TRANSPORTATION RESEARCH RECORD 735

Public Transportation Planning and Development

TRANSPORTATION RESEARCH BOARD

COMMISSION ON SOCIOTECHNICAL SYSTEMS
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C. 1979

Transportation Research Record 735
Price $3.00
Edited for TRB by Susan Singer-Bart

mode
2 public transit

subject areas
11 administration
12 planning
14 finance
16 user needs
54 operations and traffic control

Transportation Research Board publications are available by ordering directly from TRB. They may also be obtained on a regular basis through organizational or individual affiliation with TRB; affiliates or library subscribers are eligible for substantial discounts. For further information, write to the Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, N.W., Washington, DC 20418.

Library of Congress Cataloging in Publication Data
National Research Council. Transportation Research Board.
Public transportation planning and development.

(Transportation research record; 735)
1. Local transit–Addresses, essays, lectures. 2. Urban transportation–Addresses, essays, lectures. I. Title. II. Series.
TE7.H5 no. 735 [TA1155] 380.5s [388.4'068] 80-13295
ISBN 0-309-02990-2 ISSN 0361-1981

Sponsorship of the Papers in This Transportation Research Record

GROUP 1–TRANSPORTATION SYSTEMS PLANNING AND ADMINISTRATION
Leon M. Cole, Library of Congress, chairman

Public Transportation Section
Kenneth W. Heathington, University of Tennessee, chairman

Committee on Public Transportation Planning and Development
George E. Gray, California Department of Transportation, chairman
Donald C. Kendall, Transportation Systems Center, secretary
William G. Barker, Joby H. Berman, Patricia Suanne Brooks, John L. Crain, Russell Cummings, Frank W. Davis, Jr., John W. Dickey, James C. Echols, Marta V. Fernandez, Harold H. Geissenheimer, Jacqueline Gillan, F. Norman Hill, William T. Howard, Carol A. Keck, Eugene J. Lessieu, David R. Miller, Ray A. Mundy, Philip J. Ringo, Gilbert T. Satterly, Jr., George M. Smerk, Donald R. Spivack, William L. Volk, Edward Weiner, Joel Woodhull

GROUP–3 OPERATION AND MAINTENANCE OF TRANSPORTATION FACILITIES
Adolf D. May, University of California, Berkeley, chairman

Committee on Transit Service Characteristics
James E. Reading, Central Ohio Transit Authority, chairman
Peter Wood, Mitre Corporation, secretary
Dolores K. Allison, Nicholas E. Bade, Arline L. Bronzaft, Robert C. Buchanan, Howard B. Clarkson, Peter B. Everett, Gordon J. Fielding, Martin Flusberg, Harold H. Geissenheimer, Benita Gray, Aaron Isaacs, Judith Kaplan, Karla H. Karash, Thomas Starr King, Brian C. Kullman, Barry D. Lundberg, Faye L. Mench, Ray A. Mundy, Ronald C. Pfefer, Robert W. Pully, Philip J. Ringo, Sherrill Swan

W. Campbell Graeub, Transportation Research Board staff

Sponsorship is indicated by a footnote at the end of each report. The organizational units and officers and members are as of December 31, 1978.

Contents

Attitudinal Market Segmentation for Transit Design, Marketing, and Policy Analysis

Timothy J. Tardiff*, Department of Civil Engineering and Division of Environmental Studies, University of California, Davis

The segmentation of a population into groups that have similar perceptions of transit attributes or similar outlooks on transportation issues could be very useful in the design, marketing, and operation of transit systems and in the analysis of transit policies. This paper uses a variety of statistical methodologies in the development of such market segments. The data are from a representative sample of households in the Sacramento metropolitan region. A set of 23 general transportation attitude items and a set of 30 specific transit attributes are the basic inputs into the analysis. Responses to items in each set are factor analyzed, and the resulting factor scores are input into a hierarchical cluster-analysis program. The outputs are the market segments. The segments are then examined for differences in objective characteristics and travel behavior patterns. Groups that have similar patterns of general or specific attitudes were found to emerge, and these groups differ in some objective characteristics and travel behavior. The market segmentation based on specific transit attributes appears to be useful for design and marketing decisions; the general market segments are primarily useful for analyzing support for transportation policies.

The design, provision, and marketing of transit services may be improved by focusing on differentiated transit markets rather than on an undifferentiated service market (1). The use of market segmentation tools developed in other marketing contexts may be useful in transit management (2-5).

At least three purposes for market segmentation have been identified:

1. Demand forecasting tools may be improved by development of separate models or sets of models for various segments (2, 4, 5),
2. Division of the population into homogeneous segments may be useful in the design and marketing of transit services (3), and
3. Market segmentation might help managers identify groups that support or oppose various transit policies, independent of their potential transit ridership (2) (e.g., various people may support public transit funding without actually using the system).

This paper focuses on the second and third purposes. Four criteria, or segmentation bases, have been suggested for dividing a population into market segments. These are

1. Demographic variables,
2. Measures of transportation opportunities (e.g., automobile and transit availability) (6, 7),
3. Travel behavior variables, and
4. Perceptions of transportation systems and issues (i.e., attitudinal variables).

The identification of groups that are sensitive to particular transit characteristics or to particular policies could be very important information for transit policymakers. For this reason, this paper will focus on market segmentation based on attitudinal variables.

METHODOLOGY

The techniques used to develop transit market segments based on attitudinal variables are similar to those used by General Motors researchers in a pioneering transportation market segmentation study (4, 5). The key inputs into the analysis are the responses to two sets of attitudinal items obtained from a household survey. By use of appropriate multivariate statistical techniques, the respondents are categorized into a small number of market segments based on similar responses to the attitudinal items. The segments are then examined for differences in objective individual and household characteristics and for differences in travel behavior.

The data were collected in the spring of 1975 in the Sacramento metropolitan area. A representative sample of 1280 households was contacted and a questionnaire containing items relevant to several transit planning and marketing issues was administered to one member of the household. Details of the study design and a copy of the questionnaire are available in Ingram (8) and Tardiff and others (9).

The first set of attitude items contains 23 statements designed to measure general feelings toward automobile and transit systems and policies relevant to those systems. The second set is a list of improvements in 30 specific transit attributes. Respondents were asked to indicate the likelihood of increased transit ridership with each of the 30 improvements. The two sets are used separately to yield a market segmentation based on general and specific attitudes, respectively.

Each set is factor analyzed to yield a smaller number of more basic attitude dimensions. Kaiser varimax rotation was used for principal components analysis. Factor scores for each individual are used as input into the Bimed hierarchical cluster-analysis program (10, 11). The output from the program is the classification of the sample into a small number of market segments. Finally, differences in objective characteristics and travel behavior are examined by the use of simple descriptive statistics. Discriminant analysis, a multivariate technique, can also be used to examine differences in objective characteristics. This was done elsewhere (9, 12), where it was found that the qualitative interpretation of group differences was the same as that derived from the simple statistics. Therefore, the results of the discriminant analyses are not reported here. More details on the methodology are reported elsewhere (9, 12). A complete set of computer programs has been developed and tested for market segmentation analyses by using survey instruments similar to the one used in the Sacramento study (13).

These procedures result in the division of the sample into groups that have similar general feelings toward transportation issues or similar perceptions of specific transit attributes. By observing differences in objective characteristics, it is possible to determine whether groups that have similar attitudes also have similar

Table 1. Pattern of mean responses for the general market segments on the five input factors.

Factor Number	Factor Label	Segment 1 Proautomobile Restrictions (N=136)	Segment 2 Transportation Supporters (N=490)	Segment 3 Antitransit (N=106)	Segment 4 Antifreeway Expansion (N=135)	Segment 5 Satisfied with Status Quo (N=120)	Segment 6 Miscellaneous (N=216)
1	Buses cause problems		*	x		*	x
2	Profreeway improvements		x		**		
3	No serious automobile problems	x	*			xx	
4	Increased transit role	*	x	**	x		
5	Automobile restrictions necessary	x				*	

Notes: xx = much stronger than average agreement; x = stronger than average agreement; blank = about average; * = stronger than average disagreement; and ** = much stronger than average disagreement.

objective characteristics, which allows the analyst to more clearly identify the segments. The differences in travel behavior reveal the extent to which attitudes are related to behavior.

Market Segments Based on General Attitudes

Responses to the 23 general attitude items were measured on a five-point agreement-disagreement scale, ranging from strongly agree to strongly disagree. A factor analysis of these items yields a five-factor solution that explains about 43 percent of the variance of the input variables. Based on interpretation of factor loadings, the factors are labeled:

1. Buses cause problems,
2. Profreeway improvements,
3. No serious automobile problems,
4. Increased transit role, and
5. Automobile restrictions necessary.

Only the 1203 respondents who responded to all 23 items are included in this and subsequent analyses in this section.

The five-factor scores for each individual were input into the hierarchical cluster-analysis program. The solution with five groups plus a sixth miscellaneous group, which contained respondents not easily classified into any of the five larger groups, is the most satisfactory. The mean responses for the six market segments on the five factors are represented in Table 1. The segments are labeled based on interpretation of the pattern of mean factor scores (i.e., the pattern of agreement or disagreement with the themes represented by the factors). For each factor, the differences in means for the segments are highly statistically significant, using the standard F-test.

By observing the profiles of mean factor scores for each segment, the attitudinal features of each group can be identified. Because of very large average values on one of the factors, the third, fourth, and fifth segments have fairly straightforward interpretations. Members of the third segment tend to disagree strongly with an increased role for transit. The stronger than average agreement with the belief that buses cause problems is consistent with the general profile. Based on this reasoning, the third segment is labeled "antitransit".

The fourth segment exhibits a much larger than average disagreement with freeway improvement. Also, members of this segment tend to agree with an increased transit role. This pattern suggests a label of "antifreeway expansion" for this segment.

People in the fifth segment tend to agree strongly that no serious transportation problems are caused by the automobile. In addition, they tend to disagree with the contentions that buses cause problems and that automobile restrictions are necessary. This profile suggests relative satisfaction with the existing transportation situation. This group is close to the average on the two factors that indicate expansion of either freeways or transit, which is consistent with the relative satisfaction interpretation. Therefore, this segment is labeled "satisfied with status quo".

Because of a lack of very high average scores on any of the factors, the remaining three segments are somewhat more difficult to label. The sixth segment is made up of numerous individual cases and small clusters. Probably the miscellaneous label is most appropriate; however, there does appear to be some concern about the problems caused by buses. This suggests a subtitle of "concerned about bus problems".

The first segment has moderately large average factor scores on the third, fourth, and fifth factors. The profile that emerges is one of agreement that there are no serious automobile-related transportation problems, disagreement with an expanded role for transit, and agreement with the need for automobile restrictions. Although this pattern seems somewhat inconsistent at first, if it is noted that the automobile-related problems in the third factor are primarily congestion and parking problems, the agreement with automobile restrictions might be for other reasons. At any rate, this segment is labeled "proautomobile restriction".

Because the second segment is much larger than the others, it is not surprising that average scores are not as extreme. The strongest sentiment seems to be one of disagreement with the contention that there are no serious automobile-related transportation problems. This fact, together with the tendency to disagree that buses cause problems and agree with expanded roles for both freeways and the bus system, suggests a label of "transportation supporters".

Differences in Individual and Household Characteristics

The market segments are examined for differences in six characteristics: (a) age, (b) sex, (c) income, (d) education, (e) the ratio of automobiles to licensed drivers in the respondent's household, and (f) a transit level-of-service index. The last variable was developed

Table 2. Means and standard deviations for the general market segments on six objective characteristics.

Segment		Age[a]		Sex		Income		Education[a]		Automobiles per Licensed Driver[a]		Level of Service Index	
Number	Label	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Proautomobile restrictions (N=114)	43.34	15.86	1.66	0.48	3.23	1.60	3.66	1.39	0.82	0.50	1.75	0.85
2	Transportation supporters (N=431)	40.06	15.30	1.61	0.49	3.13	1.53	3.89	1.49	0.87	0.36	1.56	0.83
3	Antitransit (N=88)	46.30	17.52	1.53	0.50	3.40	1.74	3.80	1.36	0.96	0.37	1.57	0.87
4	Antifreeway expansion (N=122)	40.55	15.16	1.57	0.50	3.38	1.68	4.71	1.76	0.86	0.33	1.56	0.88
5	Satisfied with status quo (N=107)	47.57	14.67	1.49	0.50	3.64	1.67	3.94	1.76	0.95	0.39	1.71	0.85
6	Miscellaneous (N=181)	42.27	16.19	1.60	0.49	3.19	1.78	3.82	1.72	0.81	0.33	1.75	0.89

Notes: Sex 1 = male, 2 = female; income 1 = 0 - $5000, 2 = $5000 - $10 000, 3 = $10 000 - $15 000, 4 = $15 000 - $20 000, 5 = $20 000 - $25 000, 6 = $25 000 - $30 000, 7 = over $30 000; education 1 = 0 - 8 grades, 2 = 9 - 11 grades, 3 = 12 grades, 4 = some college, 5 = junior college graduate, 6 = 4-year college graduate, 7 = postgraduate; level of service index 0 = no transit service, 1 = below average service, 2 = good transit service, 3 = excellent transit service. Age is measured in years and automobiles per licensed driver is as defined.

