more then two-thirds were unfamiliar with the departure and arrival times of the most convenient bus to or from work or home. Nearly two-thirds were also unfamiliar with the fare needed to ride the bus.

More than two-thirds of the respondents stated that they were unfamiliar with available carpooling/vanpooling programs. However, a later question cast some doubt on respondents' initial claim of unfamiliarity with ridesharing programs. Although only 26 percent of the respondents said that they were familiar with available carpooling programs, 47.33 percent indicated in a later question that they would know how to sign up for a carpooling/vanpooling program if they wanted to join one.

Transit and Ridesharing Interest

In response to the four types of transit information given in Table 2, more than one-quarter of the respondents said that they would be likely to commute by bus if various types of transit information were readily available to them at home and at work. For each of the information types given in Table 2, individuals who made less than $20,000 annually were significantly more likely to commute by bus if they had transit information than were those who made more than $40,000.

Respondents were asked to rate how likely they would be to use the ridesharing types given in Table 3 if these types of ridesharing were readily available in Bellevue Place. Nearly 24 percent said they would be moderately to very likely to carpool/vanpool on a regular, scheduled basis. Respondents who made less than $20,000 annually were significantly more interested in this type of carpooling than were respondents who made over $40,000 per year. About 21 percent of all respondents said that they would be moderately to very likely to carpool/vanpool for special trips on an on-demand basis. Of the three types of ridesharing described, carpooling/vanpooling to or from work on an on-demand basis was the most popular: nearly 35 percent of all respondents said that they would be moderately to very likely to use such a form of ridesharing if it were available in Bellevue Place.

Importance of Ridesharing Features

Respondents were asked to rate how important the ridesharing features in Table 4 would be in making their decision to join a carpool or vanpool. If respondents already carpooled or vanpooled, they were asked to rate how important these features were to them currently.

Having a guaranteed ride home was by far the most important ridesharing feature to respondents, with approximately 62 percent rating it very important. The second most important feature was saving time over their current transportation mode with 48 percent rating it as very important. Reducing pollution and having their preferences met were the third and fourth most important features, respectively.

Several ridesharing features related to safety issues: knowing other participants, meeting other participants before forming a carpool/vanpool, participants being co-workers, and participants being prescreened. Of these safety features, participants being prescreened appeared to be the most important to respondents, with 53.54 percent responding with moderately to very important. All of the safety features were significantly more important to lower-income respondents than to higher-income respondents.

TABLE 2 Likelihood of Commuting by Bus

Likelihood of commuting by bus if the following bus information were provided:	Rating (in percent) Very likely	Moderately likely	Slightly likely	Not at all likely
Scheduled bus departure time from your stop near home/work				
All	11.71	15.32	21.32	51.65
Under $20,000 income	22.58	17.74	29.03	30.65
Over $40,000 income	7.15	10.71	10.71	71.43
Exact current location of your bus				
All	12.20	15.85	19.50	52.44
Under $20,000 income	21.67	21.67	25.00	31.67
Over $40,000 income	8.93	12.50	8.93	69.64
Actual bus arrival time at your stop near home/work				
All	11.78	16.01	21.15	51.06
Under $20,000 income	22.58	17.74	30.65	29.03
Over $40,000 income	5.36	14.29	10.71	69.64
Detailed route and transfer information between your origin and destination				
All	10.19	15.43	20.37	54.01
Under $20,000 income	17.24	20.69	29.31	32.76
Over $40,000 income	7.27	12.73	7.27	72.73

TABLE 3 Likelihood of Carpooling

Likelihood of carpooling if carpooling/vanpooling were available:	Rating (in percent) Very likely	Moderately likely	Slightly likely	Not at all likely
To or from work on a regular, scheduled basis				
All	10.65	13.12	17.21	59.02
Under $20,000 income	14.67	24.00	21.33	40.00
Over $40,000 income	3.28	4.92	19.67	72.13
For special trips on an on-demand basis	8.22	13.03	16.43	62.32
To or from work on an on-demand, flexible basis	12.50	22.01	17.66	47.83

Preferences for Sign-Up Methods

Respondents were asked how they would prefer to sign up for a carpool/vanpool program and receive ridematch information. The three most preferred sign-up methods (in order) were: in person, interactive computer in Bellevue Place's lobby, and interactive phone system. The most preferred methods for receiving ridematch information were (in order): mail, in person, and interactive computer in the office complex.

