Survey to Assess Public Perception of Values Critical to Transportation Planning

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A survey in a middle-class suburb used an experimental dollar response scale to estimate the relative values as perceived by the public of competing features in a transportation system. The research supported a planning study in which a questionnaire was mailed to heads of households in a Maryland suburb of Washington, D.C. The population surveyed was predominantly middle class, affluent, and well-educated. Objectives of the questionnaire were (a) to determine the relative values that residents assigned to alternative characteristics (advantages, aversive features, impacts, and costs) of planned future transportation options and (b) to predict future user behavior. To measure variables otherwise difficult to compare, the researchers used four item formats that included an experimental item strategy in which the item described an aversive circumstance (waiting in the rain, air pollution) and that asked respondents to select an avoidance payment on a six-celled graduated response scale. The experimental items included noise, air pollution, transfers, waiting, walking, security, crowding, carrying packages, and extended work range. Analysis suggested the item strategy is reliable, gives good resolution and significance, and is effective for measuring the difficult-to-quantify vectors of public opinion. Findings included a strong interest in personal security and an aversion to two transfer trips. Further research is suggested to improve the item format and to test the effectiveness of the strategy with less sophisticated populations.

It is now commonplace to recognize that the lay public should play a role in transportation planning. Participation in planning by public users will ensure that the true needs of the community are met and that the opinions of individual citizens are considered. The need for public participation is easy to recognize but less easy to achieve.

For many years, highway planners have operated with independence and have based their plans largely on engineering considerations. More recently, however, both growth and highway development have come into question. Public resistance has stopped dozens of projects: Segments of the Interstate highway system have been left incomplete, and urgent regional plans have been paralyzed by indecision. New mechanisms are needed to decentralize decision making to the local level. This decentralization would provide an outlet for public concern and would allow decision making to reflect the tastes and values of respective communities.

It is within this context that the Rockville Corridor Transportation Alternatives Feasibility Study was undertaken in 1974. The survey discussed in this paper is one of several means used to establish contact with the public; the survey was intended as a means for expressing community values and for predicting future behavior in the public's use of transportation facilities. The survey is an accepted tool for planning; it employs a systematic sampling technique that ensures representative opinions. Other means of public expression tend to reflect the bias of interest groups or vocal minorities. In contrast, surveys offer manageable, quantifiable, and interpretable data. Shaffer (1) has observed that a survey properly executed and designed can accurately assess the thinking of the community.

The survey discussed in this paper used an innovative technique to study public values and probable public behavior in a Washington, D.C., suburb. It employed a new technique for measuring cost-benefit trade-offs and for equating system characteristics against imponderables such as social values, land use planning, and environmental impact. The technique was an experimental dollar-equivalent rating scale, which might be usefully applied elsewhere.

STUDY AREA

The study area is a suburb that, in several respects, is not typical. The area is a supporting suburb of Washington, D.C., that is characterized by a very high median family income ($24 000 in 1974) and a very high level of education (approximately one-third of adults are college graduates). More than 80 percent of family housing units are single-family dwellings. Furthermore, the residents of this suburb are observably more informed and politically aware than residents of other typical suburban communities.

Publication of this paper sponsored by Committee on Social, Economic, and Environmental Factors of Transportation.

Note: The authors were employed by URS/Matrix Company at the time of the study.

RESISTANCE TO HIGHWAY OPTIONS

The community had a clear history of opposition to new highway construction in their area. The records of hearings and press reports suggested that a new highway facility was viewed as detrimental to the environment and not in consonance with the needs or goals of the community. Many citizens had asserted that a freeway would increase noise and air pollution unacceptably, and they had also raised questions about loss of open space and aesthetic degradation in the corridor.

