USER PREFERENCES FOR A DEMAND-RESPONSIVE TRANSPORTATION SYSTEM: A CASE STUDY REPORT

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If it is to help solve urban transportation problems, a demand-responsive transit system such as dial-a-bus, dial-a-ride, or demand-responsive jitney must be designed to provide service that is attractive and competitive in a consumer-oriented market and socially concerned society. Obtaining pertinent information concerning the potential users' preferences for the design of a transportation system of this type, as well as preferences for those not receiving direct benefits, is an important step in improving and making viable urban transportation and in providing increased benefits to the users of the system. This paper discusses the measurement of user preferences for a demand-responsive transportation system. The study was composed of three phases: survey design, which included the selection and grouping of system characteristics, the adaptation of psychological scaling techniques, and the design of an attitudinal survey; data collection, which involved the implementation of a home interview survey in a specific city; and data analysis, which included trade-offs between various design characteristics. The analysis was performed both on data for all respondents and also on data for particular market subgroup stratifications. Data from the application of the methodology in a case study community are provided, and interpretations of the analysis are discussed.

•THIS PAPER discusses the results of a research study to determine user preferences for a public transportation concept called the Demand-Responsive Jitney System (abbreviated D-J). The study has been conducted as one part of the Transportation Research Department's D-J systems study, which has analyzed the engineering, economic, and political feasibility of one type of demand-responsive transportation system in a chosen case study area.

The D-J system is intended to provide service for the user where he wants it and when he wants it. Because the system is demand responsive, it has some of the characteristics of a conventional taxicab system. However, to minimize costs of operation requires that passengers share the use of the vehicle; therefore, the D-J vehicle is somewhat characteristic of small buses, airport limousines, and shared taxis—the class of systems that may be called jitneys. As a hybrid between the taxicab and bus, the D-J system is generically similar to the demand-responsive systems previously described by General Motors and others under names such as dial-a-bus, Genie, and DART (1, 2, 4, 5, 6, 13, 14).

Within the overall framework of the D-J systems study, this research was aimed at the potential users of the D-J system. Of course, the design of any new transportation system involves more than satisfying the needs of those who are likely to use it. In a competitive, consumer-oriented market, however, user satisfaction is one of the most important considerations in achieving system success. In the past, public transportation system operators, designers, and planners have found it difficult to satisfy adequately consumer requirements when confronted with the competition of the private

Sponsored by Committee on New Transportation Systems and Technology and presented at the 50th Annual Meeting.

automobile. If new systems like the D-J and others are to be more successful, they must be designed to provide service that is attractive and competitive within the growing and changing consumer market for transportation.

The research study sought to achieve four specific objectives:

1. To gather information from potential users of the system about their relative preferences for specific system characteristics and specific design solutions being considered for incorporation into the design of the D-J system (these characteristics and solutions were classified into subsystems of vehicle design, levels of service, and convenience factors);
2. To analyze the differences in preferences found within and between each of these four categories for the total population sampled and for each of eight market subgroups identified within the total sample;
3. To identify by market subgroup and design subsystem the trade-offs that appear to be important; and
4. To permit conclusions to be drawn about the most desirable design of the D-J system from the users' points of view.

The research was conducted in five phases, as shown in Figure 1. The first phase—survey design—included a number of design and decision steps that led to the construction of an attitudinal survey composed of two separate questionnaires. The second phase—data collection—concerned the execution of a home interview survey in the case study community. The third phase included detailed analyses of the data collected for the total population. In phase four, the data were analyzed by market subgroups. The last phase involved the synthesis of preferred design. A detailed discussion of the methodology of this study is given in another report (3).

SURVEY DESIGN

The methods of paired comparison and semantic scaling were used to measure user preferences in the D-J attitudinal survey. These devices satisfied the criteria of validity, reliability, quantifiability, analysis potential, objectivity, and simplicity of administration (12).

The paired comparison technique was used to establish a scale of preferences for a set of system characteristics, and the semantic scaling technique was used to investigate design alternatives for a number of these characteristics. The survey there-

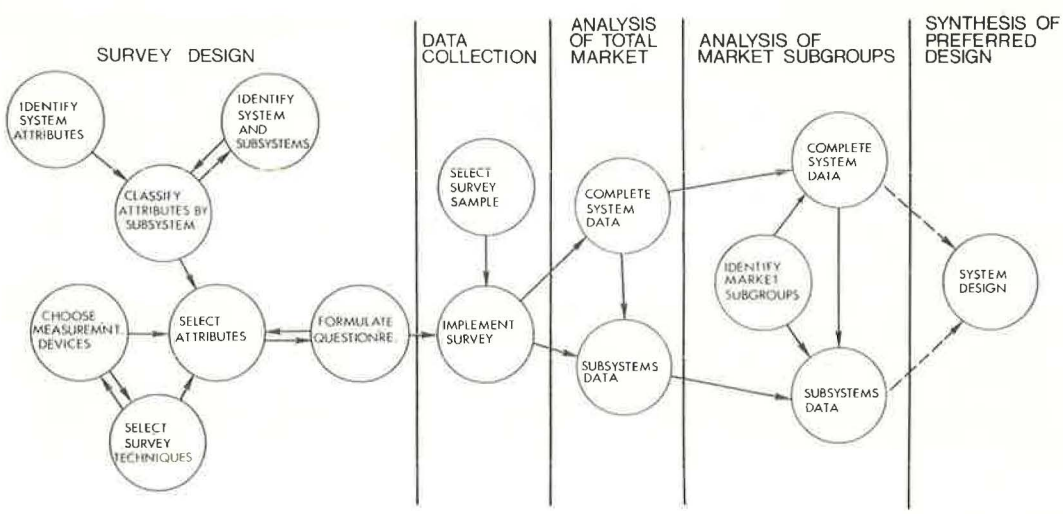


Figure 1. Research framework.

fore employed two separate but related questionnaires—a paired comparison questionnaire and a semantic scaling questionnaire.