[a]Differences in segment means significant at $p < 0.01$.

by transportation planners to summarize transit availability in the Sacramento region.

Table 2 lists the means and standard deviations for the six market segments on the characteristics just defined. All differences are based on respondents who gave a complete set of answers for all six characteristics. This results in some reduction in sample size. The differences in means for the age, education, and automobiles per licensed drivers variables are all highly significant. Also, when income is used as a categoric variable, statistically significant differences in income distributions appear (9). Therefore, differences among the market segments on these four variables are noted.

First, the largest segment, the transportation supporters, appear to be about average on most of the characteristics examined, with the exception of below average age and income. The same is basically true for the miscellaneous segment, with the exception of somewhat below average automobile availability.

The first segment, the proautomobile restrictions group, appears to include respondents who have average income but are somewhat older, have lower automobile ownership, and have lower educational status than average. Perhaps the support for automobile restrictions arises from the lower than average automobile availability.

The antitransit and the supports-the-status-quo segments (3 and 5) have very similar patterns of characteristics. Both exhibit high automobile availability, higher than average income, and tend to contain older respondents. The difference is in the education level; the status quo segment has about average education and the antitransit segment has below average education. The higher level of education may be the cause of the difference between the conservative antitransit position and the moderate or establishment status quo position.

The antifreeway expansion segment appears to have a unique profile. The lower than average age arises from a high representation of people in the 21-39 age categories and the moderately high income represents a high concentration in the $15 000-$20 000 categories (9). These features and the very high level of educational achievement all suggest a concentration of young professionals. The antifreeway expansion sentiment is also accompanied by a higher than average level of support for an increased transit role. Therefore, this segment appears to be the strongest ally of active and innovative transportation planners.

It is interesting to note that the differences in the transit level-of-service index are not significant, which suggests that general attitudes toward transportation systems are not related to currently available levels of service. Finally, although there are some distinct differences in average characteristics, correspondence is not perfect between objective characteristics and attitudinal variables (i.e., there is overlap among the segments in their objective characteristics). Consequently, attitudinal market segmentation is different from segmentation based on objective characteristics.

Differences in Travel Behavior

Two types of travel behavior are used in this analysis. First, respondents reported the monthly frequencies of trips for school, work, shopping, and miscellaneous (medical, personal business, church, sports or entertainment, and dining) purposes. The total for these four purposes was used as a fifth trip purpose. Second, respondents were asked whether they were users of six nonautomobile driver modes: (a) frequent transit users, (b) occasional transit users, (c) carpool for work, (d) carpool for shopping, (e) carpool for recreational trips, and (f) walk or ride a bicycle to work or school.

Since the qualitative pattern of monthly travel frequencies is more informative than the actual numerical values, it will be noted without reporting numerical results. There are statistically significant differences in mean travel frequencies for school trips, work trips, and total trips.

The general pattern is interesting. The proautomobile restrictions segment and the antitransit segment both have substantially below average frequencies. The antifreeway and status quo segments have somewhat above average frequencies, and the remaining two segments are about average.

The general pattern shows that, although the antitransit and status quo segments are very similar on their personal and household characteristics, including automobile availability, they are very different in their behavior. The former segment is

much more similar to the proautomobile restrictions segment, with its low automobile availability, and the latter segment is similar to the antifreeway group.

The tests for differences in the proportions by use of various transportation modes result in only one relationship that is statistically significant—whether or not the respondent is a walking or bicycle commuter. The highest proportion of people who commute by walking or bicycle is contained in the antifreeway segment (14.1 percent); however, the following three segments are substantially less likely than average to contain such commuters: proautomobile restrictions (2.9 percent), antitransit (3.8 percent), and status quo (3.3 percent). The other two segments, transportation supporters (10.6 percent) and miscellaneous (6.9 percent), have proportions closer to the sample proportion. Although the differences in the proportions of frequent transit users are only significant at the 0.12 level, it is interesting to note that the antitransit segment has the lowest proportion of frequent transit riders. This finding is consistent with the antitransit attitudes of this segment.

In many cases, the segments do not appear to differ substantially in their behavior. This is especially true for the various indicators of nonautomobile driver modal use, where one might expect substantial differences. In particular, there were no statistically significant differences among the market segments with respect to frequent or occasional transit use. Such a finding may indicate that general feelings toward transportation modes may not be strongly related to modal selection. This is consistent with Johnson's (14) findings and suggests that segments based on general attitudes may be more useful in identifying groups that support or oppose particular transit policies than in explaining travel behavior.

The behavioral patterns for the various segments offer new insights into their characteristics. The antitransit group and the proautomobile restrictions group are quite similar in their behavior. Both groups exhibit low mobility, even though the former group has higher than average automobile availability and the latter group is below average. The antifreeway and status quo segments are similar in their behavioral patterns. Both groups have high mobility. The remaining two segments, the transportation supporters and the miscellaneous group, both were fairly average in their travel behavior.

MARKET SEGMENTS BASED ON SPECIFIC ATTITUDES

The purpose of developing market segments based on specific transit attributes is to identify groups of people who are especially sensitive to particular attributes. In the General Motors study (4, 5) the segmentation was based on responses that indicated the importance of specific attributes in current modal choice decisions. These data are not available in the Sacramento study. However, respondents were asked to indicate the likelihood of increased transit use if improvements were made in 30 specific attributes. The responses were recorded on a four-point scale, ranging from very likely to not likely at all. These responses may be used as an indication of the current importance placed on particular transit attributes rather than as accurate indicators of future behavior. With this interpretation, the variables yield information similar to the importance data used in the General Motors study.

The factor analysis of the data for specific transit attributes uses the 966 cases that have complete responses on all 30 items. The analysis yields three factors that explain about 57 percent of the total variance in the input variables (12). These factors are relevant to actions transit managers may take to design, market, or improve their systems. Items that have loadings greater than 0.5 are given primary attention in factor interpretation.

Factor 1 appears to be an indicator of the sensitivity of future transit use to the overall quality of the system. The specific items that have loading greater than 0.5 all refer to the ease or pleasantness of using the system (bus routing, scheduling, fare levels and collection, information availability, safety, and cleanliness).

The second factor contains high loading items that focus on the overall time requirements for a transit trip. Of the 12 items that have loadings of at least 0.5, 9 are related to time. Specifically, the items that cover the overall travel time relative to the automobile, walking time, transfers, directness of bus routes, and frequency all are consistent with a concern for trip time. The remaining items can be interpreted as comparing the quality of the transit ride to that of the automobile. Therefore, although the dominant theme in factor 2 is transit trip time, there might be an underlying comparison of transit to automobile.

The third factor appears to be psychological well-being or comfort. The six items that have loadings greater than 0.5 contribute to a feeling of being at ease while riding the bus. Four of these items refer to the desirability of other passengers, one to the courtesy of the driver, and the remaining item refers to the ease of bus use for the physically disabled.

The three factor scores for each individual are input into the hierarchical cluster-analysis program. A four-group solution, which contains 964 of the 966 cases, is the most satisfactory (12). The remaining two cases are not easily classified into any of the four groups and are excluded from subsequent analyses.

The mean responses for each cluster on the three factors are represented in Table 3. The differences in mean factor scores among the segments are all highly statistically significant.

The profile of mean factor scores for the first segment shows a general pattern of relative unresponsiveness to transit improvements. The high negative average for the time factor and the moderately high negative average for the transit quality factor suggest that this segment is especially unresponsive to the types of actions transit managers can make to improve the physical performance of the system. This segment is labeled "unlikely transit ridership growth segment".

The average factor scores are all positive for the second segment, which indicates a general pattern of responsiveness to transit improvements. The fact that the psychological comfort factor has the highest average value suggests that people in this market segment could be especially responsive to improvements in the psychological environment. Based on the general pattern of responsiveness, this segment is labeled "potential transit ridership growth segment".

The third market segment is characterized by a high positive average value for the trip time factor but moderately negative averages for the other two factors. This pattern suggests that people in this group are relatively quite responsive to improvements that reduce overall transit trip times but relatively unresponsive to changes in transit characteristics related to the other two factors.

Table 3. Pattern of mean responses for the specific market segments on the three input factors.

Factor Number	Factor Description	Segment 1 Unlikely Transit Ridership Growth Segment (N=241)	Segment 2 Potential Transit Ridership Growth Segment (N=387)	Segment 3 Travel Time Minimizers (N=203)	Segment 4 Transit Quality Seekers (N=133)
1	Transit quality	*	x	*	xx
2	Transit trip time	**	x	xx	*
3	Psychological well being or comfort	*	x	*	*

Notes: xx = much more responsive than average to transit improvements; x = more responsive than average to transit improvements; * = less responsive than average to transit improvements; and ** = much less responsive than average to transit improvements.

Table 4. Means and standard deviations for the specific market segments on six objective characteristics.

Segment Number	Description	Age[a] Mean	Age[a] SD	Sex[b] Mean	Sex[b] SD	Income[b] Mean	Income[b] SD	Education[a] Mean	Education[a] SD	Automobiles per Licensed Driver Mean	Automobiles per Licensed Driver SD	Level of Service Index[b] Mean	Level of Service Index[b] SD
1	Unlikely transit riders (N=203)	45.16	17.64	1.52	0.50	3.36	1.81	3.74	1.51	0.88	0.36	1.82	0.83
2	Potential transit riders (N=349)	40.11	15.65	1.61	0.49	3.18	1.48	3.93	1.52	0.87	0.40	1.65	0.81
3	Travel time minimizers (N=181)	43.06	14.79	1.57	0.50	3.50	1.76	4.49	1.73	0.90	0.35	1.65	0.90
4	Transit quality seekers (N=116)	41.55	15.24	1.68	0.47	3.03	1.45	3.84	1.77	0.84	0.36	1.50	0.90

Notes: Sex 1 = male, 2 = female; income 1 = 0 - $5000, 2 = $5000 - $10 000, 3 = $10 000 - $15 000, 4 = $15 000 - $20 000, 5 = $20 000 - $25 000, 6 = $25 000 - $30 000, 7 = over $30 000; education 1 = 0 - 8 grades, 2 = 9 - 11 grades, 3 = 12 grades, 4 = some college, 5 = junior college graduate, 6 = 4-year college graduate, 7 = postgraduate; level of service index 0 = no transit service, 1 = below average service, 2 = good transit service, 3 = excellent transit service. Age is measured in years and automobiles per licensed driver is as defined.

[a] Differences in means significant at $p < 0.01$.

[b] Differences in means significant at $p < 0.05$.

For this reason, the segment is labeled "travel time minimizers".

People in the fourth segment tend to be very responsive to changes in the general quality of the transit system (i.e., improvements in the ease or pleasantness of using the system that result from changes in bus routing, scheduling, fare levels and collection, information availability, safety, and bus cleanliness). On the other hand, respondents in this market segment tend to be moderately unresponsive relative to the sample average to changes in trip time and quite unresponsive to changes that improve the psychological environment. This profile suggests the label "transit quality seekers".

Differences in Individual and Household Characteristics

The same six variables that were used to examine the general market segments are used here. Table 4 contains the means and standard deviations for the market segments on these characteristics. Again, all differencee are based on respondents who gave a complete set of answers for all six characteristics, which results in some reduction in sample size. There are statistically significant differences for five of the six variables. Also, when the automobiles per licensed driver variable is treated as a categoric variable, significant differences emerge (12). Therefore, differences in the market segments on all six characteristics are noted.

By considering the labels for each segment with their objective characteristics, some insights into potential responses to changes in the transit system and marketing campaigns may emerge. The first segment, the unlikely transit ridership growth segment, tends to have older members, males, somewhat higher income, low average education, somewhat higher than average automobile availability, and higher than average regional transit service. In addition, respondents in this segment are least likely to ride transit. The combination of above average income, below average education, and above average age suggests that members of this segment may tend to be at the upper levels of nonprofessional job categories. All in all, changes in transit service levels or marketing appear to be least likely to generate transit ridership among this segment, which is 25 percent of the sample.