The most frequently heard opinion was that new roads would encourage automobile use, and this use might compete with mass transportation in terms of passengers and money. Objections were also expressed that linked automobile use to the larger issues of increased housing density, business development, and land use planning. To what extent these opinions were those of the majority was not clear; therefore, one objective of the survey was to explore the negative opinions quantitatively. We also wanted to know which transportation alternatives were acceptable to the public and to the transportation users. Ideally, the behavior of these users would be predicted in terms of accepting or rejecting specific alternatives in the system.

BEHAVIOR AS AN OBJECTIVE

The questionnaire was planned as a straightforward procedure and was within the state of the art for survey design. However, two difficulties were quickly recognized.

1. Since the survey focused on questions of value and of social goals, these matters would be difficult to quantify; and
2. Since transportation planning cannot be based on current opinion, a knowledge of future choice-of-mode behavior would be needed.

The transportation planner needs to know what the community desires and will support politically and also what a future public will choose, use, and pay for. The use of surveys is excellent for finding opinions, but opinions do not necessarily predict behavior. The planner who is concerned with system characteristics and service levels cannot depend on what people think they will want because future modal choices are made within a system that cannot be seen or experienced. These two considerations led to the development of an innovative questioning strategy.

STUDY DESIGN

In the survey, the specific questions were derived from a list of requirements submitted by members of the Rockville research team that included the engineering, socioeconomic, and environmental research staffs. The list of issues was large and was reduced by a cost-benefit sort to 32 items, a rule-of-experience limit for mailed surveys. These issues were then fitted to questioning strategies and phrased as specific items.

Conventional Question Strategies

A few demographic data were required, and four data items asked age, sex, household size, time of residence, and income. These questions used a standard multiple-choice strategy and conformed to phrasing and categories of the 1970 U.S. census. Further data were not required since demographic information was available from other sources that included an earlier population growth study by Pulliam (2).

Six questions addressed issues on urban growth and transportation planning policy. An open-ended item was in the following form:

Are you in favor of limiting urban growth in the study area?
- Yes
- No
- No opinion
- Comment

This type of question is expensive to score since it requires a scoring panel that uses Q-sort techniques. However, the format offers certain advantages: When comments are given, they offer a very large amount of information per item. The format encourages comment, which about 20 percent of respondents provided. The questions automatically adapt to a wide range of opinion, and the answers are in the respondent's language. The format protects against researcher bias and error in phrasing the questions. Item stems were written to define fields of controversy rather than to ask a specific question.

New Question Strategy

Information was also needed for trade-off decisions that concerned the costs and characteristics of transportation. The circumstances of the study required that costs include not only direct dollar costs, but also indirect costs such as those of human energy or of social and environmental impact. These costs needed to be weighed against benefits of time, freedom of movement, and economic advantage. The resulting data needed to be credible so it could predict the public's behavior in accepting, using, and paying for a future transportation system. However, the center of the difficulty was that disparate values were to be compared; there is no conventional scale on which to compare the value of clean air against the inconvenience of a bus transfer.

To compare disparate values, a dollar-scaled questioning strategy was developed. This strategy, which had not been previously suggested, had the following features:

1. The strategy used a 6-celled, nonlinear interval scale in which each cell represented a dollar cost;
2. Each scale was introduced by a situational description;
3. The scales ranged from a zero value cell to an infinite value cell, and most of the questions were expressed in terms of avoiding a distasteful condition; and
4. Four intermediate cells contained dollar-cost ranges.

The strategy was experimental, and we recognized the defects in logic and psychometric theory. Nonetheless, the strategy performed well in both the pretest and field test, and it exceeded expectations in the final survey. The strategy was not intended to measure or predict what people would actually pay for any future benefit. However, it was expected to be more comprehensible (to respondents) than other scaling systems, to be more reliably interpreted from question to question, and to be more reliably indicative of the relative values that people assign to the variables described.

For analysis, the cells of the scale were ranked according to their relative order of value (1, 2, . . . , 6) so that central tendency, relative rank of variables, and dispersion of opinion could be computed. The data were also examined for a possible relation to dollar terms. Except for one item, all of the items were in terms that expressed avoidance of an aversive circumstance. This

Table 1. Dollar-scale questions.

