USER PREFERENCES FOR DIAL-A-BUS

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This paper discusses the results of a survey of user preferences for the dial-a-bus transportation system in Columbia, Maryland. The analytical techniques used in the Columbia survey are based on those in surveys conducted in the cities of Warren and Center Line, Michigan (1, 5, 6).

The present research study sought to achieve 2 objectives:

1. To determine user preferences for dial-a-bus in an area where an actual system existed, and
2. To evaluate similarities and differences between the results of the surveys in Warren and in Columbia.

Two attitudinal surveys conducted in different cities can provide further insights into the transportation system characteristics that users regard as important. A survey conducted in one city is difficult to generalize to other areas. Preconceived notions of transportation and prejudices often force the analyst to reserve judgment of preferences to the case study city. The attitudinal surveys in Warren and in Columbia afford an opportunity to compare the preferences of 2 different populations in dissimilar environments.

Warren has primarily blue-collar workers; most residents have only a high school education. The household incomes are concentrated in the $10,000 to $15,000 range. The amount of public transportation available is limited; and most important, a dial-a-ride system was a completely new concept to these people. The system was explained thoroughly during the home interview, but the respondents were forced to rely on their imagination or their own perception of public transportation.

Columbia has a more diversified population than Warren. There is a greater proportion of people earning more than $15,000 in Columbia and about the same proportion in the lower income brackets. The respondents have a higher educational level. The population is more dense but much smaller; Columbia has a population of 10,000 as opposed to 200,000 in Warren. The residents of Columbia have seen a dial-a-bus system in operation.

The dial-a-ride service was truly a demand-responsive transportation system providing many-to-many service for the Columbia residents (1). The fare was $0.25 or 10 tickets for $2.25. To request service, the resident called the dispatcher, who checked the location of the vehicles and then assigned the caller to one of the vehicles if the estimated pickup time was agreeable. The dispatcher also took calls to reserve service in advance.

SURVEY DESIGN

The methods of paired comparison and semantic scaling were selected as the measurement devices for the home interview. The method of paired comparison was used to establish a scale of preferences for various system characteristics. The semantic-scaling technique was used to evaluate design alternatives for a number of system characteristics. A more detailed discussion of the techniques and the questionnaire design is given in another report (4).

The paired-comparison questionnaire originally had 32 system characteristics. For the Columbia survey the number was reduced to the following 15:

1. Arriving at your destination when you planned to,
2. Making a trip without changing vehicles,
3. Spending a shorter time waiting

to be picked up,
4. Paying a lower fare,
5. Spending less time walking to a pickup point,
6. Spending a shorter time traveling in the vehicle,
7. Being able to take a direct route, with fewer turns and detours,
8. Having small variation in travel time from one day to the next,
9. Being assured of getting a seat,
10. Calling for service without being delayed,
11. Having more protection from the weather at public pickup points,
12. Being able to select the time when you will be picked up,
13. Having a convenient method of paying your fare,
14. Having freedom to turn, tilt, or make other adjustments to the seat, and
15. Having a greater chance of being able to arrange ahead of time to meet and sit with someone you know.

The semantic-scaling questionnaire evaluated the desirability of design alternatives for the 15 characteristics. Those characteristics that were common to both Warren and Columbia surveys had exactly the same wording and accompanying illustrations in both surveys. The same statistical operations were performed on both sets of data.

In the paired-comparison questionnaire, not all of the paired choices were included in the survey. Three subsets of characteristics were established: levels of service characteristics, convenience factors, and vehicle design characteristics. Lower fare, assurance of a seat, and shorter travel time were paired with all of the characteristics. This allowed the development of a general scale from the relation of the 15 characteristics to the selected 3.

In the original surveys in Warren, no questions assessed the respondent's previous experience with public transportation systems. An additional page was added to the Columbia survey asking the respondent whether he used dial-a-bus frequently, occasionally, or not at all.