The potential transit ridership growth segment, which constitutes 40 percent of the sample, is primarily characterized by its low average age. Since this segment seems to be most responsive to the social and psychological environment of transit, marketing campaigns that emphasize this aspect of bus service, which are targeted to younger people, may be effective. The current Sacramento Regional Transit campaign, which emphasizes the nice people who ride the bus, might be a good example of such an approach.

The third segment, the travel time minimizers, tends to have people in the 30-59 age groups (12) and has the highest average income, education, and automobile availability. This combination suggests a high representation of people in professional job categories. Service improvements and marketing strategies targeted for this group probably should focus on direct and timely bus travel. This segment, which contains 21 percent of the sample, has the highest proportion of frequent transit riders, which indicates the possibility that this group would be quite responsive to improved transit.

The transit quality seekers are 14 percent of the sample. The segment has a higher than average representation of females and has below average values on the income, education, automobile availability, and transit level-of-service variables. In spite of its below average level of service, this segment has the highest proportion of occasional transit riders and the second highest percentage of frequent transit riders. Since the convenience and ease of using the transit system are much more important for members of this segment than for respondents in the other segments, any bus improvement program or marketing effort directed at this group should probably emphasize these aspects. An information campaign that emphasizes the convenience of bus travel might be effective with this segment. For example, Sacramento Regional Transit currently publishes a bus book, which is designed to make the bus system easier to use.

Differences in Travel Behavior

The same measures of travel behavior that were previously used are used here. For the variables that measure monthly travel frequencies, the general pattern is noted without presenting numerical results. Proportions that use various nonautomobile driver modes are also discussed.

For the monthly travel frequency variables, only the differences in school trip frequencies are statistically significant; the key difference is the low monthly frequency for the unlikely transit ridership growth segment. Although none of the other differences was significant, the general pattern for most purposes is that the unlikely transit riders have the lowest trip frequencies, the transit quality seekers have the second lowest frequencies, the potential transit riders have the second highest frequencies, and the travel time minimizers have the highest frequencies.

The tests of distributions in the modal selection variables result in the differences that involve whether the respondent carpools for shopping or recreational trips; commutes by walking or bicycle are almost negligible. The differences in frequency of transit use are highly significant. In order of increasing proportion of transit use, the segments are the unlikely transit riders (6.2 percent), the potential transit riders (12.9 percent), the transit quality seekers (15.0 percent), and the travel time minimizers (16.3 percent). Although the differences in the occasional transit use variable are not statistically significant, this general pattern also holds with the exception of a reversal in the two highest frequency segments. In increasing order the proportions are 8.7, 12.4, 12.8, and 15.8 percent. Also, consistent with the pattern for the two transit variables, the unlikely transit riders have the lowest proportion of members who carpool to work, although the difference is not quite significant even at the 0.10 level.

For purposes of explaining current travel behavior, the general conclusion appears to be that market segments based on specific transit attributes are primarily useful for explaining transit use. The fact that the segment that tends to be the least likely to increase transit use with improved transit service also has the lowest proportion of current transit users certainly suggests a consistent pattern. On the other hand, differences in other travel behavior are generally insignificant.

SUMMARY AND CONCLUSIONS

The empirical results indicate that a sample may be divided into a reasonably small number of groups that have similar attitudes. Further, there are differences in both objective characteristics and travel behavior associated with membership in a market segment. Therefore, the results serve to further demonstrate the usefulness of market segmentation methodology in transportation planning contexts.

By considering both general and specific transportation attitudes as bases for market segmentation, a comparison of their usefulness for transit planning is possible. Because of the identification of attitudinal dimensions that suggest specific improvements in transit design, operations, and marketing and the formation of groups based on these dimensions, the use of specific market segments appears to have the most immediate practical application for transit managers. Particular marketing or design actions appear to be the most appropriate for particular segments. Further, because the segments tend to have different objective characteristics, there is some indication on how particular strategies may be targeted more effectively.

On the other hand, a general market segmentation may be useful if a transit official is interested in examining levels of support for transit policies. In this case, the concern is not so much one of whether public decisions will lead to changes in travel behavior but one of mobilizing support for public decisions. An official of a public transit system has the dual role of implementing public policies that at least indirectly affect the general public and of providing a service that currently reaches a relatively small segment of the public. The results of this paper suggest that different market segmentation approaches may be desirable for analyzing issues relevant to the two roles.

Unlike the findings in the General Motors studies (4, 5), there is a strong statistical association between membership in general and specific market segments. That is, for any particular general market segment, the members do not appear to be randomly distributed among the specific market segments and vice versa (12). A complete description of the pattern of association is beyond the scope of this paper. Some of the more interesting relationships are the higher than average proportion of people in the general antitransit segment who are members of the specific unlikely transit ridership growth segment and the high representation of antifreeway members in the travel time minimizers segment. The difference between this study and the General Motors study with respect to this finding could be caused by different sets of attitude items, different sample populations, and somewhat different methodologies.

Attitudinal market segmentation methodologies have the potential of offering useful information for the design and marketing of transit systems and for transit policy analysis. The results of this paper are best viewed as a preliminary demonstration of the potential usefulness of the market segmentation approaches. Further studies in other areas, using somewhat different survey instruments and methodologies, are necessary to a fuller assessment of the usefulness of the approach. Also, a post hoc assessment of the effectiveness of transit policies that are based on prior information from a market segmentation study would be the ultimate test of the efficacy of transit market segmentation.

ACKNOWLEDGMENT

The work was performed under contract with the Division of Mass Transportation, California Department of Transportation. The views in the paper are

mine and do not necessarily reflect the position of the sponsoring agency. The comments of Kenneth Ingram, Norris Millikin, Gene Berthelsen, and James Rae, all of the California Department of Transportation, during the course of this project were very useful. The assistance of Behrooz Mohammadi and Manouchehr Vaziri, who are transportation graduate students at the University of California, Davis, and Ted Spelis of the California Department of Transportation in the data analysis is gratefully acknowledged.

REFERENCES

1. R. R. Reed and K. R. Ingram. Starting the Transit Industry on a Search for Affluent Markets. TRB, Transportation Research Record 590, 1976, pp. 9-13.
2. D. A. Hensher. Uses and Applications of Market Segmentation. In Behavioral Travel-Demand Models (P. R. Stopher and A. H. Meyburg, eds.), D. C. Heath and Company, Lexington, MA, 1976.
3. R. Dobson. Market Segmentation: A Tool for Transportation Decision-Making. Paper presented at the Third International Conference on Behavioral Travel Demand Modeling, Tanunda, Australia, 1977.
4. T. F. Golob and G. C. Nicholaidis. Comparison of Segmentation Bases for Modeling Consumers Preferences for Transportation Modes. Paper presented at the meeting of the American Institute for Decision Sciences, San Francisco, 1976.
5. G. C. Nicolaidis, M. Wachs, and T. F. Golob. Evaluation of Alternative Market Segmentations for Transportation Planning. TRB, Transportation Research Record 649, 1977, pp. 23-31.
6. W. W. Recker and T. F. Golob. An Attitudinal Modal Choice Model. Transportation Research, Vol. 10, No. 5, Oct. 1976, pp. 299-310.
7. W.W. Recker and R. F. Stevens. An Attitudinal Travel Demand Model for Non-Work Trips of Homogeneously Constrained Segments of a Population. Transportation Research, Vol. 11, No. 3, June 1977, pp. 167-176.
8. K. R. Ingram. Researching and Identifying Consumer Attributes of Public Transportation by Using Segmentation Analysis. Division of Mass Transportation, California Department of Transportation, Sacramento, 1976.
9. T. J. Tardiff, B. Mohammadi, and M. Vaziri. Analysis of the Sacramento Area Transit Market. Division of Mass Transportation, California Department of Transportation, Sacramento, Final Rept., 1977.
10. W. J. Dixon, ed. BMD: Biomedical Computer Programs. Univ. of California Press, Berkeley, 1975.
11. S. L. Johnson. Hierarchical Clustering Schemes. Psychometrika, Vol. 32, 1967, pp. 241-254.
12. T. J. Tardiff. Transit Market Segments Based Upon Specific Modal Attributes. Univ. of California, Davis, 1978.
13. T. J. Tardiff, B. Mohammadi, and M. Vaziri. Procedural Manual for the Analysis of the Sacramento Area Transit Market. Division of Mass Transportation, California Department of Transportation, Sacramento, 1977.
14. M. A. Johnson. The Influence of Basic Preference Attitudes on Choices Between Auto and Transit Travel. Univ. of California, Berkeley, Urban Travel Demand Forecasting Project Working Paper No. 7701, 1977.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

**T.J. Tardiff is now with Charles River Associates, Inc., Boston.*

The Transportation Manager: An Evolving Concept

Frank W. Davis, Jr., and Lawrence F. Cunningham, Department of Marketing and Transportation, Transportation Center, University of Tennessee, Knoxville

Solutions to the new transportation needs of the United States require the development of problem-solving skills, which augment the historical role of the highway engineer and highway planner. This new role, the transportation manager, is the direct result of several factors in our environment and, more particularly, in our transportation systems. For example, although vehicle kilometers of travel are projected to increase by 39 percent by 1985, resistance to new highway construction is increasing, and mass transit is severely limited in its ability to serve peak-hour commuter needs by using expensive vehicles and full-time labor. As a result, the focus of transportation activities is shifting to improved management techniques. The new transportation needs will require individuals who have a different perspective and approach than that of the traditional engineer or planner. The new management emphasis will address more day-to-day decision making and have the opportunity to initiate low-cost, incremental changes to systems that are reversible on short notice. Cost/benefit analyses of detailed planning efforts associated with such incremental efforts reveal that the transportation manager will consume less resources in examining the data and undertaking corrective action. The paper will trace the development of public involvement in transportation to demonstrate the evolving needs of transportation and the orientation toward the professional urban transportation manager.

Public transportation programs have changed in the last few decades, and in the 1980s we will witness a major shift in the emphasis of public transportation. At the turn of the century, public transportation frequently consisted of a county commissioner who supervised the construction and routine maintenance of roads. Maintenance was a very large expense because many dirt roads required constant care. During the first half of the century, emphasis was placed on construction of upgraded

hard-surface roads, which were funded by all levels of government. This effort reached its peak with the Interstate highway program, which was initiated in 1956 and is now almost complete. This emphasis on construction of highways created the era of the civil engineer, who was responsible for the survey, design, and construction of massive new infrastructures.

By the early 1960s, the Interstate highway program had elevated highway decision making from a local concern to a regional and national concern. This ushered in the era of the highway planner, who became responsible for the coordination of highway activities of surrounding jurisdictions to create a coordinated, cooperative, and continuous long-range planning process. Before the end of the decade, elements of society had begun to express major concerns regarding the loss of control of transportation activities to the professional planner. This concern resulted in the development of the environmental impact statement and full implementation of the previously required public hearing process.

During this evolutionary period of highway development, public mass transportation was also undergoing a parallel but distinctly different evolutionary process. Intracity and rail commuter service evolved rapidly with the development of streetcars. Since the electric trolley frequently was developed by the same organization that built and operated power-generating companies, both organizations were given a public franchise. Streetcar companies were regulated as to entry, exit, competition, fares, and schedules.

Although the civil engineer was essential for design and construction of facilities, the main public involvement was through the attorneys who wrote and administered the regulatory process. The attorneys constantly monitored rates to control excess profits and, in many cases, required the streetcar companies to maintain streets and to provide street lighting. Private companies were able to continue to provide service under the locally granted monopoly until the 1950s. Decline in ridership, increases in operating costs, decreases in population density, and rapid suburbanization created severe financial difficulties for public transportation.

The Transportation Act of 1958 was designed to facilitate discontinuance of intercity rail passenger service. However, the mayors of New York, Boston, and Philadelphia realized that the accompanying loss of rail commuter service would make it difficult for the central cities to remain viable and made a major effort to obtain federal funds to support rail commuter service and subsequently to broaden the mass transit funding to include city bus lines (1).

When public funds became available, cities used the money to purchase declining private bus companies. Thus, the focus shifted from franchise and regulation of private providers to the planning and operation of systems by use of the highway planning techniques then in vogue.