No.	Text	Item Name
12	To avoid waiting 15 minutes (each way) for a ride, I would pay up to:	Wait 15
13	To avoid waiting 25 minutes (each way) for a ride, I would pay up to:	Wait 25
14	To avoid having to transfer, or change from one kind of transportation to another, 1 time each way, I would pay up to:	Transfer 1
15	To avoid having to transfer, or change from one kind of transportation to another, 2 times each way, I would pay up to:	Transfer 2
16	To avoid waiting 15 minutes (total) when it is raining, I would pay up to:	Rain 15
17	To avoid riding 30 minutes in a very crowded vehicle, I would pay up to:	Crowded 30
18	To avoid carrying heavy packages for a 15 minute walk, I would pay up to:	Packages 15
19	To avoid walking 15 minutes to get my ride, I would pay up to:	Walk 15
20	To avoid feeling personally in danger, while waiting or traveling, I would pay up to:	Danger
21	To avoid traveling 15 minutes longer each way, I would pay up to:	Ride 15
22	To avoid additional intrusive traffic noise in my neighborhood, my family would pay, on a daily basis, up to:	Noise
23	To avoid making air pollution worse, my family would pay, on a daily basis, up to:	Pollution
24	Suppose you were seeking employment. How much would it be worth to you (per day) to be free to seek and take work in a wider area without increasing your travel time?	Work range

phrasing provided parallel expressions for each of the variables. The researchers would have preferred phrasing in positive terms, but were unable to achieve this goal.

The item statements (Table 1) avoid description of the specific modes (automobile, bus, rail) in which the described aversive circumstances were to occur. It was considered that, although individual preferences regarding considerations such as speed and waiting are mode dependent, it was desirable to know what dollar worth time is to people in mode independent terms.

Field Test

A field test of the structure, content, and wording of the draft survey was conducted in two phases. The survey was informally administered by the researchers, and the respondents were questioned about language, method, and acceptability of the questionnaire. After modification, a formal field test was conducted by mailing a sample of 182 questionnaires. The 70 responses to the field test were analyzed by hand. The results indicated that the survey was understood by the respondents, produced an adequate response rate, and gave a satisfactory statistical resolution of responses.

Sampling Procedure

As a first priority, the sample was structured to ensure a representative geographic sample. Stratification of the sample by socioeconomic background and by categories of transport users was desired. This stratification was achieved by using a geographic sample from census data. The study area had previously been mapped for 10 study zones, and the zones followed the lines of the 1970 census and of natural community limits such as park-belts and freeways. A criterion for rate of return was established at a total of 1200 usable questionnaires and 100 questionnaires/study zone.

The sample was randomly selected from listings in the Haines Criss-Cross Directory, which was corrected for unlisted numbers and for persons with no phone (rare in this area). A table of random numbers was used to select 20.2 percent of households in the area, and this percentage produced a mailing sample of 6800 names and addresses. Listings were edited to eliminate businesses and second telephones and were posted to a map to ensure that the percentage sampled from each 1970 census tract was within 3 percent of proportionality. Tests for sampling error by strata revealed that residents of apartment dwellings (22 percent of the 1970 census) were underrepresented in the sample. Thus, a 6 percent adjustment was made to increase the number of mailings to multiple-unit dwellings.

Mailing and Return

Surveys were coded with a census tract number and were mailed during the first week of November 1974. Undeliverable mail that was returned during the following week was matched and replaced by mailing to a new name in the same census tract. After 1 week, the six tracts with an unsatisfactory amount of low returns were resampled to further ensure a representative geographic sampling of returns.

Of the 6551 questionnaires that reached the addressees, 2131 were returned in a form suitable for analysis. The response rate was 31.5 percent, which is high for a mailed survey and suggests the technical adequacy of the survey and method. However, consideration must also be given to the fact that the population in the study area is highly literate and that there is a high level of interest in the subject matter of the survey. The distribution of responses was analyzed in reference to the 10 geographic study zones and was highly representative of the known population within the error range of -2.2 to +3.6 percent.