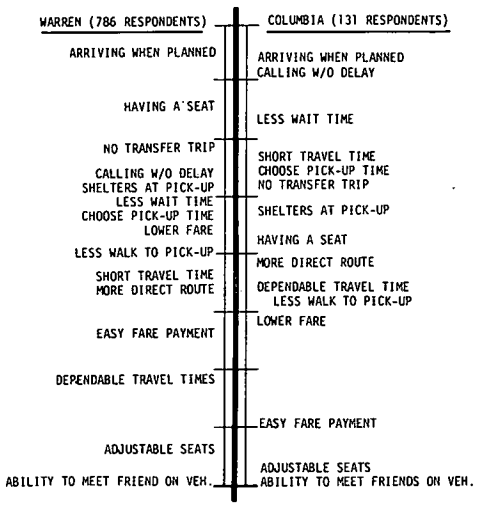
DATA COLLECTION

A home interview survey was conducted for 2 populations: (a) all residents of Columbia and (b) users of dial-a-bus. The general population survey sample was selected as follows: From the alphabetic list of residents for each village, a name in the first 10 names was randomly selected and then every tenth name thereafter was selected. The address was located on a map and assigned to a sample survey area. The users of dial-a-bus were selected from the records of 1 week's calls to the dispatcher. One of the first 10 names was randomly selected and then each tenth name thereafter. This list was merged with the general population list, and the names were randomly assigned to 1 of 6 interviewers. Interviews were conducted during the day and evening. Two call-backs were made before the name was removed from the list. All members of the household over the age of 14 were interviewed. The paired-comparison survey yielded 131 respondents, and the semantic-scale survey had 100 respondents.

ANALYSIS OF WARREN AND COLUMBIA RESULTS

The preferences derived from the paired-comparison surveys in Warren and in Columbia are shown in Figure 1. Only the 15 system characteristics common to both surveys are indicated on the scale. The results from the 2 surveys are quite similar in that dependability is most

Figure 1. Responses to paired-comparison questionnaires in Warren and Columbia.



important to both populations. Characteristics relating to time and cost are in a cluster below the most preferred characteristics. Then, well below these characteristics are those concerned with convenience and vehicle design.

The Warren respondents have only a traditional transit system as a frame of reference, and that is probably reflected by the high preferences for having a seat and a no-transfer trip. The Columbia residents did not rank those characteristics so high because dial-a-bus does not have transfers or very many standing passengers.

The Columbia residents have indicated through their preferences some of the shortcomings of dial-a-bus, particularly those experienced when the service was initiated. The dispatcher was averaging 2 minutes on the phone per request because he had to supply system information. A separate number was provided for system information but was seldom used. Therefore, many potential users were unable to contact the dispatcher. Consequently, calling without delay had a higher preference ranking from the Columbia residents. The service was well received, and often vehicles were unable to serve the demands, and wait times were as high as 60 minutes. The overload also caused increases in the travel time.

Table 1. Means of semantic scales for Warren and Columbia respondents.

Characteristic	Warren (813)	Columbia (100)
Importance of fare	5.7	4.8
Importance of travel time	5.5	5.2
Assurance of a seat	5.2	4.7
Waiting time at pickup	5.9	5.7
Pickup location		
Place of call	6.1	6.4
Nearest corner	5.5	5.1
Neighborhood	4.9	4.2
Nearest major street	4.1	4.3
Facilities at pickup location		
None	4.0	4.2
Curbside phone	4.6	5.0
Enclosed shelter	5.5	5.7
Overhead shelter	5.4	5.7
Waiting time, min		
5	6.1	6.4
10	5.8	6.1
15	4.9	5.0
20	3.8	3.9
Early arrival, min		
5	6.1	6.4
10	6.1	6.2
20	4.2	4.0
30	2.7	2.6
Interior design		
Standard	5.1	5.6
Grouped seats	3.0	3.8
Deluxe	5.2	5.4
One-way fare, dollars		
0.40	5.7	4.1
0.50	5.7	3.3
0.60	4.5	2.2
0.80	2.9	1.6
0.90	3.0	1.4
1.00	1.7	1.4
Fare collection		
20-trip ticket	4.2	4.3
Credit card	3.3	2.9
Monthly pass	3.7	4.0
Tokens	4.1	4.3
Exact fare only	4.2	4.6
Cash with change made	5.3	5.9

This problem is indicated by the preferences for shorter travel time and dependable travel time.