The output of the paired comparison questionnaire is a preference scale of system characteristics as rated by the respondents. Both the rank order of the characteristics and an estimate of the preference intervals separating these characteristics were determined. The output of the semantic scaling questionnaire is an estimate of the mean acceptabilities of the design alternatives and estimates of the variances associated with the mean ratings. The methodology underlying these techniques is discussed elsewhere (7, 8, 9, 10, 11, 12).

An important first step in the preparation of the questionnaires was the determination of the set of characteristics to be measured. Over 100 characteristics were selected and grouped into three categories that determined how, or if, they would be used in the questionnaires. These categories are:

1. System characteristics for which the specific form would be based entirely on professional analysis and judgment and not subject to trade-off (these were not included in the questionnaire);
2. System characteristics for which relative user importances were desired (thirty-two of these formed the basis of the paired comparison questionnaire); and
3. System characteristics for which a user preference for alternative design solutions was desired (twenty-seven of these formed the basis of the semantic scaling questionnaire).

The 32 system characteristics selected for use in the paired comparison questionnaire are as follows:

1. Shorter time spent traveling in the vehicle;
2. Shorter time spent waiting to be picked up;
3. Arriving at your destination when you planned to;
4. Ability to adjust the amount of light, air, heat, and sound around you in the vehicle;
5. More space for storing your packages while traveling;
6. Stylish vehicle exterior;
7. Freedom to turn, tilt, or make other adjustments to your seat;
8. Availability of coffee, newspapers, and magazines in the vehicle;
9. Small variation in travel time from one day to the next;
10. More phones to use to call for service available in public places;
11. More protection from the weather at public pickup points;
12. More chance of riding in privacy;
13. More chance of meeting people in the vehicle;
14. More chance of being able to arrange ahead of time to meet and sit with someone you know;
15. More chance of rearranging the seats inside the vehicle to make talking with others easier;
16. Lower fare for passengers;
17. Making a trip without changing vehicles;
18. Less time spent walking to a pickup point;
19. Being able to select the time when you will be picked up;
20. Longer hours of available service;
21. Vehicle whose size and appearance do not detract from the character of the neighborhood through which it passes;
22. Calling for service without being delayed;
23. Being able to talk to, and ask questions of, systems representatives when desired;
24. Easier entry and exit from the vehicle;
25. Room for accommodating baby carriages, strollers, and wheel chairs in the vehicle;
26. Assurance of getting a seat;
27. Less chance of meeting with people who may make you feel insecure or uncomfortable;

28. More room between you and others in the vehicle;
29. Being able to take a direct route, with fewer turns and detours;
30. Being able to take rides that are pleasant or scenic;
31. More chance of riding with different kinds of people; and
32. Convenient method of paying your fare.

Comparing all 32 within a single matrix of paired choices would result in 496 paired choices, far too many to be included in a home interview survey. To reduce the number of paired choices while still retaining those choices that were important and logical, we developed nine smaller matrices, each related to a specific group of characteristics. As the matrices were formed, care was taken to group only those characteristics that the designer might actually trade off in making design decisions. To provide a common basis for measuring the relative importances of all of the characteristics even though separated into groups, we included several characteristics in more than one group. In the final questionnaire, 168 paired choices were presented. Part of a page of this questionnaire is shown in Figure 2.

The second aspect of the survey involved the determination of relative preferences for various design alternatives as means for achieving certain of the system characteristics. It was the purpose of the semantic scaling questionnaire to explore, over a selected range, the acceptability of various design alternatives for 27 of these characteristics. Questions were constructed describing the various design solutions for each, and the respondent indicated the importance, acceptability, or desirability to him of each of the design alternatives presented for a system characteristic by ranking the alternative on a 1 to 7 semantic differential scale. Part of a page of this questionnaire is shown in Figure 2.

DATA COLLECTION

A home interview survey technique was used to implement the paired comparison and semantic scaling questionnaires. The survey was conducted by an independent market research firm to help ensure unbiased and objective results. The survey area selected was a suburb of a large metropolitan area. A cluster sampling technique was used to identify the sample of households within the case study community. The sample was composed of 210 clusters, and the starting point for each cluster was selected at random from the set of all households within the case study community. Within each cluster area, interviews were completed at six households according to a predesigned sampling plan. In this manner, interviews were completed at 1,260 households. If no one was at home at a selected household, a maximum of two-call-backs were made. If no one was at home during the second call-back, that households was replaced with another household selected according to a specific skip selection plan. Households for which interviews were refused were also replaced according to this particular plan.

Once an interviewer was allowed admittance to the household, she was to obtain as many interviews as possible from the adult members of that family. An adult was defined as anyone 14 years of age or older. The procedure for conduct of the interview was for the respondent to self-administer the questionnaire and for the interviewer to administer the introductory sections and help the respondent begin work on the self-administered part to ensure comprehension and establish rapport. The interviewer then monitored the remainder of the questionnaire and answered any questions of the respondent. Interviewers were able to obtain 1,631 interviews, or 1.3 interviews for every household in the sample. The number of questionnaires processed, after rejection of incomplete returns, was 1,603. Because approximately every other interviewed household received the paired comparison questionnaire whereas the remaining households received the semantic scaling questionnaire, there was a final total of 786 completed paired comparison questionnaires and 817 completed semantic scaling questionnaires.