Incentives To Rideshare

In most ridesharing programs, people needing rides can be expected to use the system more aggressively than people offering rides. Consequently, the research team wanted to determine how likely respondents would be to drive for a carpool/vanpool if offered various incentives, such as special parking privileges, expense sharing, and shopping discounts. As Table 5 indicates, all incentives received similar responses.

Delivery Preferences for Commuter Information

Respondents were asked how likely they would be to change the following if up-to-the-minute traffic information were available to them at home and at work and that information indicated that their usual commute route was congested: (*a*) departure time from home to work, (*b*) departure time from work to home, (*c*) route, and (*d*) transportation mode. Respondents who made less than $20,000 annually were significantly more likely than those who made over $40,000 annually to change their transportation mode on the basis of up-to-the-minute traffic information. In addition, 34.33 percent of the lower-income respondents said that they would be moderately to very likely to change commute mode, whereas only 12.7 percent of the higher-income respondents were moderately to very likely to do so (see Table 6). These results replicated those of previous Seattle-area commuter surveys (*2,3*).

Respondents were then asked to rate how likely they would be to use commuter information if it were delivered in various ways (see Table 7). The most popular method for delivery of commuter information appeared to be by telephone (50.15 percent said they

TABLE 4 Importance of Ridesharing Features*

Ridesharing feature	Rating (in percent) Very important	Moderately important	Slightly important	Not at all important
Having a guaranteed ride home in an emergency	62.08	23.70	9.48	4.74
Saving time over current transportation mode	48.33	27.75	15.31	8.61
Reducing pollution	43.26	35.10	17.79	3.85
Having your preferences met (e.g., riding/driving in a non-smoking environment)	39.43	25.48	26.44	8.65
Saving money over current transportation mode				
All	37.14	38.10	16.67	8.09
Under $20,000	52.00	38.00	4.00	6.00
Over $40,000	20.69	44.83	17.24	17.24
Participants being pre-screened				
All	22.22	31.32	27.27	19.19
Under $20,000	31.82	34.09	20.45	13.64
Over $40,000	17.86	17.86	42.85	21.43
Meeting other participants before forming a carpool/vanpool				
All	17.88	25.60	36.23	20.29
Under $20,000	26.53	30.61	28.57	14.29
Over $40,000	10.35	20.69	37.93	31.03
Knowing other participants				
All	13.40	30.62	30.62	25.36
Under $20,000	22.45	28.57	34.69	14.29
Over $40,000	3.33	26.67	23.33	46.67
Participants being co-workers				
All	12.08	24.64	25.60	37.68
Under $20,000	18.75	39.58	18.75	22.92
Over $40,000	10.00	20.00	20.00	50.00

*For variables that resulted in significant differences between lower income (<$20,000 individual annual income) and higher income (>$40,000 individual annual income) respondents, percentages for all respondents, lower income respondents, and higher income respondents are provided.

TABLE 5 Likelihood of Riding/Driving in Carpool If Provided Incentives

Incentive	Rating (in percent) Very likely	Moderately likely	Slightly likely	Not at all likely
Carpool/vanpool (drive or ride) if given:				
Special parking privileges	22.66	29.06	33.01	15.27
Drive for a carpool/vanpool if given:				
Full compensation for expenses	26.13	24.12	21.61	28.14
Full compensation for expenses and special discounts at downtown businesses	26.00	27.00	20.00	27.00

would be moderately to very likely to use it), followed by interactive computer in Bellevue Place's lobby (44.29 percent said they would be moderately to very likely to use it).

Level of Comfort Using Various Technologies

Respondents were asked to rate how comfortable they are using various technologies (see Table 8). Overall, about 83 percent of survey respondents said that they were very comfortable using a touch-tone telephone to access information, 68 percent said that they were very comfortable using a voice mail system, and about 58 percent said that they were very comfortable using a computer.