Highway planning was in the long-range comprehensive planning phase when the transition was made to mass transit; therefore, planners attempted to apply tools and approaches for mass transit that were similar to those that they applied to highway planning. It was only natural that large rail systems were designed with little attention to factors such as marketing, labor relations, private-public coordination, service for the transportation disadvantaged, service to suburbs, and the most effective means of providing service. Taxis, school bus fleets, air ground-transport providers, the intercity bus industry, and all other providers largely were ignored because the planners were anxious to build publicly owned mass transit systems similar to the comprehensive highway networks. Resources were diverted into the development of high-technology systems for use in the urban areas. Planners, at that time, envisioned a technological solution to the problems of urban mass transportation. They felt that it was possible to substitute speed for the inherent advantages of the automobile, such as flexibility (2).

Ironically, at the very time that mass transit lobbyists were appealing for more funds to develop new mass transit facilities, government was continuing to regulate and to tax heavily the last remaining private operations. Rather than intentionally taxing and regulating the private sector out of business, local governments, in most cases, simply did not address the impact of taxes and regulation on the private sector while they were preoccupied with buying and building public bus companies.

While the transportation interests were busy combining highway design and planning with government operation of transit, social service agencies and others were faced with a critical dilemma—how to deliver services to clients when existing public transportation networks did not meet the needs of the clients. Agencies procured services from taxicabs, volunteers, or casual carriers, but they soon found that the regulatory process and insurance presented formidable barriers to low-cost operation. Thus, pressure was placed on government to provide vehicles under Section 147, 16b2, of the Federal-Aid Highway Act of 1973 and other programs. However, the inflexibility of state and local laws restricted the ability of social service programs to obtain service. The only feasible option available was government ownership of fleets of vehicles and centralized operators under purchase-of-service contracts to other agencies. The high cost and extensive managerial effort required to operate the many different systems led to new efforts to coordinate services.

Thus, in the name of coordinating transportation for the disadvantaged, traditional highway planners and regulators have favored the establishment of a single operator of a single type of service under one management, like a public utility, with the assumption that, if all service is provided by the same management, coordination will ensue. Inherent in this approach is the need of a regulatory body (be it public utility commission, local transit authority, or elaborate public hearings and planning) to protect the public interest.

Social service agencies, on the other hand, often feel that the best way to coordinate is to have as many options as possible so that the service that best meets the needs of the clients may be selected. Agencies feel that the franchise system sets arbitrary service standards, and, if clients cannot use the franchised systems, no other option is available for them. Thus, the major question for the 1980s is, Should all public money go to a single system, or should various agencies be able to select from a wide range of services the one that best meets their needs?

Concurrent with this evolution in public transportation was the evolution of thought on airport operations. The Airport and Airways Development Act of 1970 made money available for airport construction. The primary emphases were on obtaining public money and on consideration of the design and construction techniques. Not until 1970 did environmental issues, intermodal coordination, noise levels, and public resistance to new airports assume paramount importance in relation to construction as a management problem.

Traditionally, the movement of urban goods has been handled by zoning requirements and by the designation of loading zones. With the continued shift from rail to truck for most nonbulk goods, the delivery of goods into shopping centers, industrial parks, and downtown areas can be a major generator of congestion, parking, and

environmental problems. Therefore, the management of truck traffic is becoming a major component of transportation activities within urban areas.

EVOLVING PROBLEMS

Conditions are rapidly changing; no longer is the planning and construction of new facilities the central focus of transportation activities. Perhaps the sentiments expressed by former Secretary of Transportation Brock Adams best summarize the direction of federal commitments in the future (3):

> We [U.S. Department of Transportation (DOT)] are shifting from an agency that builds systems to one that is concerned about how those systems serve people.... Moving from an emphasis on new construction does not mean slowing down. Our energies must focus on the improvement and integration of the services of the various transportation modes, on increasing operational efficiency, and on eliminating wasteful redundancy in existing facilities.

New forces are focusing on the management of facilities that are already in place. This emphasis is being driven by the following.

Public Resistance to New Construction

Whether it is the completion of I-40 through Overton Park in Memphis, the building of the Westside Highway in New York City, the widening of a local intersection in Knoxville, or the extension of I-66 in Washington, D.C., the public turns out in large numbers to voice opposition. In many cases, projects are delayed for long periods of time, if not totally abandoned. New airport construction generally is limited to expansion of existing terminal facilities or the construction of remote regional airports far removed from residential areas. Even new mass transit construction is receiving increased public opposition.

Dramatic Increases in Transportation Maintenance Costs

New transportation facilities, like new machines, require minimum maintenance for the first few years. Today the highway system has reached the point where maintenance costs are beginning to increase rapidly (4). Now emphasis is on pothole repair and bridge replacement. Age and the increased travel weight of the larger trucks will continue to have a major impact on maintenance cost. Besides the increasing emphasis on maintenance of superhighways, the rehabilitation of rural roads is receiving increasing attention. The Highway Trust Fund is simply not adequate. The nation is now painfully aware of the consequences of deferring maintenance on the railroads and probably will be reluctant to let highways, port facilities, airports, or other transportation facilities follow the same path.

Increase in Vehicle Kilometers of Travel

With the increase in female participation in the work force, increased disposable income, and decreased family size, the number of vehicles in use is increasing rapidly (4). Prior to the oil shortage of 1979, vehicle kilometers of travel were expected to increase by 39 percent by 1985 and by 75 percent by the year 2000 (4). (Assuming a continuation of present government policies and programs, moderate population growth, healthy economic growth, and no significant changes in lifestyle, automobiles in use will increase by 24 percent by 1985 and by 56 percent by the year 2000. Licensed female drivers are projected to increase by 49 percent by the year 2000 compared to a 25 percent increase for male drivers.) Traditionally, congestion has been controlled by new construction. But, with this option restricted, stronger focus will be on increasing the rates at which vehicles can use existing highways or on increasing vehicle occupancy through ride sharing. If this is not done, individuals must make their own efforts to control congestion by moving their residences closer to their places of work. This could increase the number of residences in downtown areas; however, the probable outcome will be greater decentralization as businesses, industries, and support services move to suburbs and smaller communities.

Evolving Safety Issues

The 1974 oil embargo and its accompanying reduction in highway accidents brought a short recess in concern over highway safety. However, highway deaths are climbing once again (4). (Highway deaths are expected to increase at almost twice the rate of population growth until the year 2000.) In addition to concern about vehicle design, attention will probably turn to three new areas.

Efforts to cope with new energy concerns have encouraged larger trucks and smaller automobiles. This difference in truck weight plus the increased distance required for larger trucks to stop (almost twice that for automobiles) is creating a serious safety problem, especially in the case of rear-end accidents. The 121-brakes were supposed to help, but there is now a moratorium on 121-brake standards. This almost certainly will lead to new management techniques for restricting trucks to a single lane, to restricting hours of truck operations, or to other ways of minimizing safety problems.

A second major safety problem is the habitual offender who, due to drugs, alcohol, or poor driving attitudes or skills, persistently is involved in accidents or violations (4). Currently, judges are reluctant to take away a license for fear that the person will no longer be able to get to work. Thus the judge is confronted with the dilemma of a potential welfare family or potential future fatalities. The new emphasis invariably will be on the development of new risk-management programs, using driver training, commuter pools, and other programs to control the use of highways by habitual offenders.

Many traffic management programs are made impossible by current legal enforcement requirements. A parking ticket, for example, can be given to a vehicle, but a moving violation must be issued to the driver. This eliminates the use of radar, closed-circuit television, and video tapes to obtain pictures of speeding vehicles, single-occupant vehicles in carpool and bus lanes, and other violations. New technology will focus on complementing the new traffic management schemes without requiring high-speed police chases on crowded highways.

Rapid Increases in Cost

The increased public involvement in mass transit has helped the public sector discover a concept that the railroad commuter lines learned in the 1890s: It is extremely expensive to transport commuters by using full-time labor because much of the peak-hour demand is over before the vehicle and workers can return for a second run. Like rail commuter service, transit systems continue to have fewer riders per vehicle kilometer operated every year. As a consequence, operating deficits increase by 800 percent between 1970 and 1976, but vehicle kilometers of travel in new service increased by only 1.5 percent (4). Thus, public ownership has not substantially changed the economics of privately owned mass transit—it has only made more money available to

finance the decline. While many proponents of transit argue that city officials should pay little attention to the size and increase of transit deficits because such services are similar to police and fire protection, the question that must be addressed is whether this is the most effective use of scarce resources.

Another area of rapidly increasing cost is the construction of new highways and subways. The environmental and political delays that normally are encountered in such activities result in costs inflated substantially beyond original estimates. As a consequence, many projects that initially are priced reasonable become exceedingly expensive. With the advent of Proposition 13 in California, competing demands for social programs and local budget crunches, many transit and highway projects may be constrained heavily by financial pressures.

Labor Issues Involved in Providing Public Transportation

As planners wrestle with new approaches to the cost of providing public transportation, they are forced to comply with Section 13c of the Urban Mass Transportation Act of 1964, as amended, which was designed to protect the bargaining rights, jobs, and salary levels of existing employees. As the act currently is being administered, prior agreements must be negotiated with the transit employees as a condition for receiving public funds. In practice, this procedure has become an effective mechanism for ensuring that only members of the local transit union will be able to operate the new services (5). Thus, Section 13c is administered in such a manner as to create a closed shop on all publicly funded transportation projects nationwide. There is little concern about the long-term financial impacts of guaranteeing job protection, bargaining rights, pension rights, and salary levels, including the six-year guaranteed income protection in case of layoff. In addition, this closed-shop approach makes innovations using public funds difficult.

Increased Concern for Those with Special Needs

No longer is it sufficient to provide airports, highways, and mass transit systems; services must be accessible to all people regardless of their handicap. Since 70 percent of mass transit ridership is commuter service, there has been extensive discussion about its ability to serve the elderly and handicapped. U.S. Department of Health, Education, and Welfare (HEW) programs spent $1.8 billion (HEW estimate of federal and state funds spent on HEW transportation program) on specialized transportation (6). This does not include U.S. Department of Labor, Appalachian Regional Commission, U.S. Department of Agriculture, U.S. Department of Housing and Urban Development, Urban Mass Transportation Administration (UMTA) or Federal Highway Administration (FHWA) programs for special groups; nor does it include the requirements of Section 504 of the Rehabilitation Act of 1973 or school busing programs to achieve racial balance or other social objectives. Public transportation goals have expanded greatly during the last decade.

Airport Noise Abatement Programs

Concern over noise abatement programs at airports has produced new ways of managing noise, such as modifying flight paths and controlling climb rates.

Limitation of Regulatory Process

According to traditional regulatory procedures, government sets the standards whereby businesses must operate if they are to retain the privilege of operating in the area where that government has jurisdiction. The new trend is to place greater reliance on market forces to provide a broad array of transportation services from which customers may select the service that best meets their needs (7). The Civil Aeronautics Board, first by regulatory decisions and then by legislation, has opted to decrease regulation significantly, and airline profits and service levels appear to be substantially higher. Government efforts to improve automobile fuel economy standards appear to be controlling the amount of fuel used by the private automobile. The Transbus standards, on the other hand, have put AMC General out of business, and General Motors' bus division has indicated that it will cease operation rather than meet the standards. Perhaps one of the major dilemmas of the future is to determine how much regulation can be imposed on industry without becoming counterproductive. The result of overregulation appears to be that the government, in effect, must federalize the industry it regulates out of existence and become the provider of last resort.