DATA ANALYSIS FOR THE TOTAL MARKET

The nine matrices of comparisons produced nine preference scales, each of one group of system characteristics. (A tenth matrix, concerned with alternative methods

GROUP C

This set of decisions deals with the interior design and structure of the vehicle that might be used in a new transportation system. For example, some of the choices will involve the amount of light, air, heat and sound around you in the vehicle, the exit and entry ways and several more.

Again, select your choice by circling the letter A or B, whichever is appropriate.

1. A. Ability to adjust the amount of light, air, heat and sound around you in the vehicle.
   or
   B. Easier entry and exit from the vehicle.

2. A. Easier entry and exit from the vehicle
   or
   B. Lower fare for passengers.

11 Occasionally it might be necessary to be able to identify one particular Demand-Jitney vehicle from others (e.g., at a common pick-up point at a shopping center). There are several ways in which this could be done. Indicate your preference for the various methods described below.

USE OF CODE NAMES ON VEHICLES

	1	2	3	4	5	6	7	
Undesirable	I	I	I	I	I	I	I	Very Desirable

USE OF A LARGE LETTER OR LETTERS TO IDENTIFY SPECIFIC VEHICLES

	1	2	3	4	5	6	7	
Undesirable	I	I	I	I	I	I	I	Very Desirable

USE OF AN IDENTIFICATION NUMBER

	1	2	3	4	5	6	7	
Undesirable	I	I	I	I	I	I	I	Very Desirable

USE OF COMBINATIONS OF A LETTER AND A NUMBER FOR IDENTIFICATION

	1	2	3	4	5	6	7	
Undesirable	I	I	I	I	I	I	I	Very Desirable

Figure 2. Sample from paired comparison questionnaire.

of fare collection, was included in this questionnaire as well as in the semantic scaling questionnaire to provide a comparison test between paired comparison and semantic scaling methods of preference rating. Results of this comparison test are discussed later in this report.) To formulate one integrated relative preference scale required that all nine scales contain the characteristic "lower fare." The value of lower fare in one comparison scale was then used as the standard value. The scale value for each characteristic was adjusted by the difference between the standard lower-fare scale value and the specific lower-fare scale value for the comparison scale in which the characteristic is contained. Because some characteristics were included in more than one comparison scale, there is more than one adjusted scale value for those characteristics. The adjusted scale values were compared to check the consistency of the data, and the largest deviation among the values was found to be within acceptable bounds. After all the scale values were adjusted to lower fare, the process of combining the scales was completed by plotting all the adjusted values on one scale (Fig. 3).

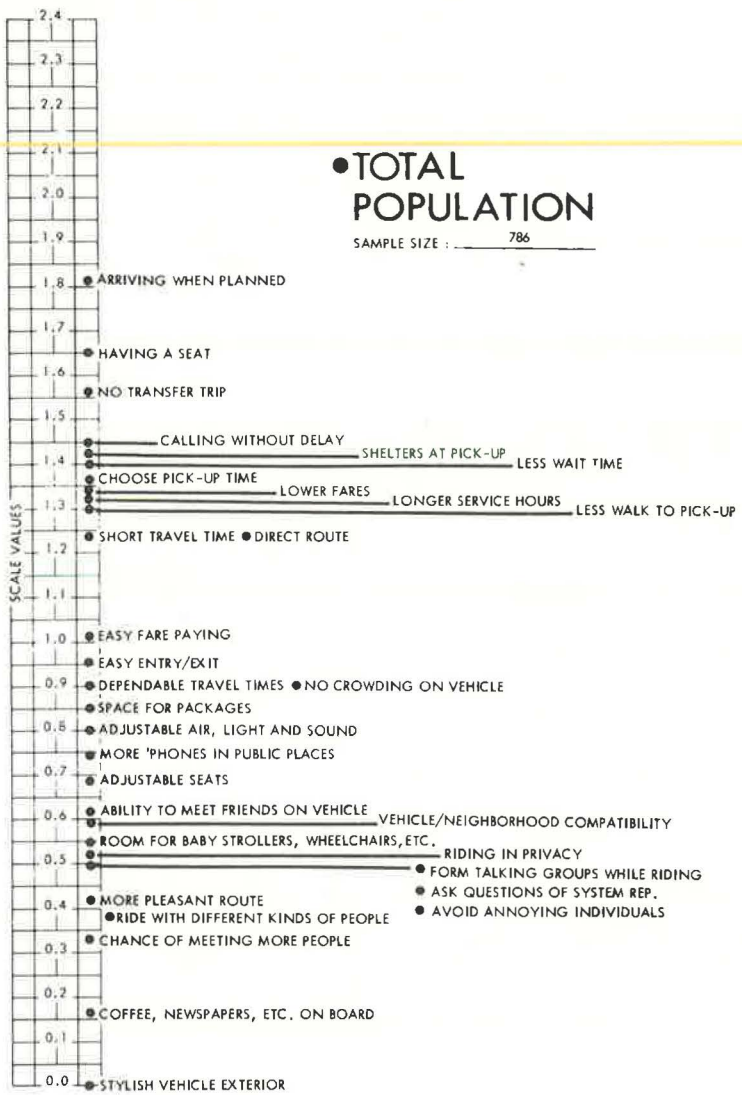


Figure 3. Scale of adjusted values.