The fare for dial-a-bus was $0.25, and the fare for the fixed-route system in Warren was $0.35. The Warren residents would most likely believe that any new system would cost even more. Because of the existing fare levels, one would hypothesize that the relative preference for lower fare would be lower in Columbia than in Warren, which is the case.

Table 1 gives the means of semantic scales for both the Warren and the Columbia surveys. The means of the desirability of system alternatives closely paralled each other. The fare importance is lower, which is consistent with the paired-comparison results. The desirability of pickup at the place of call is higher for Columbia, and the desirability decreases more rapidly as the pickup gets farther away from the respondent's place of call.

Figure 2 shows the respondent's sensitivity to changes in the amount of waiting time. The curves for both Warren and Columbia are horizontal up to a 10-minute wait, at which point the user's satisfaction diminishes more rapidly as the waiting time increases. The early-arrival sensitivity demonstrates the same 10-minute threshold (Fig. 3). Not only is the threshold similar for both waiting for the bus and arriving early (another form of waiting), but the rate of change of acceptability up to 20 minutes is approximately the same.

The shape of the fare-sensitivity curves shown in Figure 4 is similar for both populations. Also the "knee" of the curve occurs at $0.65 and $0.75, and this may represent an upper limit of fares for those potential patrons with a choice of transportation modes. The different levels of satisfaction can be attributed to the existing public transportation fares. A $0.40 fare is consistent with existing public transit fares in Warren, but it represents a 60 percent increase in Columbia.

Figure 2. Waiting-time sensitivity of Warren and Columbia respondents.

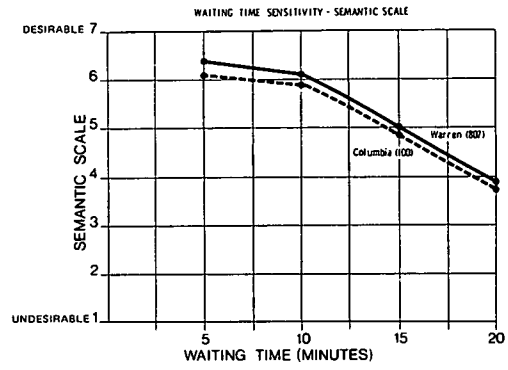
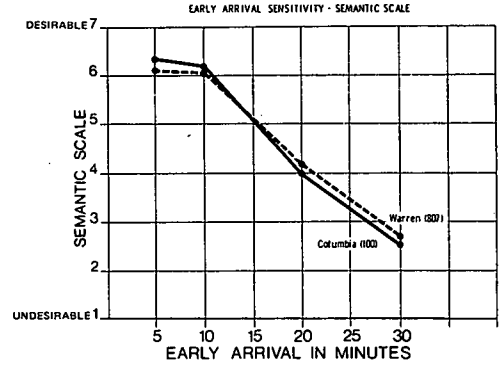


Figure 3. Early-arrival sensitivity of Warren and Columbia respondents.



ANALYSIS OF SUBGROUPS IN COLUMBIA

The paired-comparison results strat-

Figure 4. Fare sensitivity of Warren and Columbia respondents.