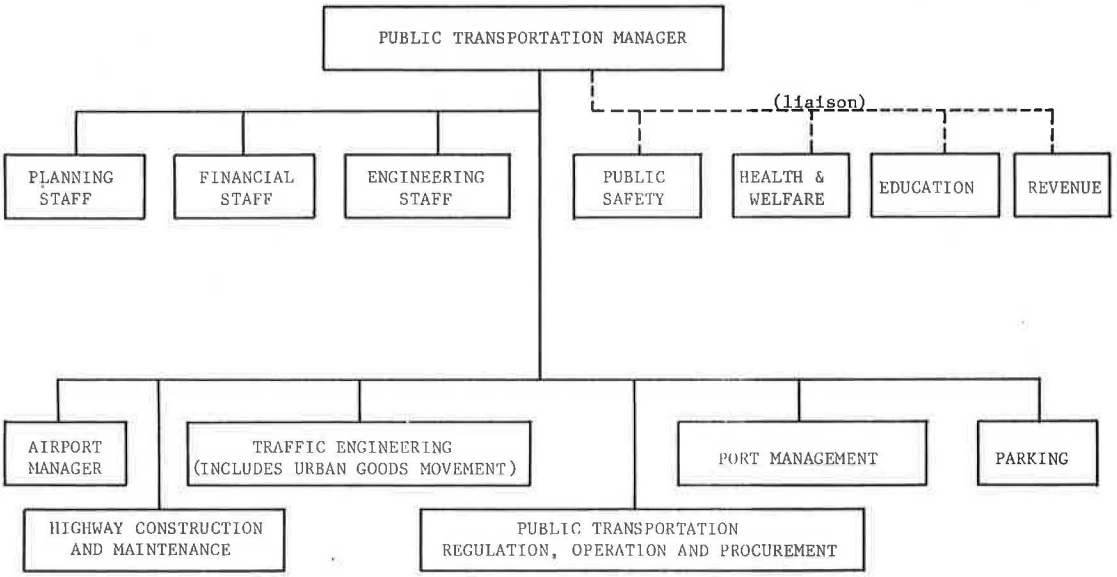
RESOURCE MANAGEMENT APPROACH TO TRANSPORTATION

These nine items are not meant to be inclusive but to present examples of the major issues that affect the evolution of transportation activity in local areas. Because of the evolving new issues, a new emphasis on transportation resource management is developing. The new approach will focus not on the coordination of transportation planning and construction activities, but rather it will focus on how to solve specific local problems effectively and at the lowest cost. Highway emphasis already has begun to shift toward transportation systems management, including channelization, computerized traffic control, ride sharing, and maintenance procedures for existing facilities (7). Other possibilities include promotion of flexible work hours, exclusive lanes for high-occupancy vehicles or large trucks, zoning to limit the number of parking spots, restraints on business delivery hours, standards for off-street loading zones, planned decentralization, transportation brokerage, and other options that have yet to be conceived.

These same factors will force traditional transit operators and policy boards to expand their thinking to include not just the 64 000 current mass transit vehicles but to integrate all 114 million privately owned vehicles into the public transportation system. Budget crunches will force them to develop strategies for getting business and community groups to operate their own programs in an effort to minimize the cost to government. Labor agreements, coordination with private operators, constructive regulation, entrepreneurial planning (developing plans for getting private enterprises involved in providing transportation), purchase-of-service contracts for social service transportation, and many other programs probably will be developed.

Airport management will focus increasingly on local standards set in cooperation with airlines to protect local interests and to protect airlines from the uncertainties of what is necessary to prohibit litigation. Urban goods movement also may undergo major changes in policy. The direction will depend largely on regulatory changes at the state and federal levels.

Figure 1. Organizational chart for transportation manager.



EVOLUTION OF THE PUBLIC TRANSPORTATION MANAGER

Just as businesses go through phases, so must public bodies. Most firms start out as production-oriented or market-oriented, then they usually pass through a period of financial focus before they effectively learn to coordinate all functional levels. Part of this focus generally includes the evolution of the traffic manager into a distribution manager. Where the traffic manager was responsible for getting a truck line to pick up the product, the distribution manager is responsible for getting the product from the production line into the customer's hands according to a service level established by the company. The distribution manager is charged with transportation, warehousing, inventory control, sales order processing, packaging, and demand forecasting. The distribution manager is placed on the same level as the production, marketing, or financial managers in the company.

Cities will probably find that a new level of professional is required to cope with transportation in the local areas. At the University of Tennessee, the individual is called a public transportation manager. Through training, the individual will be thoroughly familiar with

1. Highway design and planning;
2. Traffic engineering;
3. Contracting and procurement procedures;
4. Economic regulation of transportation companies;
5. Labor relations and labor law;
6. Economics of operating various modes of transportation;
7. Traffic regulation, enforcement, and control;
8. Taxing policy and its effect on private firms;
9. Market segmentation techniques for working with young, elderly, handicapped, and poor clients (8);
10. Public hearing procedures;
11. Public finance issues;
12. Accounting procedures;
13. Channel relationships for the distribution of products and services;
14. Public administration; and
15. Insurance principles and legal standards of care.

The transportation manager should be on the same level as the directors of education, public safety, health, welfare, or revenue, and the transportation manager will oversee a department that may be organized as shown in Figure 1.

The public transportation manager will meet with other department heads to develop strategies for solving urban problems. Each department will be given a mission to perform, with specific measures for determining success. The public transportation manager then will meet with each bureau head in transportation to determine the best way of accomplishing the transportation component of the strategy and will assume responsibilities for accomplishing the task. This makes the transportation manager mission oriented. When the community has a problem, the public transportation manager has the mission of solving the problem. This is in contrast to the modal orientation that currently exists in many areas, where each problem is seen as another reason for placing more funds with that mode, often with limited evaluation as to whether the mission is being accomplished. The financial evaluation staff will be responsible for ensuring that the most cost-effective methods are used.

SUMMARY

In summary, public transportation has evolved through the legal regulation stage, the engineering and construction stage, the planning stage, the environmental impact stage, and the public hearing stage. Now it appears that the new emphasis will be on improved management. This does not imply that each of the stages is no longer important, but rather that it is now important to integrate all the preceding stages into a unified, mission-oriented approach to solving transportation-related problems. The individual required to serve in this new role will require a very broad background. This probably will require major changes in the transportation curriculum offered by most schools today.

REFERENCES

1. H. Mertins. National Transportation Policy in

Transition. Lexington Books, Lexington, MA, 1972.
2. R. D. Eckert. California Transportation Planning: Examining the Entrails. International Institute for Economic Research, Los Angeles, Paper 19, Feb. 1979.
3. Transportation Policy for the Future Revealed by DOT Secretary Adams. Traffic World, Vol. 173, No. 7, Feb. 13, 1978, pp. 23-28.
4. Office of Technology Assessment. Change in the Future Use and Characteristics of the Automobile Transportation System, Summary and Findings. Congress of the United States, 1979.
5. C. Burbank. Transit Financing Trends and Outlook. In Urban Transportation Economics, TRB, Special Rept. 181, 1978, pp. 201-203.
6. Comptroller General of the United States. Hindrances to Coordinating Transportation of People Participating in Federally Funded Grant Programs. General Accounting Office, Vol. 1, Oct. 17, 1977.
7. D. J. Brown, P. B. Schary, and B. W. Becker. Marketing Down the Road: The Role of Marketing Analysis in Transportation Planning. In Research Frontiers in Marketing: Dialog and Directions (S. Scjain, ed.), Proc., American Marketing Assn., Chicago, 1978.
8. R. J. Fisher and H. J. Sinkowitz. Priority Treatment for High-Occupancy Vehicles in the United States: A Review of Recent and Forthcoming Projects. U.S. Department of Transportation, FHWA-RD-77-56, Aug. 1978.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

Abridgment

Components of a Transit Marketing Program

Keith M. Thelen, Neal K. Liddicoat, and Robin C. McNulty, Knoxville-Knox County Metropolitan Planning Commission

In spite of a marketing consciousness that has emerged among transit planners and operators, there has been little discussion of what a marketing program should include, or how it should be organized. Such terms as market research, user information, and target markets are widely used; however, little attention has been directed toward how these and other elements might be integrated to achieve a unified transit marketing program.

ORGANIZING TRANSIT MARKETING ELEMENTS

The first step in coordination of the marketing program is organization of its components. The following types of marketing activities are available to the transit operator: (a) market research, (b) market planning, (c) service planning and development, (d) pricing strategies, (e) communication channels, (f) public relations, and (g) passenger amenities and other services.

Market Research

Market research helps to complete the communication cycle between buyers and sellers by providing feedback from customers to providers of the good or service. It provides information on consumer attitudes and needs as well as pointing out service opportunities. Marketing studies that apply to transit include (a) demographic profiles and target market research, (b) attitude surveys, (c) communication effectiveness evaluations, (d) evaluations of service performance, (e) concept test research, (f) alternative pricing strategy research, and (g) promotional program evaluations.

The Marketing Plan

The marketing plan provides a blueprint for phasing, organization, and control of the marketing program. The plan components would include

1. Establishment of objectives to give the program direction and purpose;
2. Situation analysis to identify current and future market position under various conditions;
3. Setting of priorities to channel resources toward specific objectives;
4. Development of detailed programs to enumerate program components, budget requirements, staff assignments, and project phasing requirements; and
5. Regular update of the plan.

Service Planning and Development

The process of service planning and development includes the addition of new services, deletion of obsolete services, and service modifications. Service planning and development should ensure that local transit services serve the travel desires of the community. The process would include (a) searching for new service ideas, (b) impact assessment, (c) development of a service prototype, (d) planning and execution of a market test, and (e) an evaluation of the potential for full-scale implementation of the service.

Although there are benefits to a good service development program, there are also obstacles to the development of such a program. Extensive service development programs can increase short-term expenses and require expensive new equipment; consumers may be slow to accept and use new services; and, if there have been many past failures, the company may be reluctant to at-

tempt new or modified services. These limitations must be recognized; however, service planning and development can help to ensure that transit services do not become obsolete as new travel needs emerge. The feasibility of transit as an alternative mode rests with its effectiveness in meeting changing community needs.

Pricing Strategies

Transit service pricing is tied to community objectives as well as to the marketplace. Each community must determine the degree to which transit is expected to be self-supporting and then set prices accordingly. Pricing strategies can be broadly grouped into two categories: (a) price variations based on time period, clientele, and type of service; and (b) short-term price discounts for promotional programs.

Communication Channels

The ways in which transit service information reaches the general public can be described as communication channels. These channels can be grouped into six categories:

1. Printed materials,
2. Point-of-purchase information,
3. Advertising,
4. Telephone information services,
5. Inquiry handling, and
6. Direct mail.

The effectiveness of information distribution networks will depend on four factors: (a) their content and clarity, (b) their success in satisfying consumer needs, (c) how well information pieces are coordinated with promotional programs, and (d) the ability of management to carry out, maintain, and continually update information-dispersal programs.

Printed materials include information on route location, time of service, fares, connecting routes, and how to use the service. Examples of printed materials include route and schedule brochures and systemwide maps.

Point-of-purchase information that is clear and complete is critical to the consumer. The average individual purchases a wide variety of consumer items and has become accustomed to having complete information available at the point of purchase. Unless transit duplicates these expectations, the nonusing public may decide that the risk of boarding the wrong bus overshadows the benefits of transit use. Examples of point-of-purchase information are bus stop signs, vehicle head signs, and information disseminated by drivers.

"Advertising communicates a message through selected media with the intent of influencing people to purchase a product or service or react in an otherwise desired manner. . . . Advertising helps create a better atmosphere where sales can be made" (1, p. 6-1). It familiarizes prospective buyers with a company and its product or service, which can ultimately make the sale of the product or service easier. The use of advertising to promote transit services must recognize the characteristics of advertising media relative to transit services, such as the following:

1. Most media forms have audiences and subscribers over a wide geographical area, whereas transit services are usually not available to that same area;
2. The time and space constraints of media advertising limit the amount of information that can be transmitted about transit services; and
3. Advertising that seeks to encourage new riders may not be appropriate in cases where transit services cannot be expanded to accommodate increased ridership.

Advertising, if used judiciously, can support other marketing activities by making the public familiar with the service, inducing inquiries for more information, and providing broad notification of service expansions or special programs. The following are common advertising media: (a) newspaper and magazine advertising, (b) radio and television advertising, (c) outdoor advertising (billboards), and (d) vehicle advertising.

Telephone information services are vital to dissemination of transit information to the public. The ability to respond to public inquiries about service changes, new services, and clarification of information supports user comprehension of the service. The public has come to rely heavily on the telephone for its many information needs and it is often the means first perceived as an information source. The telephone number of the transit property should be easy to locate in the telephone directory, and it should appear under several headings. It should also appear prominently on all printed materials, bus stop signs, and advertisements.

Direct mail can either be accomplished through door-to-door distribution or by use of post office mail. Direct mailing may have unique applications to the marketing needs of transit services. Specific geographical areas can be designated to receive information. Significant amounts of information can be included in direct mail packets, such as routes and schedules, how-to-ride brochures, and systemwide maps.

Inquiry handling is a means to handle requests for information. Various methods are available to encourage interested individuals to obtain detailed transit information. An inquiry is a positive show of interest by consumers, and a means for handling such requests is essential where mailback forms are used.

Public Relations

Public relations is one of the least expensive marketing activities and can help to focus attention on company accomplishments to earn public appreciation for the provider. In general, publicity programs include the planning, creation, and placement of favorable news items, as well as face-to-face contacts with various segments of the public. This public would include users of the service, employees, potential users, the community at large, and elected and appointed officials. In addition to the media, there are several other techniques of communicating with specific publics including: (a) annual and quarterly reports, (b) speakers at community meetings, and (c) employee communications programs.