For the last two technologies given in Table 8 (voice mail and computer), there were significant differences between the comfort levels of lower-income and higher-income respondents. Respondents who made over $40,000 annually were significantly more comfortable using voice mail systems (85 percent responded very

TABLE 6 Likelihood of Changing Commute Features on the Basis of Traffic Information

Commute feature	Rating (in percent)			
	Very likely	Moderately likely	Slightly likely	Not at all likely
Departure time from home to work	41.39	24.16	16.45	18.00
Departure time from work to home	34.64	24.22	18.75	22.39
Route	48.66	22.69	14.92	13.73
Transportation mode				
All	10.79	9.66	20.74	58.81
Under $20,000	22.39	11.94	22.39	43.28
Over $40,000	6.35	6.35	20.63	66.67

TABLE 7 Likelihood of Using Commuter Information

Likelihood of using commuter information if delivered by:	Rating (in percent)			
	Very likely	Moderately likely	Slightly likely	Not at all likely
Telephone (24 hours per day)	22.93	27.21	26.93	22.93
Interactive computer in Bellevue Place's lobby	17.66	26.63	28.81	26.90
Computer at home or work (via modem)	13.32	19.57	25.27	41.85
Hand-held message receiver (similar to a pager)	10.47	14.60	23.69	51.24

comfortable) than were those who made less than $20,000 (41 percent responded very comfortable). As far as using a computer, 76.19 percent of the respondents who made over $40,000 said they were very comfortable compared with about 35 percent of respondents who made less than $20,000 annually, a significant difference.

Telephone Interview Findings

After analyzing the results from the written commuter surveys, the research team conducted two sets of telephone interviews to gather user input on specific system features. For the first set of interviews, only survey respondents who said that they would be very likely to use an on-demand carpool system were contacted. In this group, nine randomly selected participants (seven women and two men) answered questions about how they would use the system as riders. For the second set of interviews, only survey respondents who said that they would be very likely to drive for a carpool if fully compensated for their expenses were contacted (seven people—six women and one man—were interviewed) about how they would use the system as drivers. For both groups, interviewees were asked how much in advance they would be likely to call the system if they were offering or checking for a ride, whether the free use of a pager was an incentive to offering or checking for rides, how much drivers/riders would be willing to wait beyond their desired departure time to make a ride match, how far they were willing to drive/walk to meet a ride match, and so on.

The results of the telephone interviews are as follows:

- In general, potential riders said that they would use the system to find rides much less frequently than potential drivers would use the system to offer rides.
- Pagers were an incentive to use the system for both riders and drivers.
- Drivers were more likely to offer a ride through the system 3 days in advance than were riders; drivers were also less likely to call the system close to their departure time than were riders. Only one potential driver said that he would call the system 1 hr before he planned to leave, yet some potential riders were willing to check the system for a ride offered up to 15 min before leaving.

TABLE 8 Rating of Comfort Level with Various Technologies

Technology	Rating (in percent)			
	Very comfortable	Moderately comfortable	Slightly comfortable	Not at all comfortable
Touch tone telephone to access information	82.90	12.96	2.07	2.07
Voice mail system				
All	68.17	18.83	8.75	4.24
Under $20,000	40.85	38.03	12.67	8.45
Over $40,000	85.48	3.23	9.68	1.61
Computer				
All	58.16	22.10	13.16	6.58
Under $20,000	34.72	31.95	20.83	12.50
Over $40,000	76.19	6.35	15.87	1.59

- Although drivers were less likely to call the system and offer a ride close to their departure time, they were willing to accommodate a rider who contacted them up to 1 hr before they left.
- Drivers were less willing to delay their departure time to work to make a ride match than were riders (five out of seven drivers said that they would not delay their planned departure time to work). However, drivers were more willing to delay their departure time for the trip home; four out of seven said that they would delay their departure time for the trip home, of whom three would wait ½ hr to make a ride match.
- Riders were much more willing to wait past their desired departure time to make a ride match than were drivers (four out of nine said they would be willing to wait ½ hr and one said she would be willing to wait 15 min).
- Both drivers and riders were willing to go 10 to 15 min or 3 to 4 mi out of their way to make a ride match.
- Riders were willing to listen to five ride-offered messages. However, a few said they would be willing to read more than five messages on a pager but would not want to have to listen to more than five over the phone.

Focus Group Findings

In addition to the written surveys and the telephone interviews, the research team held two focus groups to gather data from employees who did not participate in the survey. One focus group was held to determine the interest level and reactions to the proposed BST dynamic ridesharing program of employees of a major software developer at the test site. The employees who participated in the focus group were all SOV drivers (nine men and three women).

Because the research team was considering expanding its focus to an area greater than Bellevue Place, the second focus group was conducted with people who worked in downtown Bellevue and participated in the Bellevue TMA's ridesharing program. All of the participants in the second focus group (five men and nine women) were currently carpooling. This focus group was also held to determine their interest level and reactions to the proposed BST ridesharing program.