FINDINGS

Representativeness of the Sample

Demographic data were collected to measure the stratification of the sample. These data were analyzed and compared by study zone according to characteristics of the population known from the 1970 census, data collected regionally (3), and socioeconomic studies that were previously conducted by Pulliam (2). The results coincided with the expectations that were based on these data. Thus, the sample was considered representative of the population in the dimensions of demography, economic status, and automobile ownership.

Open-Response Goal Questions

Five questions in the survey dealt with policy concerning urban growth, commercial development, alternatives to the automobile, improvement of roads, and private automobile use. These questions could be answered with a yes or no response, but additional written comment was requested and was offered by over 20 percent of respondents. The response to these questions appeared well-informed and was not polarized into the strong adversary positions that had been expected from reading the public hearings and press reports. There was a cautious consensus for limited, planned urban growth and for commercial development. Although there was an emphasis on limitation, the majority thought some growth was necessary. Most of the respondents agreed that alternatives to use of private automobiles for commuting were necessary, but they had strong reservations about the feasibility and availability of alternative modes. Roadway improvement was overwhelmingly favored over major new throughways. The forced limitation of private auto-

mobile use was not approved.

Dollar-Scaled Questions

There were 13 experimental questions, and these were used to find the values assigned by the public to specific characteristics of transportation systems. These questions are of technical interest. As described earlier, the questions measured the perceived values of specific characteristics of transportation systems that included aversive features and environmental impacts and were in reference to a dollar scale.

These questions were considered analogous to real-world decisions in which a person must decide how much he or she is willing to pay to avoid discomfort, inconvenience, or environmental degradation. The avoidance value is measured by the question and is presumably a reciprocal of the positive value of a related comfort, convenience, or environmental quality. Thus, the avoidance value is objectively described in terms of what a person is willing to pay to achieve the alternative.

Obviously, the question format was intellectually demanding. Although the format worked in the field test, there was concern that it might be difficult to use, might be objectionable, or might be unreliable. It was agreed that the test of acceptability would be the response rate. Tests of internal consistency would provide an estimate of reliability.

The rate of response dropped at the experimental series of questions. In comparison with questions in the more conventional format, the rate of usable response was lower for the value-scale questions by about 9 percent. There were 250 cases of unusable responses. About 150 of the respondents apparently failed to answer some of the questions because the respondent was unsure of the method or found the mental effort too great. The remaining 100 respondents marked the question, but made an unusable response such as marking more than one cell, altering the boxes, or responding with a written comment. As the respondents proceeded from question to question within the experimental, dollar-scaled section of the questionnaire, the number of mismarked questions decreased and the number of declined-to-answer and did-not-answer questions increased. Because in this case the questionnaire was administered to a relatively sophisticated population and concerned matters of general public interest, the unfamiliar strategy did not greatly affect the usefulness of the returns. Thus, the high information content of findings justified the experiment. However, the method should be further simplified before being used under different conditions.

Estimates of Reliability

The strategy was recognized as experimental; therefore, evidence was examined that might suggest to what extent the scale data were meaningful. Two tests of internal consistency were applied as estimators of reliability, and one was applied as a rough test of validity. Single-item statistics such as full-range median, mean and mode, median of the dollar intervals, interval 2 (I_2) through interval 5 (I_5), and moment of the end intervals (I_1 and I_6) were displayed in rank order and examined for deviations. The observed orders were almost entirely consistent, and this suggests an internally consistent scale. Indexes of dispersion were examined by using the semi-interquartile range (Q), quartile differences ($Q_2 - Q_1$ and $Q_3 - Q_2$), and the sums of the extreme cells. The standard deviation is not applicable in this study since the data were not normally distributed. The dispersions reflected were mutually consistent. Finally, an index of value was computed by assigning assumed values to the six cells of zero, \$0.12, \$0.25, \$0.50, \$1.00, and \$2.00 respectively. These values were placed in a rank order identical to that of the previously reported measures of central tendency, and they are used again in the findings.