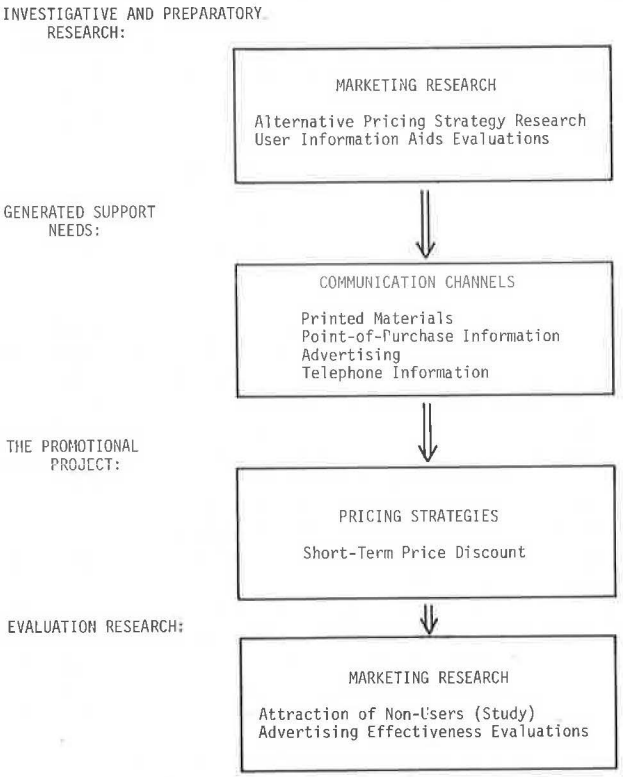
Passenger Comforts, Amenities, and Other Services

Although this category of activities is not always considered within a traditional marketing context, passenger amenities nonetheless contribute toward improving the quality of transit services as well as improving the image of the provider. They should serve a basic human need and provide a well-defined consumer service. Passenger amenities typically associated with transit services include (a) bus stop shelters, (b) bus stop benches, and (c) priority seating and boarding for the elderly and handicapped.

INTEGRATION OF MARKETING PROGRAM ELEMENTS

A study by Liff (2, p. 57) concludes that "...people's

Figure 1. Coordination of promotional program elements for short-term price discounts.



attitudes toward transit or their utilization of transit does not appear to be significantly dependent upon information service. This finding negates the hypothesis... that more complete and effective information about transit routing and scheduling would increase ridership." That hypothesis may reflect a common attitude within the transit field, namely that individual marketing elements are capable of independently promoting transit services. This is probably not the case for most elements within a transit marketing program. Each tool and activity has a specific role to play, and that role may be support- or evaluation-oriented, rather than to directly promote transit services. For example, if short-term price discounts are used to encourage new riders (promotion), bus stop signs would be needed to direct and reassure new riders (support) and research would be needed to determine how many new riders were attracted to the service (evaluation). Each marketing element must therefore be treated as part of a larger program instead of as an independent project. To illustrate, let us assume that a short-term price discount promotional program is to be undertaken. How would various marketing elements relate to one another? Figure 1 shows schematically how different elements in a short-term price discount promotion might be coordinated, and general descriptions of the different functional categories are given below.

Investigative and preparatory research provide data that guide the promotional program. It could identify the prospects for attracting new riders with a short-term price discount. It could also predict the financial effects of the promotion and the adequacy of information materials to be used by new riders.

Generated support needs refer to those items that will be required once a promotional program is implemented. For example, if a short-term price discount promotion is undertaken, some advertising would be required, along with clear printed information and bus stop signs. Unless such support materials are available and easy to understand, prospective riders may not be willing to risk using the bus and the promotional project may not achieve its objectives.

The promotional project is that activity intended to induce new ridership, in this case the short-term price discount. In other situations, advertising or new service additions might be considered a promotional activity. Although other elements are no less a part of a marketing program, taken by themselves they may not perform a promotional function.

Evaluative research determines the effectiveness of the promotional project. This type of research can point out weaknesses in the promotional program and its supporting elements. It can also help to determine whether increases in new transit patronage justify the cost of the promotion.

Figure 1 implies (on a representative basis) that separate marketing components are interdependent and must be coordinated. Upgrading of the marketing program can be done on a systematic basis when the role and interdependence of all elements is understood. For example, it may be more appropriate to spend initial budget allocations on upgrading user information aids (to improve information accessibility) than to spend large amounts of money on promotional advertising. Finally, the marketing director should be better able to pinpoint deficiencies in the program if the role and interdependence of marketing elements are well understood.

RESEARCH NEEDS

This paper provides a general framework for building a unified transit marketing program. To be of use to transit managers, however, this general framework needs to be operationalized. A series of recommended practices for each marketing tool and activity could be useful to transit managers. These recommended practices could include suggested approaches to bus stop signing, route and schedule brochures, and example surveys for marketing research. A series of marketing handbooks that concisely outline recommended practices, recommended program priorities, phasing requirements, and examples of how to handle specific problems would help managers with limited staffs to conduct coordinated marketing programs. The information in these handbooks would be based on state-of-the-art data as well as on research that had identified the most effective methods of approaching specific problems. If transit marketing programs are to achieve cost-effectiveness throughout the country, marketing information must be made available to transit managers who are attempting to solve large-scale problems with small-scale budgets and staff.

REFERENCES

1. K. L. Barasch. Marketing Problem Solver. 1st Ed. Fullerton, CA, Vol. 2, 1973.
2. S. D. Liff and R. M. Michaels. Public Information Systems in Urban Mass Transit. Northwestern Univ., Evanston, IL, Aug. 1971.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

Abridgment

Alternative Methodologies for Measuring Transit Benefits

A. Jeff Becker, Tidewater Transportation District Commission, Norfolk, Virginia
Wayne K. Talley, Old Dominion University, Norfolk, Virginia

In order to make correct policy decisions concerning investment and subsidization for transit services, a correct methodology must be used for measuring transit benefits. In this paper we argue that the commonly used cost-savings approach has restrictive limitations for the measurement of transit benefits. This approach assumes that the benefits from a given mode of transportation are the cost savings from other modes due to the availability of the given mode. Because of these limitations, an alternative methodology for measuring such benefits is proposed. This methodology determines transit benefits by finding areas under transit demand curves. Although this methodology has been proposed previously for measuring transportation benefits, its use has been limited due to the difficulty of determining demand curves. However, in this paper, transit benefit algorithms based on the above methodology, which only requires limited information, are derived.

THE COST-SAVINGS APPROACH FOR MEASURING TRANSIT BENEFITS

Assume that two modes are available for passenger transportation in a given urban area—the automobile and transit. Further assume that the benefits and costs from automobile travel are B_A and C_A, respectively, and the benefits and costs from transit travel are B_T and C_T, respectively. By the cost-savings approach for measuring benefits, $B_A = a_A C_T$ and $B_T = a_T C_A$, where $0 < a_A < 1$ and $0 < a_T < 1$.

If the benefits of automobile travel exceed its cost ($B_A/C_A > 1$), then $a_A C_T > C_A$ or $C_T > C_A/a_A$. Furthermore, when $0 < a_A < 1$, then $C_A/a_A > C_A$. When $C_T > C_A/a_A$ and $C_A/a_A > C_A$, it follows that $C_T > C_A$.

If the benefits of transit travel exceed its cost ($B_T/C_T > 1$), then $a_T C_A > C_T$ or $C_A > C_T/a_T$. When $0 < a_T < 1$, then $C_T/a_T > C_T$. Hence, when $C_A > C_T/a_T$ and $C_T/a_T > C_T$, then $C_A > C_T$. However, we have a contradiction.

In one situation transit travel costs exceed automobile travel costs, and in the other situation they are less than automobile travel costs. Based on the cost-savings approach, if the benefits of automobile travel exceed its costs, then the benefits of transit travel will be less than its costs. Thus, in the above situation the cost-savings approach precludes the possibility of transit benefits exceeding its costs. Because of the above limitations of the cost-savings methodology for the measurement of transit benefits, let us now consider an alternative methodology.

A DEMAND APPROACH FOR MEASURING TRANSIT BENEFITS

The demand for transit travel is represented by the demand curve D in Figure 1. The curve shows that, as fare increases, the number of transit-passenger trips demanded decreases. At fare P, Q individuals purchase transit service. Every individual who makes a transit trip pays the same fare. Furthermore, we assume that everyone willing to pay this fare values the trip by at least the amount of the fare, or he or she would not make the trip.

We can see that all individuals up to Q - 1 transit-passenger trips are actually willing to pay a fare greater than P. The rider of transit-passenger trip Q′, for example, would pay fare P′. Thus, we can divide the value of this individual's trip into two parts: the actual cash value (the fare paid of amount P) and the surplus value that the individual would pay over and above what is actually paid (amount P′ - P).

In Figure 1, if we add together all the cash values paid by riders of Q transit-passenger trips, we obtain shaded area A, which is the transit service revenue for the Q trips. If we add up all the surplus values, we obtain shaded area B, which is the surplus value of the Q trips. This area or additional benefit over and above what individuals pay for Q trips is consumer surplus. The transit revenue plus the consumer surplus is the total value of Q trips to transit riders and represents total user benefits from Q trips.

In the estimation of transit demand, two basic types of demand functions have been estimated in the literature: multiplicative and linear. A multiplicative demand function for transit-passenger trips may be expressed as:

$$T_{ij} = CF_{ij}^{-e} X_{1ij}^{b_1} X_{2ij}^{b_2} \ldots X_{nij}^{b_n} \quad (1)$$

where

T_{ij} = the number of transit-passenger trips from zone i to zone j,
F_{ij} = the transit-fare price from zone i to zone j,
X_{kij} = the kth variable that influences the demand for transit-passenger trips from zone i to zone j (k = 1, 2, . . . , n), and
C = a constant.

By substituting the values of the X_{kij} variables for a given ij zonal pair in Equation 1, we obtain the following demand-curve equation for transit-passenger trips:

$$T_{ij} = a_{ij} F_{ij}^{-e} \quad (2)$$

where $a_{ij} = C X_{1ij}^{b_1} X_{2ij}^{b_2} \ldots . X_{nij}^{b_n}$. Demand curves for transit-passenger trips for given ij zonal pairs based on Equation 2 will have the same fare elasticity (-e) but different slopes, since the slope of a given demand curve will be $dT_{ij}/dF_{ij} = -ea_{ij}F_{ij}^{-e-1}$ and since a_{ij} would be expected to vary from one ij zonal pair to another.

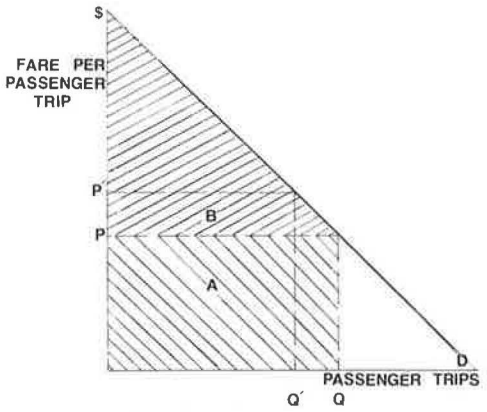
In order to derive a benefit algorithm for measuring user benefits for a given ij zonal pair based on demand Equation 2, let us solve Equation 2 for F_{ij} in terms of T_{ij} to obtain:

$$F_{ij} = (a_{ij}/T_{ij})^{1/e} \quad (3)$$

In order to obtain the user benefits from $\bar{T}_{ij}$ trips, we integrate Equation 3 from one (an improper integral will result from using zero) to $\bar{T}_{ij}$ and obtain the following:

$$CS_{ij} + FR_{ij} = [a_{ij}^{1/e}/(1 - 1/e)]\,[(1 - \bar{T}_{ij}^{1/e-1})/\bar{T}_{ij}^{1/e-1}] \quad (4)$$

Figure 1. Transit benefits.



where CS_{ij} = the consumer surplus from $\bar{T}_{ij}$ trips and FR_{ij} = the fare revenue from $\bar{T}_{ij}$ trips. If we let $FR_{ij} = F_{ij}\bar{T}_{ij} = a_{ij}^{1/e}\bar{T}_{ij}^{(-1/e+1)}$ and subtract it from Equation 4, we obtain the following algorithm for estimating consumer surplus:

$$CS_{ij} \doteq FR_{ij}\{[\bar{T}_{ij}^{1/e-1} - (1/e)]/[(1/e) - 1]\} \quad (5)$$

Let us now assume that the demand function for transit-passenger trips from the i th to the j th zone is linear and may be expressed in terms of F_{ij} as:

$$F_{ij} = a_{ij} - b\,T_{ij} \quad (6)$$

where $a_{ij} = C_0 + C_1X_{1ij} + C_2X_{2ij} + \ldots + C_nX_{nij}$, and F_{ij} and T_{ij} are the same as defined previously. The consumer surplus and fare revenue for $\bar{T}_{ij}$ trips may be expressed as:

$$CS_{ij} + FR_{ij} = a_{ij}\bar{T}_{ij} - (b/2)\,\bar{T}_{ij}^2 \quad (7)$$

By multiplying Equation 6 by T_{ij}, we can obtain the fare revenue for $\bar{T}_{ij}$ trips or:

$$FR_{ij} = a_{ij}\bar{T}_{ij} - b\bar{T}_{ij}^2 \quad (8)$$

By subtracting Equation 8 from Equation 7, consumer surplus may be expressed as:

$$CS_{ij} = (b/2)\bar{T}_{ij}^2 \quad (9)$$

With the fare elasticity expressed as $-e_{ij} = (-F_{ij}/\bar{T}_{ij})/b$ and $FR_{ij} = F_{ij}\bar{T}_{ij}$, solution of this relationship for b and substitution of this into Equation 9 will obtain the following consumer surplus algorithm:

$$CS_{ij} = FR_{ij}/2e_{ij} \quad (10)$$

Note that a_{ij} does not appear in either Equation 5 or 10. Thus, only the number of trips ($\bar{T}_{ij}$), the fare revenue, and the fare elasticity are required to determine consumer surplus.