The characteristic receiving the highest preference by the total market was "arriving at your destination when you had planned to," abbreviated in Figures 3, 4, and 6 as "arriving when planned." This was followed by "assurance of getting a seat," abbreviated as "having a seat," and "making a trip without changing vehicles," abbreviated as "no transfer trip." These three preferred characteristics are followed by a cluster of nine characteristics concerned mainly with the customers' time, fare, and shelters. Lower on the scale is a large cluster of 18 characteristics that are concerned primarily with interior design, aesthetic and social aspects of the actual trip, and passenger convenience. The two characteristics that are least preferred by the total market are "coffee, newspapers, and magazines on board the vehicle" and "stylish vehicle exterior."

The 32 characteristics were classified into three subsystems: vehicle design, levels of service, and convenience factors. The universal preference scale is split into three separate scales, one for each of the subsystems (Fig. 4), and a black line indicates the position of the common characteristic lower fare. One can conclude by examining these scales that the vehicle design subsystem is the least important of the three because none of the relative differences from lower fare are less than 0.3. The level of service subsystem has three characteristics preferred to lower fare and four others clustered around lower fare. Only three characteristics of this subsystem are ranked significantly below lower fare. The convenience factors exhibit the widest dispersion; four characteristics are preferred to lower fare; "having a seat" is the most preferred. Four other characteristics have a significantly lower importance. The characteristics of most concern to the respondents involved levels of service and certain aspects of convenience, with the respondents especially concerned with time, dependability, and avoidance of physical inconveniences.

The universal preference scale is a very convenient way of establishing an order and preference ranking for the 32 characteristics, but the designer must keep in mind that this universal preference scale of the 32 characteristics is drawn from the nine scales where direct comparisons are made. Scale values of the 31 characteristics are implied through their relationship to lower fare. The implied scale value may be biased by the fact that a particular characteristic is not compared with all 31 remaining characteristics and may in fact be compared with only four or five. This does not mean that the scale values in the universal preference scale are not reliable; it only indicates that the system designer must keep in mind that some of the figures may be biased and that the analysis of the total preference scale should be limited to major differences in characteristics and should not attempt to draw fine lines between characteristics that are grouped closely together.

The semantic scaling questionnaire (with a semantic scale range of 1 to 7) was used to establish preferences for design alternatives for 27 of the system characteristics. For the vehicle design subsystems, a low two-step entry is preferred (mean = 6.0) over the standard three-step entry (mean = 3.8) as a solution to the entry-exit problem. The difference in preferences for the deluxe interior and the standard interior is not significant, as was determined by a statistical t-test (which measures the significance level of differences between statistical parameters of different distributions). Providing storage alongside the seat (mean = 5.0), under the seat (mean = 4.7), or on racks above the seat (mean = 4.6) are all preferred to storage near the door (mean = 2.6) or outside the passenger compartment (mean = 2.4).

Also important are items dealing with vehicle and passenger safety (all had mean acceptances of 5.5 or above), the identification of the vehicle (mean = 6.1), and the need for air-conditioning (mean = 5.6). Less preferred are various types of flexible or adaptable seating (interior grouped seats, rotatable seats, informal seat groupings, or tilt-back seats) intended to provide individual or group variations.

Some conclusions about vehicle design can be reached. The priorities for vehicle design include providing easier entry and exit, air-conditioning, more spacious seating, convenient storage areas close to the seats, and a more personally controlled microclimate. Less emphasis should be placed on providing for privacy or for a variety of social arrangements or on providing adjustable and movable seats. Styling, although still an integral component of vehicle design, would have to be considered as being shaped by, rather than shaping, these more important requirements. The designer