Finally, it was noted that the findings met the rough validity tests of consistency with logic and expectation. The matters that had known results and were highly distasteful (personal danger) outweighed the other matters that had unknown results. Waiting in the rain outranked simply waiting. Waiting for 25 min outranked waiting for 15 min, and transferring twice outranked transferring once. The selected scale-of-dollar values was credible and showed a good metric resolution. Therefore the scale-of-dollar values had some credibility as a referent to the dollar values perceived by the public for the specific variables of travel that the questions described.

Statistical Significance

A chi-square test was applied to determine the possibility of a reported difference due to chance alone. There was one case of least scalar difference between variables (0.01 between rain 15 and transfer 1), and the significance was low ($p = <0.20$). All other ordinal differences in rank of variables were significant ($p = <0.001$).

STUDY RESULTS AND INTERPRETATION

Table 1 gives a listing of the questions in their original order. The last three items are listed separately because they are not strictly comparable with the first 10 items. The phrasing for the last three items is not parallel, and the response scale used did not include box I_6 (I would not travel) because it was inappropriate to the question.

Table 2 gives a listing of item name and the rank order of perceived value as found by the survey. Three indexes describe the response. The respondents who marked the first box (percent don't care) indicated that they would not mind the hazard or inconvenience. The respondents who marked the second box (percent won't travel) objected so strongly that they would not travel under aversive circumstances. The index of value is the central tendency of dollar values that was assigned by respondents. This statistic is considered to be the best metric of relative aversion or disutility for the aversive variables and for the positive value of the work range.

This dispersion of opinion for each variable is of interest because it presumably measures the degree of public agreement or disagreement with the value. The dispersion of opinion for the first 10 variables is also given in Table 2. Since the data are not derived from a normal distribution (standard deviation is not an appropriate measure), they are shown in the semi-interquartile range (Q). The Q-values represent the distance on the scale (in numbers and decimal fractions of whole cells) that is occupied by the central 50 percent of responses.

The results are of interest because of their presumed value, and this value can be used to decide which alternatives will be used in a future transportation system for the study area. Collectively, the results indicate some clear value relations among variables of transportation.

Safety

The threat of physical danger was the most distasteful of all conditions measured. The item was phrased,

Table 2. Responses to dollar-scale questions by rank order of findings and dispersion of opinion.

Item Name	Don't Care (%)	Won't Travel (%)	Index of Value	Q-Range
Danger	11.4	40.3	1.31	1.55
Transfer 2	9.6	33.9	0.66	1.67
Wait 25	8.8	25.1	0.43	1.67
Packages 15	17.8	22.6	0.41	1.67
Crowded 30	19.7	20.2	0.34	1.53
Transfer 1	22.9	16.3	0.28	1.27
Rain 15	23.5	15.6	0.27	1.07
Ride 15	26.6	11.8	0.22	1.07
Walk 15	33.9	15.0	0.19	1.21
Wait 15	32.7	11.5	0.16	1.07
Work range	27.2	NA	0.62	NA
Pollution	15.1	NA	0.36	NA
Noise	25.4	NA	0.40	NA

"... feeling personally in danger while waiting or traveling." Pretest interviews had verified that the danger perceived was that of robbery or assault. Respondents objected to this danger twice as much as the next most aversive condition, and more than 40 percent of the respondents indicated they would not travel if they felt threatened. The implication for public rapid transport systems is clear. The relatively high dispersion of opinion (Q = 1.55) suggests diverging attitudes, and, in fact, the distribution had two modes that reflected a large population (about 54 percent) who would pay more than a dollar to avoid danger (or not travel). Another group of respondents (about 35 percent), whose modal point diverged by over 2.5 scale points, were relatively unconcerned and had a modal index of only 0.25. Surprisingly, these subgroups did not correlate with income or with any of the demographic variables mentioned.