AN APPLICATION OF THE CONSUMER-SURPLUS ALGORITHMS

In this section of the paper, the consumer-surplus algorithms (Equations 5 and 10) will be used to estimate consumer surplus from transit trips for the Tidewater Transportation District Commission.

On a typical day in 1976, 41 829 bus-passenger trips were made, of which 59 percent were work trips and 41 percent were nonwork trips. Previous researchers have found a difference in the fare elasticity between work and nonwork trips; therefore, separate consumer-surplus estimates were found for these two types of trips. From demand modeling done by the Tidewater Transportation District Commission (1), we found that

1. The elasticity for work trips is -0.267,
2. The median number of work trips between all zones is 7,
3. The number of zonal pairs involving work trips is 3525, and
4. The average fare is $0.33.

Assuming a multiplicative demand function, we obtain the following estimate of the consumer surplus for work trips by using Equation 5:

$$\overline{CS}_{ij}^{w} \doteq (0.33)(7)(7^{2.74} - 3.74/2.74) \doteq \$170 \quad (11)$$

By multiplying this amount by the number of zonal pairs involving work trips (3525), we obtain $599 250 as our estimate of the consumer surplus from all work trips for the typical day.

In a study by Kraft and Domencich (2), the fare elasticity for nonwork transit trips was found to be approximately twice that of the fare elasticity for work trips. Thus, we assume that the fare elasticity for nonwork trips is -0.534. By using seven and $0.33 as the average number of nonwork trips and fare, respectively, we obtain the following estimate of the consumer surplus for nonwork trips:

$$\overline{CS}_{ij}^{nw} \doteq (0.33)(7)(7^{0.87} - 1.87/0.87) \doteq \$10 \quad (12)$$

By multiplying this amount by the number of zonal pairs that involve nonwork trips (2450), we obtain $24 500 as our estimate of the consumer surplus from all nonwork trips for the typical day.

By summing the consumer-surplus estimates for work and nonwork trips and multiplying by the annual factor of 300 days, the estimated consumer surplus for the 1976 fiscal year is $187 125 000. By adding the fare revenue of $4 997 160 for the 1976 fiscal year to our consumer-surplus estimate, we obtain $192 122 160 as our estimate of user benefits from the Tidewater Transportation District Commission for the 1976 fiscal year.

By using the linear consumer-surplus function represented by Equation 10, the consumer surplus for work trips is $15 263/day and $5296/day for nonwork trips. Hence, the total annual benefits, including consumer surplus and revenue for the year, was found to be $11 163 660. The total operating and capital cost in 1976 was $10 286 820.

SUMMARY AND CONCLUSION

In this paper alternative methodologies for measuring transit benefits were analyzed. It is argued that the cost-savings approach that is commonly employed has restrictive limitations, which may be too restrictive for this approach to be practical. The rarely used method of estimating benefits directly from the demand functions was also pursued. Although measuring transit benefits by finding areas under transit demand curves does not have the limitations of the cost-savings approach, demand curves, themselves, are difficult to estimate. However, this paper has developed algorithms for measuring such areas that require minimal and easily obtained data. The required data are fare, fare elasticity, number of trips, and revenue.

REFERENCES

1. A. J. Becker, J. E. Jones, and W. K. Talley. Transit Demand Analysis. Tidewater Transportation District Commission, Norfolk, VA, Market Research Rept. 1, 1977.
2. G. Kraft and T. A. Domencich. Free Transit. D.C. Heath and Company, Boston, 1971.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

Abridgment

Development of Transit District Boundaries for an Areawide Small Bus Program

Tapan K. Datta, Department of Civil Engineering, Wayne State University, Detroit
David M. Litvin, Goodell-Grivas, Inc., Southfield, Michigan

The development of a feasible transportation program within a metropolitan area requires the consideration of community needs, demand potential, and the system's impact on the community life-style and environment.

The population of a metropolitan area is not homogeneous; therefore, it is difficult to justify a fixed-time, fixed-schedule, line-haul system throughout an entire metropolitan area. The requirements for secondary trips, such as shopping, social, and recreational trips, are even more difficult to determine because of the peculiar nature of these trips. Yet, although such trips are secondary in nature, they are extremely important in order to maintain a proper level of service in an area as well as for the economic growth of a community. The needs of a community, therefore, require careful investigation.

The Southeastern Michigan Transportation Authority (SEMTA) is responsible for the coordination and operation of public transit in the Detroit metropolitan area. The total public transportation system in this area is primarily divided between SEMTA, which serves the entire area, and the Detroit Department of Transportation, which provides service within the limits of the city of Detroit. The current bus service program consists primarily of fixed-route, fixed-schedule buses that operate along major corridors in and out of the Detroit central business district (CBD) as well as cross-town line-haul systems. In addition, several small bus programs operate as dial-a-ride systems or feeder systems to the line-haul system in some suburban communities.

In 1976 we were involved in a study to determine the transportation service needs for the secondary trips in a three-county study area (Wayne, Oakland, and Macomb Counties) within the SEMTA region. The objective was development of a comprehensive small bus program based on this information. Determination of the service needs necessitated addressing questions related to (a) the logical boundary for the service area, (b) public transportation needs within each community, and (c) the relative priority of various service areas within the region.

A review and analysis of all the existing small programs in Michigan provided the rationale for transit district boundaries. The three-county study area consisted of an approximately 4823-km^2 (1862-mile^2) area with a population of 2.7 million; it encompassed 73 cities and 58 townships and villages.

DEVELOPMENT OF TRANSIT DISTRICTS

The criteria for transit district boundaries include service area, population of the service area, natural boundaries, continuity between adjacent areas, other geographical considerations, similarities between the socioeconomic characteristics, demographic considerations, and land use considerations. The study was conducted in a three-stage process:

1. Transit districts were developed by using the service area, with primary emphasis on the consideration of optimal service area and population density.
2. The primary candidate districts established in the first stage were tested for sufficient travel demand; nonwork trips as a percentage of total daily person trips were used as the measure of travel demand potential.
3. The different geographical units were analyzed to establish transit districts.

The nonhomogeneity of the socioeconomic, demographic, and land use characteristics were considered in this stage to arrive at the final transit district boundaries.

Data Base

The study used the available data on small bus programs for the entire state of Michigan, regional travel and socioeconomic data available from Southeast Michigan Council of Governments (SEMCOG), and census information.

The travel data used were approximately 10 years old. However, in the absence of more recent or updated data, they were sufficient for making some preliminary judgments in terms of determining the transit districts and potential for transit demand.

Development of Service-Area Criteria

In order to develop service areas that can be used to

delineate transit districts in the three-county region in the Detroit metropolitan area, data and operating characteristics were collected for 25 small urban areas. Several operating characteristics of these systems were plotted against corresponding service areas and population density. Hand-fitted curves were drawn in order to review the trend of the various operating characteristics. The data used for the analysis were from various communities in Michigan that had all used small bus systems for special transit service. The curves drawn on the basis of these data were analyzed and general trends were identified.

Figure 1. Frequency of percentage of nonwork trips (internal to internal).

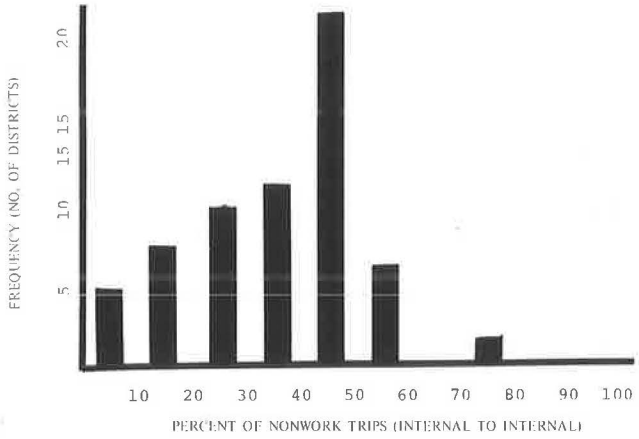
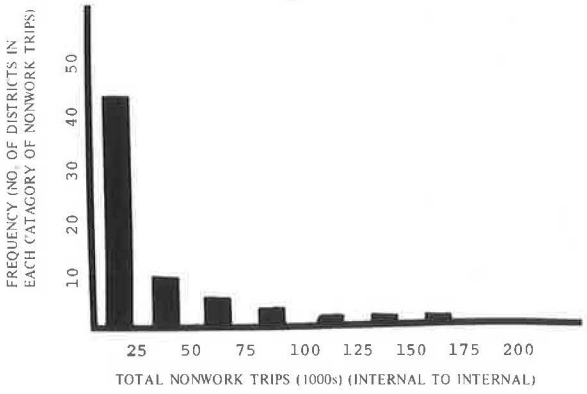


Figure 2. Frequency of total nonwork trips (internal to internal).



Based on this analysis a set of criteria were developed, which included:

1. A size of 26-44 km^2 (10-17 miles^2) of service area seems to have the most potential for transit success for a small bus program;
2. Service areas should not be less than 16.8 km^2 (6.5 miles^2);
3. Service areas should be generally less than 62 km^2 (24 miles^2);
4. The service area population should not be under 18 000; and
5. The population density of the service area should not be less than 772/km^2 (2000/mile^2).

The determination of district boundaries also included an examination of nonwork intradistrict trip behavior in each service area. This part of the study involved analysis of the frequency distribution of percentages and absolute numbers of nonwork trips based on 1965 SEMCOG trip tables (Figures 1 and 2). This distribution showed that approximately 48 percent of the 62 candidate districts showed 40 percent of their total daily nonwork trips to be within their own district boundaries. A necessary prerequisite to any transit system is the existence of substantial travel demand, both as a percentage on an absolute basis. Approximately 30 percent of the 62 districts were then cross-classified into 1 of 12 possible categories by using a two-directional matrix according to percentage and number of nonwork trips. For 17 districts within the study area, nonwork trips accounted for more than 30 percent of these internal trips, and this percentage was a number in excess of 25 000 total daily trips. When the percentage figures were raised to 40 percent, the number of districts dropped to about 15.

It was necessary to establish a threshold value in order to determine the district boundaries for the study

Table 1. Classification of transit districts on the basis of volume and percentages of nonwork trips, service area population, and service area density.