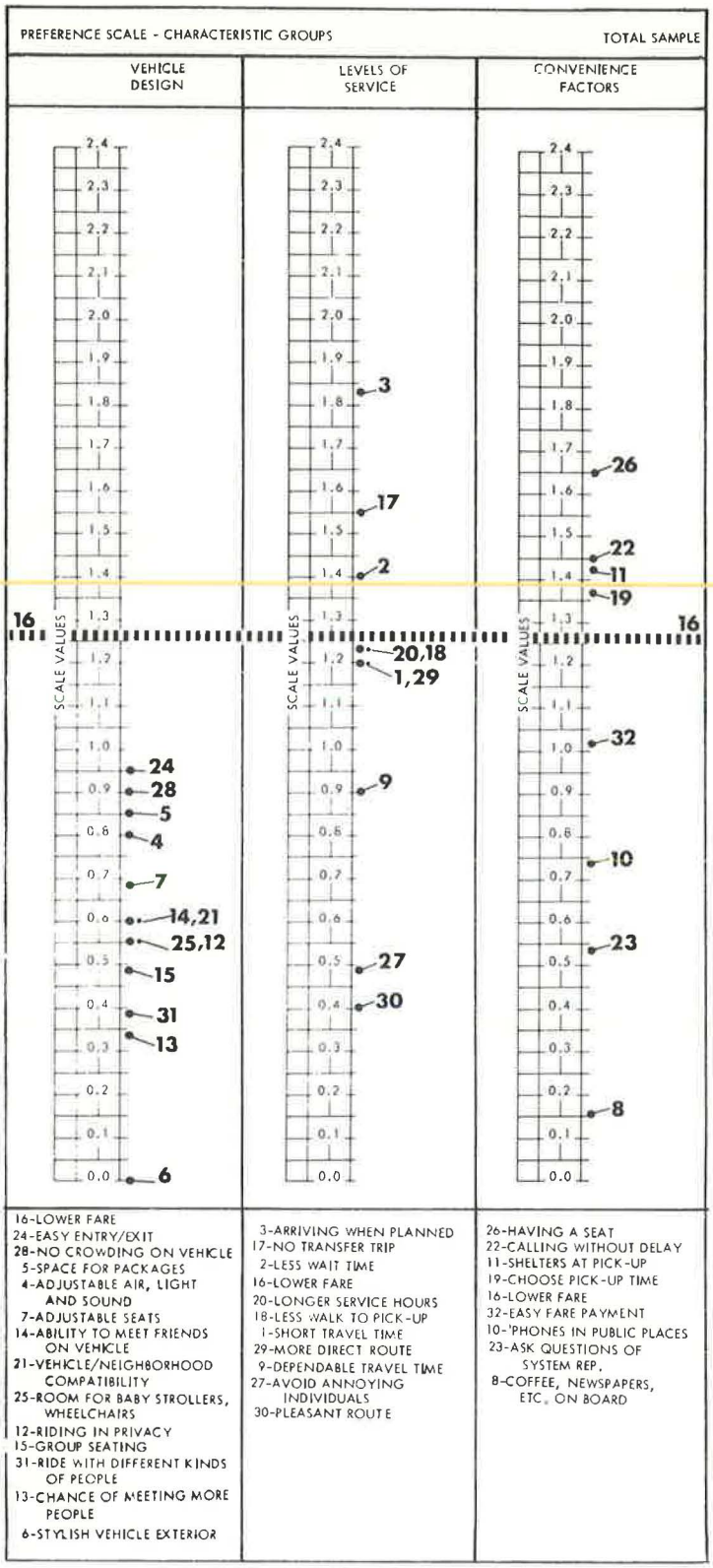


Figure 4. Universal preference scale of 32 characteristics.

should keep in mind, when evaluating various alternatives, that the user is not willing to pay a higher fare for improved design characteristics. Finally, attention should be paid to a method for vehicle identification.

For the levels of service subsystem the respondents ranked "waiting time-pickup" (mean = 5.9) and "travel time" (mean = 5.3) very high. Provision of service to areas outside the case study community was evaluated. The two (out of four) nearest shopping centers ranked the highest (mean = 4.9 and 4.8), while some interest was expressed in service to a transit line to the metropolitan area central city (mean = 3.5). Service to plants located in two nearby industrial areas ranked quite low (mean = 2.4 and 2.2). The most desirable times for operation were 9 a.m. to 7 p.m., whereas service from 5 a.m. to 9 a.m. was less desired.

The respondents ranked "pickup at place of call" (mean = 6.1) highly desirable, and the mean acceptability falls as the distance of the pickup point from the origin of the call increases ("nearest corner" = 5.5, "within neighborhood" = 4.9, and "nearest major street" = 4.0). Four possible information items that could be furnished the caller when he placed his call for service were evaluated (earliest and latest time of pickup and earliest and latest time of arrival), and all of the items were given high mean acceptance ratings (approximately 6.0). Specified time intervals for pickup and specified delivery time are most desirable. A 5-min waiting time is very acceptable (mean = 6.1) as is 10 min (mean = 5.8), but for 15 and 20 min the mean acceptability is much less (mean = 4.9 and 3.8). Early arrival experiences the same 10-min threshold because 5- and 10-min early arrivals rank high in acceptance (both 6.1), whereas a 20-min early arrival ranks much lower (mean = 4.3).

In evaluating the importance of travel time via the D-J relative to that via the private automobile, it is useful to know whether the potential customer is more interested in minimizing the difference between trip times or the ratio of trip times. The questionnaire was structured to resolve this by including questions on six travel situations involving three travel time ratios (1.5:1, 2:1, and 3:1) and two time differences for each ratio. The results of the survey indicate that the respondents are primarily concerned with the time difference in minutes rather than with the ratio of travel time.

The respondents are highly concerned with dependability of service. The characteristics receiving the highest rankings are "arriving when planned," "trip without changing vehicles," and "less wait time"—factors that could seriously inconvenience the user. The threshold for both waiting time for pickup and early arrival time is 10 min and every possible effort should be made by the system designer to provide service within these levels. A "lower fare" can be sacrificed, if need be, because this characteristic ranks below the service factors. Because the respondents are indifferent to "shorter travel time," a fast trip can also be sacrificed in order to meet the waiting time and arrival time criteria. The system should also be designed to pick up passengers as close as possible to the point from which they call for service.

Of minimal importance to the respondents are "avoid annoying individuals," "ride with different kinds of people," and "pleasant route." These characteristics should not be permitted to influence the fare. There is also little interest expressed in service to industrial areas bordering the area under consideration and service between 1 and 5 a.m.; thus a 24-hour operation of the system may not be warranted.

The semantic scaling responses indicate a more detailed measure of user preferences for various convenience factors. Both an overhead shelter with a phone (mean = 5.3) and an enclosed shelter (mean = 5.4) would be acceptable; however, the difference between the means for the two types of shelters is not significant. The median for both types of shelters is 6, which indicates that a majority of people find either shelter very acceptable. A mean of 4.7 for a curbside D-J stop indicates relatively high degree of acceptability; however, considering the importance given in the paired comparison analysis to protection from weather, it would seem that one could justify an expense for covered shelters in public areas.