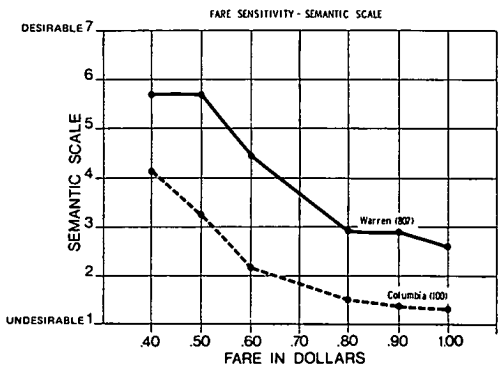
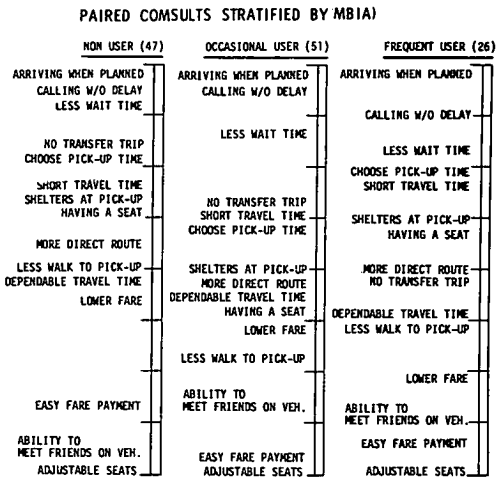


Figure 5. Responses to paired-comparison questionnaires in Columbia by user group.



ified by nonusers, occasional users, and frequent users of dial-a-bus are shown in Figure 5. The groups indicate similar ordering of preferences for most of the characteristics. The frequent users indicate a more even distribution of characteristics throughout the scale, and those seldom using the system have a tendency to group the characteristics. The nonusers indicate high preferences for system characteristics that have been a problem with the dial-a-bus service.

Calling without delay and less wait time are just below arriving when planned on the preference scale for nonusers. Calling without delay is rated the same by both occasional users and nonusers, but less waiting time is rated lower by the nonusers. Less waiting time is rated the same by frequent and occasional users, and calling without delay is rated higher by the frequent user. Sensitivity to waiting time distinguishes nonusers from users, and a preference for the calling-without-delay characteristic distinguishes the frequent user from the other two user groups. Two other characteristics decrease in preference from nonuser to frequent user: no-transfer trip and lower fare.

Users of dial-a-bus are more willing to accept the inconveniences that accompany a public transportation system. Most of the characteristics receive a lower preference rating by the users than by the nonusers except for those characteristics related to the advantages of dial-a-bus over a conventional bus system. To the frequent user, choosing pickup time and arriving when planned are important characteristics that are currently being satisfied by dial-a-bus.

Table 2 gives the means of semantic scales by frequent users, occasional users, and nonusers in Columbia. The importance of fare is consistent with the paired-comparison results. The "knee" of the curve for the seldom and occasional user is approximately $0.65. The frequent user indicates a high mean desirability for the 20-trip ticket, which is already being used and is apparently popular with the frequent user. The

Table 2. Means of semantic scales for Columbia respondents by user group.

Characteristic	Non-user (29)	Occasional User (47)	Frequent User (23)
Importance of fare	4.6	5.2	4.0
Importance of travel time	5.1	5.0	5.5
Assurance of a seat	4.4	4.8	4.6
Waiting time at pickup	5.8	5.6	5.9
Pickup location			
Place of call	6.3	6.5	6.4
Nearest corner	5.8	5.6	5.1
Neighborhood	4.9	3.8	4.0
Nearest major street	5.1	4.2	4.0
Facilities at pickup location			
None	4.1	4.5	4.0
Curbside phone	4.7	5.2	5.1
Enclosed shelter	5.5	5.8	6.0
Overhead shelter	6.0	6.0	5.3
Waiting time, min			
5	6.3	6.8	6.4
10	6.3	6.2	6.3
15	4.8	5.1	5.7
20	3.5	3.8	4.9
Early arrival, min			
5	6.3	6.5	6.4
10	6.1	6.4	6.0
20	4.2	4.1	3.8
30	2.5	2.9	2.1
Interior design			
Standard	5.6	5.5	6.1
Grouped seats	3.8	3.9	3.8
Deluxe	5.7	5.6	5.0
One-way fare, dollars			
0.40	4.0	4.3	3.8
0.50	3.3	3.5	3.3
0.60	1.8	2.3	2.3
0.80	1.5	1.6	1.9
0.90	1.3	1.3	1.6
1.00	1.3	1.3	1.6
Fare collection			
20-trip ticket	4.1	4.3	5.1
Credit card	3.3	2.6	3.2
Monthly pass	3.9	4.0	4.4
Tokens	4.0	4.7	4.4
Exact fare only	4.6	4.7	4.6
Cash with change made	5.6	6.3	5.9