Transfers

The second most objectionable matter was a necessity to transfer more than once per trip. This objection was in partial agreement with the findings of Levinson and Gersten (4), who found that the single transfer was most objectionable to their respondents. The phrasing of this question included cases of park-and-ride as well as cases of transfers during use of public modes. This phrasing may account for the lower degree of objection regarding the first transfer and the higher degree of objection regarding the second transfer as given in Table 2. The distastefulness of the two-transfer trip was more than twice that of a single-transfer mode change. Over one-third believed they would not travel, and the index of value computed was second only to that for danger. In contrast, transferring once was only a little more objectionable than the least distasteful matters measured, and it compared closely to that of waiting in the rain.

Waiting for a Ride

The third most objectionable variable was a long wait. The results given in Table 2 show that a 25-min wait was substantially more objectionable than a 15-min wait. Using psychological bases, the researchers hypothesized that the value of delay is nonlinear and that it rises sharply above 15 to 20 min. The data seem to support this hypothesis, since the 10-min interval made a difference of 2.7 times in the reported aversive value, and it more than doubled for the number of those unwilling to travel. The index of dispersion was higher for the 25-min wait (Q = 1.67) than for the 15-min wait (Q = 1.07), which reflects a wider range of opinion regarding the longer delay.

Carrying Packages and Crowding

Carrying packages for a 15-min walk and riding 30 min in a crowded vehicle were in the middle range of aversive activities. As given in Table 2, the values for these activities were grouped closely in the middle of the scale.

Mildly Aversive Conditions

Five characteristics were reported at moderately low levels of distaste, and these are displayed near the bottom of Table 2. Transferring only once, waiting 15 min in the rain, riding 15 extra min, and waiting 15 min were valued in that order and were within a 0.11 point range. From 16 to 28 percent of respondents said that to avoid the above contingencies they would not travel; and for those who would travel, they would pay an average of 27 to 32 cents/trip to avoid the inconvenience. There were more respondents who said they did not care (23 to 33 percent) than those who said they would not travel.

Air Pollution and Noise

For previously explained reasons, three variables were rated on a scale that was not strictly comparable with that used for the 10 variables. Table 2 gives the values that are reported for the two environmental impacts. The values are approximations of what heads of households believe they would be willing to pay on a daily basis to avoid increasing air pollution and to avoid intrusive traffic noise in their neighborhoods.

One can compare these values with the values previously reported for transfer 2 and rain 15. If these values are related to the 10 aversive variables, they are rated in the middle range. However, these comparisons must be made with the understanding that the two scales are of unproven equivalence.

Of note is the number of people who reported they did not care. The 15 percent who did not care enough to pay anything to avoid pollution is exceeded by the 25 percent who did not care about noise. It appears that, to this population, air pollution is a more popular issue or is more generally perceived to be a problem than is that of traffic noise.

Work Range

Finally, one question on the dollar-scaled response asked the respondents what amount they would pay to seek work within a wider area. Table 2 gives the relatively high value (0.62) assigned to that variable. The response data suggest that over 70 percent of householders in the study area believe they would value an ability to seek work within a wider area, if seeking employment. They placed the relatively high mean value of $0.62/d on that freedom and a modal value of over $1. This value is substantially higher than those assigned to environmental impacts.

CONCLUSIONS

The data suggest that a dollar-value response scale can assist in assessing the value of transportation system variables that have not been previously comparable. The technique is particularly useful to transportation planners because it permits them to look at transport characteristics without specifying modes; furthermore, it addresses behavioral responses rather than pure opinion. Further research should explore variations in format and phrasing and the degree to which the strategy works for less sophisticated populations.

ACKNOWLEDGMENTS

Data were gathered as part of a project jointly funded by the Federal Highway Administration, U.S. Department of Transportation, and the Maryland Department of Transportation. We are responsible for all data and conclusions.

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