Although recorded music (mean = 3.7) and broadcast of radio programs on board the vehicle (mean = 3.4) are rated higher than coffee and soft drinks on board (mean = 2.8), it would not appear that providing such equipment would have a significant effect on consumer acceptance of the system design.

In summary of the convenience factors subsystem, it should be noted that only protection at pickup points and factors concerning user delay are ranked above or very close to lower fare in importance. The other convenience factors should be considered only if they will not significantly affect the cost of the service.

Several methods of fare collection were evaluated by both the method of paired comparison and the semantic scaling technique. It has been presupposed by some that users of public transportation systems would prefer an easier method of payment such as a credit card. It is often argued that individuals think in terms of out-of-pocket costs and, if the method of payment for public transportation usage could be more aligned with the methods and frequency of purchases for the automobile, the demand for public transportation systems would increase. Figure 5 shows the preference scale values for the six methods of fare collection. The most preferred method of fare payment is cash with the ability to receive change. Exact fare and tokens are about the same and are next in line of priorities. A monthly pass and a 20-trip ticket maintain similar relative scale values. The respondents exhibit least desire to use a credit card to purchase usage of a public transportation system.

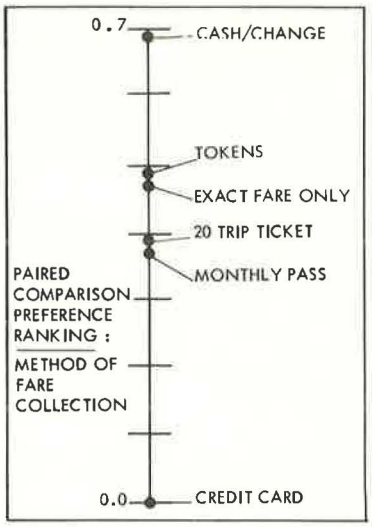


Figure 5. Preference scale values for six methods of fare collection.

This same trend is exhibited in the statistics from the semantic differential scaling responses. Paying "cash and receiving change" was ranked the highest (4.3). "Cash/exact fare only" and "twenty-trip ticket" were ranked second (both 4.2), followed by "tokens" (4.1), "monthly pass" (3.7), and "credit card" (3.3). The correlation between the results of the paired comparison method and the semantic scale method is thus observed to be good.

Some combination of fare payment methods seems to be desirable. A cash method must be provided for the occasional user, though requiring that exact change be deposited would not be unreasonable. From an operational viewpoint it would clearly be preferable for the driver of the vehicle not to be required to handle money. Twenty-trip tickets or tokens could also be sold by the system at a slightly discounted rate for the convenience of the regular user of the system. The cost to the system should be the determining factor in the selection of a convenient method of fare payment.

The attitudes of respondents toward giving fare discounts to certain classes of users were examined. These classes were students traveling at any time, students traveling to and from school, welfare recipients, children accompanied by an adult, retired persons, handicapped persons, persons purchasing a monthly pass, and persons purchasing a 20-trip ticket. The respondents strongly favor giving discounts to students traveling to and from school, retirees, the handicapped, and children accompanied by an adult (means of 6.0, 6.2, 6.2 and 5.7 respectively). Welfare recipients (mean = 5.2) and students (4.1) rate lower in acceptance toward a fare discount.

Four methods of determining the fare were examined. These were single fixed fare throughout the area, a basic fare plus an external trip charge (extra charge for trip outside city), a fare based on distance, and a zone based fare. The most desirable method of structuring the fare is a basic fare plus an external trip charge (mean = 5.4). A fare based on distance (mean = 5.2) is approximately equal to this method. The single fixed fare and a zonal fare are not too desirable (means of 3.5 and 3.9).

ANALYSIS OF THE MARKET SUBGROUPS

Attitudinal surveys can serve many important functions within a well-planned, broadly based marketing program. One of these functions is to provide information about preferences for selected market groups within the total population, thus helping to shape a more sensitive and strategic marketing plan.

User preferences were analyzed for the following market groups:

1. Low income (households with less than $5,000 annual income);
2. Elderly (respondents 60 years of age or older);
3. Young (respondents under 20 and single);
4. Nondrivers (respondents not holding a driver's license);
5. Housewives (female respondents not employed);
6. Both husband and wife employed;
7. Multicar households; and
8. One-car households.

In addition to these eight market groups, another classification was formed that analyzed the differences in relative preferences as a function of trip purpose. Three trip purposes were analyzed: work trips, shopping trips, and school trips.

Only three of the market groups, the elderly, the young, and the low-income group, demonstrated significantly different preferences from those expressed by the total market (Fig. 6).

There are four characteristics that the elderly definitely prefer. "Having a seat" and "no transfer trip" are ranked the highest and are followed by "lower fare" and "arriving when planned" (which is ranked the highest by the total population). The two clusters located at the center of the preference scale are close to the same. The exception is that "no crowding on the vehicle" and "easy entry and exit" rank in the first cluster for the elderly, whereas they rank in the lower cluster for the total market.

With respect to the subsystem groups of characteristics, vehicle design is still the least preferred; however, convenience factors are much less important to the elderly than they are to the total population. Level of service is definitely the primary concern of the elderly.