sensitivity of the respondents to various fare levels (Fig. 6) is consistent with the preferences from the paired-comparison questionnaire. A 2-factor mixed-design analysis of variance was performed on the semantic-scale data to determine whether the 3 groups are significantly different (3). The F-value for the group effect is 0.55, which indicates the means of the groups are not significantly different. The interaction of the fare level and the groups (slope of the curves) has an F-value of 1.33, which is not significant at the 5 percent level of confidence. From the data available, one is unable to reject the null hypothesis that there is no difference in the preferences of the 3 groups.

The semantic-scale values on waiting times are shown in Figure 7. Satisfaction

Figure 6. Fare sensitivity of Columbia respondents by user group.

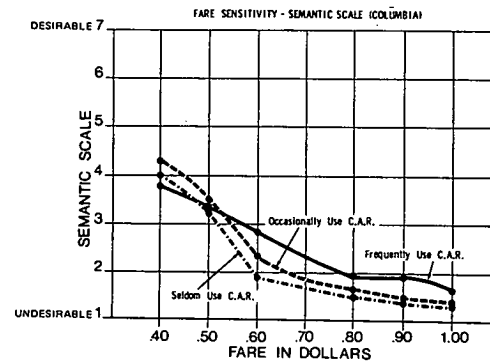
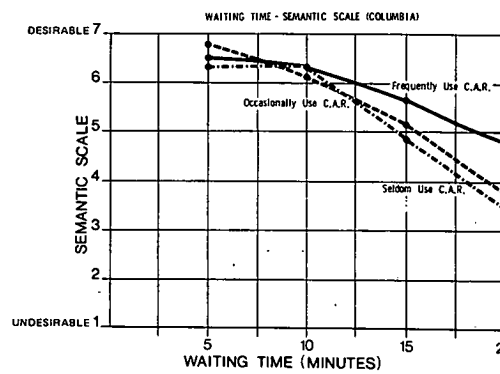


Figure 7. Waiting-time sensitivity of Columbia respondents by user group.



diminishes more rapidly for the nonusers than for the occasional and the frequent users. The 2-factor mixed-design analysis of variance was performed on the 3 groups to determine whether differences are significant. The F-value for the group differences is 0.39 (not significant at the 5 percent confidence level), which indicates that the mean values over all the waiting times are not significantly different for the 3 groups. The interaction of the waiting time satisfaction and the groups (slope of the curve) has an F-value of 2.74, which for 6 and 288 degrees of freedom is significant at the 5 percent level of confidence. The null hypothesis that there are no differences in the interaction of the user groups and waiting time satisfactions can be rejected. The nonusers are more sensitive to changes in waiting times than the users.

The paired-comparison preference scales for the households with 1 or 0 automobiles available and the households with 2 or more automobiles available are shown in Figure 8. The respondents with 2 or more automobiles available have higher preferences for certain advantages provided by the automobile: arriving when planned, no-transfer trip, and short travel time. Those respondents also indicate a higher preference for calling the system without delay and, understandably, are more sensitive to the inconveniences of public transportation.

The fare sensitivity and the waiting time sensitivity are shown in Figures 9 and 10. Both graphs demonstrate results similar to those shown in Figure 1. The households with more automobiles available can substitute the automobile for the public transit alternative more easily. If the system causes inconvenience (transfers, long waits, or long travel time), the 2-automobile household is less apt to be a continuous user of the system. The 1- or 0-automobile households often have no alternative transportation, so they are willing to endure some of the inconveniences incurred in using public transportation.

Figure 8. Responses to paired-comparison questionnaires in Columbia by automobile-ownership group.