Software Developer Focus Group

All software developer employees drove alone to and from work each day. Their reasons for not carpooling were consistent: all employees had flexible work hours and their departure times were always subject to change. Participants also reported having little motivation to carpool because they had daily access to free parking and usually commuted during nonpeak hours.

The employees were not particularly interested in the technology offered; e-mail, pagers, and an interactive phone system were viewed as archaic. Pagers were not viewed as an incentive for participating in the program.

Although there was little interest in riding in a carpool, the focus group participants were willing to drive for a carpool on the basis of a single ride offered in one direction. However, even as drivers, they were unlikely to use the system more than once if it was not trouble-free the first time they used it. For example, they did not want to wait more than 5 min for a rider. They also did not want to drive to an individual's house; they preferred to arrange pickup points.

Participants were most concerned about security issues. Participants were willing to rideshare with people who did not work at the same company provided that they were prescreened and that the system tracked who was riding together.

Bellevue TMA Focus Group

Unlike the employees of the software developer, the participants in the TMA focus group reacted positively to the pager. However, those who already carried a pager said they would be unwilling to carry a second pager.

Participants in this group were concerned about the same security issues as those in the Microsoft group. Prescreening and tracking ride matches were important; however, this group was also interested in knowing the gender of other riders/drivers.

The most important issue to this group was having a guaranteed ride home. Participants were willing to go through a multistep process to search for an alternative before exercising a guaranteed ride home option, but they were concerned about the extra time involved in the process. They refused to use an alternative mode of transportation, such as a transit trip, if it took 25 min longer than their usual means of commuting.

Summary of Survey, Interview, and Focus Group Findings

The results from the survey, telephone interviews, and focus groups inform the user requirements listed below. These requirements provided a basis for the development and design of the BST prototype traveler information center.

General Program Features

A dichotomy exists between desire to use the TIC information and willingness to use the TIC's technology. Lower-income employees were significantly more likely to use the information offered by the TIC than were higher-income employees; however, the lower-income employees were also significantly less comfortable with various technologies. Therefore, system designers should not make assumptions about potential users' knowledge of technology and must make efforts to keep the system as simple to use as possible.

Ridesharing Component

- To create a truly dynamic ridesharing system that accommodates all users' schedules, a system that allows people to rideshare at any time of day would be ideal. However, if system features prevent a 24-hr/day system, the system should minimally allow for ride matching between the hours of 6 and 10 a.m. and 3 and 7 p.m.; these hours would capture approximately 80 percent of the user audience.
- Given users' relative lack of knowledge regarding ridesharing programs, instructional information must be provided on such details as how to use a ridesharing system, how it works, and guidelines for contacting potential ride partners.
- A guaranteed ride home must be provided for ridesharing participants. Rides should be given on a point-to-point basis rather than on a door-to-door basis unless participants agree to do otherwise.

- Ride groups should be designed so that drivers/riders do not have to travel more than 4 mi to meet their ride match partners.
- The system should allow people to make a ride match 1 hr before their departure. The system should also minimize the number of messages a rider would have to listen to.
- For security purposes, the system should prescreen participants (minimally, they should be from selected employers), provide gender information, and record and monitor ride matches.
- Providing pagers and pager services would be a compelling incentive to use the system. In addition, other tangible incentives should be provided to encourage carpooling/vanpooling; the benefits of time savings and pollution reduction alone do not provide sufficient incentive.

Transit

Given users' relative lack of knowledge of bus use, the TIC should provide customized bus information to users who are interested in commuting by bus.

CONCLUSION

These findings have driven the development of the BST TIC, which is currently in the prototype stage. The goal of the BST TIC is to reduce congestion in downtown Bellevue, Washington, by providing a new alternative to SOV commuting. The TIC's main function will be to help commuters form dynamic rideshare groups, in addition to providing traffic congestion and transit information. The current TIC design reflects the preferences and needs of its potential users as revealed by the assessment methods described here. The strategy behind the development of the prototype BST TIC has been to (*a*) base its design on users' travel needs and (*b*) integrate existing technologies that enable an automated system to work efficiently and effectively. This prototype will be demonstrated and tested in a selected area of downtown Bellevue. During the demonstration, input from participants will be solicited and, whenever possible, the BST prototype will be modified to meet their needs. The kind of user assessment presented in this paper is necessary for the design of efficient transportation information systems to appropriately meet the needs of commuters.

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