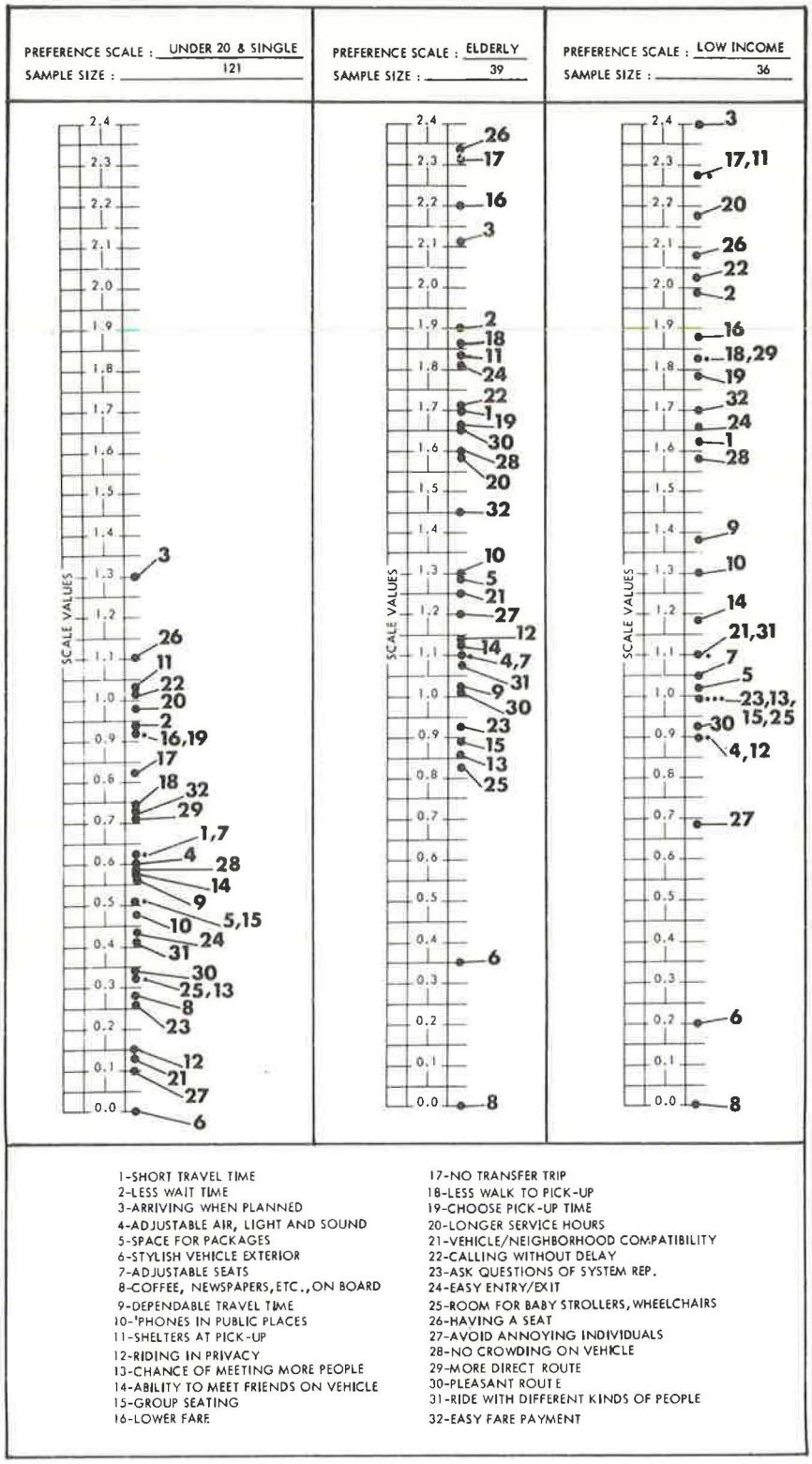
The elderly have focused attention on the special physical problem of riding public transportation—being able to get on and off the vehicle. They want to be able to sit down, not have to transfer, and pay a lower fare. They do not find most other conveniences worth extra fare, and they place a lower value on their time than does the total population. It should also be noticed that the preference scale is more dispersed for the elderly than for the total population, which indicates that a greater proportion of the respondents have extreme preferences.

The universal preference scale for the low-income group shows considerably more dispersion than the preference scale for the total market. The higher ranked characteristics do not cluster as closely as they did in the preference scale for the total population. The order of preferences is approximately the same as those expressed by the total market, except that "shelters at pickup" and "longer hours of service" are relatively more preferred by this group. There are seven characteristics of service and convenience that the low-income group prefers to lower fare.

The preferences suggest that members of this group are primarily concerned with their basic needs for public transportation. The system must be dependable. They want to be able to sit down on the bus and not have to change buses, and they have expressed a much higher preference for "shelters at pickup" and for "longer hours of service." The time that is important to them is waiting time, and they are concerned about "calling without delay." As was true for the elderly group, "easy entry and exit" and "no crowding on vehicle" are ranked much higher by this group than they are by the total sample. The lowest ranked characteristic is again "coffee, newspapers, and magazines on board."

The low-income group ranks "a convenient method of fare payment" higher than the total sample and expresses more definite preferences for methods of fare collection. In the semantic scaling questionnaire "cash/receive change" (mean = 5.4) is the most preferred form of fare payment; however, "cash/exact fare" (mean = 5.0) is almost as acceptable. The use of credit cards is even less acceptable to this group (mean = 2.7) than to the total market (mean = 3.3).