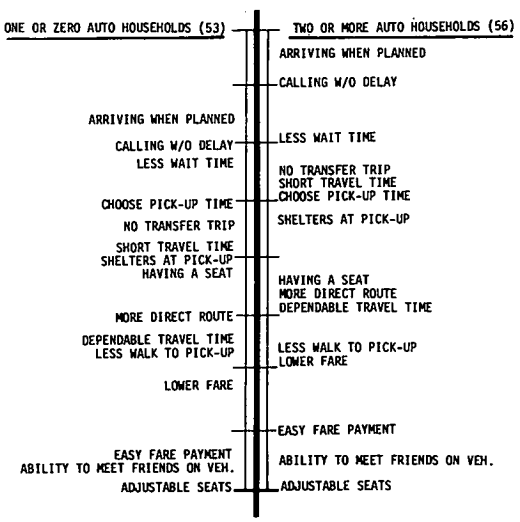


Figure 9. Fare sensitivity of Columbia respondents by automobile-ownership group.

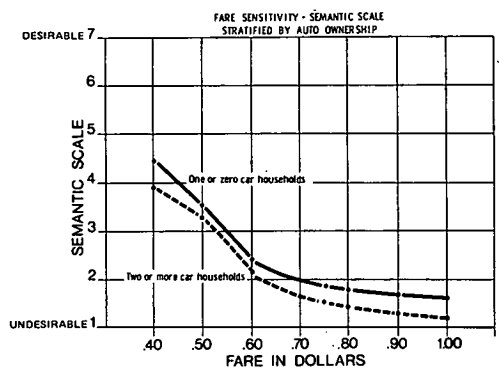
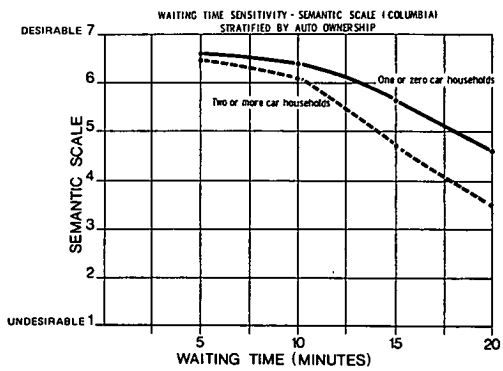


Figure 10. Waiting-time sensitivity of Columbia respondents by automobile-ownership group.



CONCLUSIONS

The Columbia survey provided some valuable information concerning user preferences for the dial-a-bus system. Specifically, it validated a previous survey conducted in Warren, Michigan, and it provided more detailed information on the preferences of the users of the system.

Columbia respondents closely paralleled their predecessors in Warren. The differences in the results are mostly related to the particular problems that dial-a-bus encountered in the implementation process. These characteristics received higher preferences in the Columbia survey because the respondent had been inconvenienced by that characteristic of the system. The similarities of the results are surprising given the differences in the 2 populations. Applying results from one community to a completely different community has been a problem. The results of this study should increase confidence in the case-study approach.

The differences indicated by users and nonusers are related to the inconvenience of using the dial-a-bus system. Phoning the system and the longer waits were more important to the nonuser than to the user. No transfer and fare have some effect in differentiating users and nonusers.

This study provides important information to the designers of dial-a-bus systems. Some reservations were expressed in previous studies concerning the applicability of surveys. The same technique was applied to 2 different areas with similar results. It, thus, represents an important step toward obtaining relevant information concerning the design of demand-responsive systems.

ACKNOWLEDGMENTS

The study is a joint effort by the staff of the Transportation Research Department of the General Motors Research Laboratories and Francis P. D. Navin. The authors wish to acknowledge the contribution of Robert Bartolo and the Columbia Association who started and operated the dial-a-bus system and allowed the surveys to be undertaken. The University of Minnesota provided the funds necessary to undertake the surveys in Columbia.

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INFORMAL DISCUSSION

Question: Who supported the surveys you described?

Answer: The Warren survey was supported solely by General Motors, and the Columbia survey was supported by the University of Minnesota.

Question: Did the responses of the Warren survey nonusers correlate with those of the Columbia survey?

Answer: That is a subject for future research. We have not had a chance to analyze those data, but we certainly intend to.