The low-income respondent's conception of the system may be different from that of a respondent from the other groups. For instance, it is likely that this person is a user of present transportation systems and perhaps conceives of waiting on a corner



1-SHORT TRAVEL TIME
2-LESS WAIT TIME
3-ARRIVING WHEN PLANNED
4-ADJUSTABLE AIR, LIGHT AND SOUND
5-SPACE FOR PACKAGES
6-STYLISH VEHICLE EXTERIOR
7-ADJUSTABLE SEATS
8-COFFEE, NEWSPAPERS, ETC., ON BOARD
9-DEPENDABLE TRAVEL TIME
10-'PHONES IN PUBLIC PLACES
11-SHELTERS AT PICK-UP
12-RIDING IN PRIVACY
13-CHANCE OF MEETING MORE PEOPLE
14-ABILITY TO MEET FRIENDS ON VEHICLE
15-GROUP SEATING
16-LOWER FARE
17-NO TRANSFER TRIP
18-LESS WALK TO PICK-UP
19-CHOOSE PICK-UP TIME
20-LONGER SERVICE HOURS
21-VEHICLE/NEIGHBORHOOD COMPATIBILITY
22-CALLING WITHOUT DELAY
23-ASK QUESTIONS OF SYSTEM REP.
24-EASY ENTRY/EXIT
25-ROOM FOR BABY STROLLERS, WHEELCHAIRS
26-HAVING A SEAT
27-AVOID ANNOYING INDIVIDUALS
28-NO CROWDING ON VEHICLE
29-MORE DIRECT ROUTE
30-PLEASANT ROUTE
31-RIDE WITH DIFFERENT KINDS OF PEOPLE
32-EASY FARE PAYMENT

Figure 6. Preference scales for 3 market subgroups.

for pickup, whereas a higher income respondent may be thinking in terms of pickup at his home. This would explain the higher importance of wait time, shelters, dependability, and longer hours of service.

The young are not as unanimous concerning their preferences as are the other subgroups. This is evidenced by smaller dispersion in the preference scale, which indicates a larger number of approximately equal proportional choices. The preferences of the young differ significantly from those of the elderly in that they are less concerned with the physical problem of riding public transportation. Such characteristics as "easy entry and exit," "no crowding on vehicle," and "no transfer trip" are given a much lower preference by the young, whereas "choosing pickup time," "calling without delay," and "longer hours of service" have higher relative importances. Because they are not constrained by the physical problem of riding a public transit vehicle, the young place more importance on items that would make the trip more enjoyable, such as "adjustable air, light and sound" and "coffee, newspapers, and magazines on board." "Riding in privacy," "avoid annoying individuals," and "vehicle/neighborhood compatibility" are of much less concern to the young than to any of the other groups or to the total market.

Convenience factors are ranked higher by the young than they are by the total population. The levels of service characteristics are ranked in about the same relative position as for the total population, with one or two characteristics interchanging positions. Vehicle design remains the least preferred subsystem, and "adjustable seats" and "adjustable air, light and sound" replace "no crowding on vehicle" and "easy entry and exit" as the most preferred of that group.

CONCLUSIONS

The study involved the application of a proven market research technique to achieve the objective of measuring user preferences for a demand-responsive transportation system. A statistically sound method of selection was used to choose a population of respondents from the case study community, and the home interview technique followed well-known guidelines in the field of marketing research.

The application of two complementary psychological scaling methods enabled a detailed analysis of the data obtained from the survey. These data were found to yield statistically significant estimates of perceived user preferences for the system characteristics investigated. The techniques yielded results that exhibited cross-validation, and the statistical estimates were found to be relatively stable across subsets of the total population.

The data enabled the analysis of user preferences and identification of trade-offs among design alternatives—two major objectives of the study. The results of the analysis are not contradictory to previous studies of user preferences and professional judgments concerning these preferences, but have, however, resulted in greater insight into design of a demand-responsive transportation system from the user's point of view. Moreover, the study has provided a source of detailed information that will be useful for future studies of related transportation systems.

The total population of respondents expressed preferences for high levels of service and certain convenience factors. These preference rankings suggest that the individuals prefer a mode that approximates the automobile with regard to level of service. The users indicate that they want to be able to depend on the system and wish to be inconvenienced as little as possible. The level of fare is important, but they are willing to trade off fare for a system that minimizes inconveniences. Dependability is much more important than extra travel time or fare level.

Social and aesthetic interests are not as important to the respondents; they appear to assess the practical aspects of a transportation mode. Special seating arrangements, coffee and music on board, or a smartly styled vehicle would be acceptable only if the inclusion of these extras did not increase the fare.

An analysis of market groups revealed that only three of the groups analyzed showed major variations from the preferences exhibited by the total sample. The elderly concerned themselves with the physical problems of riding the vehicle; they preferred not

to stand, change vehicles, be crowded, or have trouble getting on the vehicle. A low fare was also important. They were willing to trade off their time conveniences and a better vehicle design for the solution of these physical problems. The low-income group expresses preferences that imply a greater dependence on the system. This group prefers a dependable system with long hours of service at a low fare, with the provision of protection from the weather at pickup points. The young express different preferences than the other groups. They rank convenience factors very high and, as a group, are not concerned with factors such as transferring vehicles or being crowded.

This detailed survey has yielded information of importance to the designer of a demand-responsive transportation system, but the analyst must be aware of the demographic and socioeconomic characteristics of the respondents. The individuals in the community surveyed make 93 percent of their trips via the automobile mode. There are 65 percent blue-collar workers in the community. The population of the community has not voiced a need for public transportation. Although this community was chosen to be representative of many suburban communities in the nation, significant demographic differences will be found in other communities.

This study is a step forward in the art of obtaining relevant information from the potential users of a public transportation system about their preferences and needs. It thus represents an improvement in the ability to design public transportation service that is attractive and competitive within a growing and changing consumer market.

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