Internal Network Trips (%)	Population Density	0-24 999 Internal Nonwork Trips Daily			25 000-49 999 Internal Nonwork Trips Daily			50 000-74 999 Internal Nonwork Trips Daily[a]		75 000 Internal Nonwork Trips Daily[a]	
		26 km^2	26-39 km^2	39 km^2	26 km^2	26-39 km^2	39 km^2	26-39 km^2	39 km^2	26-39 km^2	39 km^2
30	<2000		30	1, 3, 39, 43, 51, 60 33, 47, 53, 57, 61 4, 9, 18, 23, 25, 32 35, 44, 45, 56, 59			35, 23		47		47
	2000-4000			22, 7, 34, 17			22,34,7,17		34, 17		34, 17
	4000-6000	11	6	12, 14, 50	11	6	12,14,50	6	14, 12, 50		14, 50, 12
	>6000	19	10, 20, 21, 16	49	19	10, 20, 21, 16	49	10, 16, 21, 48, 20	49	20	49
40	<2000			4, 9, 18, 23, 25 32, 35, 44, 45 56, 59, 60, 33, 47			35, 23				
	2000-4000			7, 34, 17			34, 7, 17		34, 17		34, 17
	4000-6000	11	6	12, 14, 50	11	6	12, 14, 50	6	14, 50, 12		14, 50, 12
	>6000		10, 20, 21, 16	49		10, 20, 21, 16	49	10, 16, 21, 48, 20, 49		20	49
50	<2000			33					47		
	2000-4000			17			17		17		17
	4000-6000			50, 14, 12			14, 50, 12		50, 14, 12		12, 14, 50
	>6000		16		16			16			

Note: 1 km^2 = 0.386 mile^2; cell entry is transit district identification number.
[a]No cell entries for 26-km^2 service area.

area. An increase in internal nonwork trips and population density increases the probability of transit success. At this point, it was hypothesized that transit success is a function of the percentage of internal nonwork trips, density of population in the service area, and service-area size. Next, the transit districts were cross-classified by using a stratification of all four factors mentioned above (Table 1).

Minimizing Socioeconomic Variability

The final criteria used in the delineation of transit districts was to check the variability in the socioeconomic characteristics of the individual minor civil division (MCD) units that had been combined to create candidate transit districts. This task was accomplished by comparing the candidate districts on the basis of relevant socioeconomic indicators (such as automobile ownership) and land use indicators (such as percentage of land area devoted to different types of activities). It was found that the individual MCDs, which had been combined to form the 62 districts, did not have widely varying socioeconomic and land use characteristics.

PRIORITY ANALYSIS

In order to make the best use of limited resources, the task of establishing the priority of a number of projects is essential. In this study a priority index for a transit district was defined as a function of rank order, level of transportation needs and success factors, and their associated parametric scores:

$$P_i = (W_j \times X_j) \quad (1)$$

where

P_i = priority index of the ith transit district,
W_j = average rank ordered weights for the jth variable, and
X_j = normalized scale score for the jth variable.

It was decided that the rank ordering of need as a transit success factor should be formed by the community representative, to ensure that the relative judgments of the community were reflected in the priority analysis process. A set of 14 transportation needs and transit success factors were identified to be subjected to priority ranking. A survey form was designed and sent to 52 local political jurisdictions within the study area with a request for them to rank the order of the 14 factors. A review of the rank ordering indicated that most of the communities spent considerable time weighing the importance of the factors as related to the transportation system requirements for their community.

The final step in the priority analysis process was the determination of the scores for the 14 factors. These absolute scores varied based on the transit district size. Instead of using the raw score for the 14 factors, the data were normalized into a scale from 1 to 10 to minimize the difference of the absolute scores among the districts. The rank of 1 indicated the highest priority and the rank of 14, the lowest priority. Thus, the mean rank used in the priority index functions was subtracted from 14 to be consistent with the priority index function.

CONCLUSION

The development of transit district service-area criteria by using travel demands for existing services is appropriate in this study area as well as in other areas in the state of Michigan. The service-area concept produced a total of 62 possible transit districts within the study area that are likely to support a small bus program. The priority ranking procedure used in this study considered community values and is considered extremely significant in the analysis process. The data base used for this study, although 10 years old, proved a valid basis for analysis, since limited tests indicated that associated economic and travel patterns in the study area followed similar trends. The priority analysis performed in this study will be updated continually as current trip and other data become available.

ACKNOWLEDGMENT

The opinions, findings, and conclusions expressed in this publication are ours and not necessarily those of the Southeastern Michigan Transportation Authority.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.

Abridgment

Study of Commuter Choice of Information Source to Improve Transit Information Systems

Richard K. Robinson, College of Business Administration, Marquette University, Milwaukee
M. M. Bakr, Division of Engineering Science, University of Wisconsin, Parkside
Thomas L. Thomson, Transportation Division, Department of Public Works, Milwaukee County, Wisconsin

In order to provide the public with information necessary to use the transit service easily, mass transit agencies are adopting a systems approach to their information programs. The transit information system, which includes the types of transit information provided as well as the available information sources, provides a framework that is particularly useful in the study of commuters' information-retrieval behavior. To date, however, investigation of the relationship between the system of transit information aids and the consumer has been minimal (1). The primary contribution of the research to date (1-5) is in the assessment of the usefulness of information aids rather than in the analysis of information-source choice behavior. The purpose of this study is to gain a better understanding of information-source choice behavior and to suggest a way it can be applied to the improvement of transit information system design. It is based on the results of a demonstration project conducted to develop more informative bus stop signs.

METHOD

The project consisted of three parts: the development, field demonstration, and evaluation of experimental bus stop signs. Three demographically representative bus routes were selected for installation of the bus stop signs. A before-demonstration survey of bus riders on the three routes was designed to determine the commuter information-retrieval pattern for the existing transit information system. The existing point-of-use information was a small sign, which displayed only the words "bus stop". Bus users were asked to indicate their preferences for information that could be displayed on a new bus stop sign. Analysis of the preference data provided a basic hierarchy of desired information (6). Based on the survey results, an experimental bus stop sign was developed. The upper part of the blue and white sign displayed a pictograph of the front view of a bus. Information strips were added below to identify the route number and name and to provide additional information. After the sign was installed, a second survey of bus users was performed to obtain feedback on specific evaluation dimensions.

Both surveys employed preaddressed, postage-paid questionnaires, which were distributed by bus drivers on the three demonstration routes. Bus drivers distributed the color-coded questionnaires to passengers who boarded on their southbound trip during an entire weekday. In the before-demonstration commuter survey, bus drivers handed out 8996 questionnaires, of which 2515 were returned by mail, for an overall response rate of 28 percent. In the after-demonstration survey, 10 207 survey forms were distributed. A total of 2361 were mailed back, for a response rate of 23 percent. Although this was somewhat lower than the response rate for the first survey, it was within the range of expectation for a longer questionnaire, which required more of the commuter's time. Response rates for the three routes were consistent for the two surveys.

RESULTS

Analysis of the survey results focused on two questions: (a) whether differences in the commuter information-retrieval patterns involving the experimental bus stop sign were statistically significant and (b) whether commuters' choice of information source was significantly related to the personal and trip characteristics of the respondents. The before-demonstration survey identified the commuters' information-retrieval patterns; the after-demonstration survey also measured the patterns as the basis for comparison and evaluation. Selected information-source choice patterns delineated by the two commuter surveys are shown in Table 1. Commuters were asked to select one information source from the five listed that they would use to find out about certain information elements when on the street or at the bus stop. The two information elements in Table 1 (bus routes and transfer points and bus stop locations) are basic information needed by the commuter for transit trip making. Responses to the first survey indicate that commuters most frequently selected the bus driver as the source of information on both information elements. In contrast to the heavy reliance on the bus driver, the weakness of the existing bus stop sign is reflected in the small percentages from the first survey.

The chi-square test was used to compare the response frequencies in the second survey with those in the first to determine whether or not any differences could be attributed to sampling variation. The results given in Table 1 indicate significant differences in choice of information source for both types of information. Additional statistical analysis of other survey data revealed that the experimental signs, which included a large bus pictograph and the route number and name, were significantly more visible and useful in the identification of bus stops. This is reflected in Table 1, which shows that the use of the bus stop sign for determining bus stop locations increased in the second survey and the use of the bus driver dropped.

To our knowledge, only one study has attempted to relate choice of information source to a set of commuter characteristics. In this laboratory study, reported in the Urban Mass Transportation Administration (UMTA) handbook (4), age, sex, education, and race were found to be significantly related to the ranking of some of the

information aids for overall usefulness. The current study expanded on this research by relating choice of information source to both personal and trip characteristics collected in on-board rider surveys. The personal characteristics included sex, age, education, race, and automobile availability, whereas the trip characteristics were frequency of use, trip purpose, and the need for transfer. The personal and trip characteristics were related to the information-source choice patterns through chi-square statistics computed from contingency tables. Although space limitations preclude presentation of detailed results, the following variables were found to be significantly related to choice of information source at or below the 0.01 significance level: age, sex, education, race, trip purpose, and the need for bus transfer. These, as well as the previous results, confirm the value of an information-aid demonstration project in better understanding transit consumer behavior and in guiding the improvement of transit information systems.

Table 1. Percentages of information-source choice for commuters in first and second surveys.

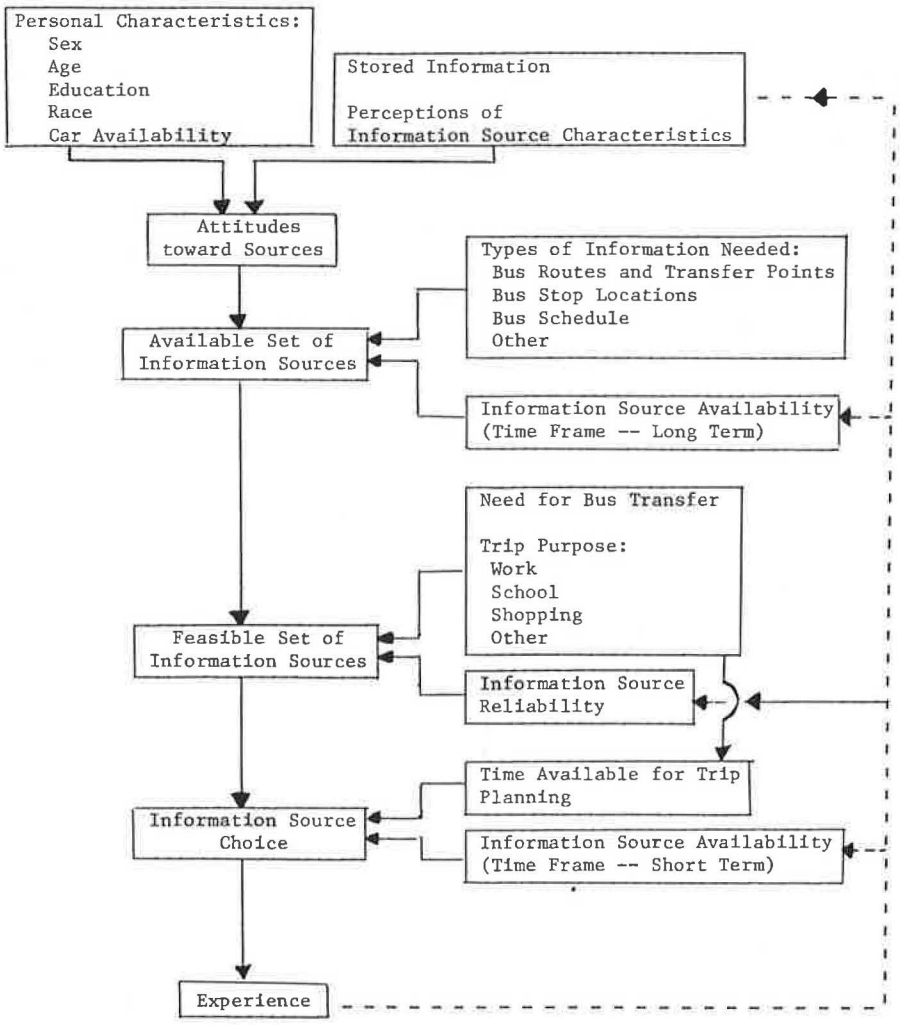
Information Source	First Survey (n = 2515)	Second Survey (n = 2361)
Bus Routes and Transfer Points[a]		
Phone information	23.6	21.6
Friend or commuter	10.6	8.1
Bus driver	45.3	44.5
Route schedule	8.1	9.1
Bus stop sign	1.2	4.1
Do not need	2.8	2.9
Marked two	8.4	9.7
Bus Stop Locations[b]		
Phone information	10.6	12.9
Friend or commuter	14.1	8.9
Bus driver	38.8	36.3
Route schedule	5.3	6.1
Bus stop sign	19.8	23.6
Do not need	6.5	7.3
Marked two	4.9	4.9

[a] $X^2 = 50.2$; $p < 0.001$.
[b] $X^2 = 40.0$; $p < 0.001$.

INFORMATION-SOURCE CHOICE MODEL

Based in part on the results of the demonstration project, a model of the process by which the transit consumer chooses an information source is presented in Figure 1. Relationships between the trip and personal characteristics and choice of information source shown in the model have been established. The statistical analysis used to determine the relationships involved tests in a static framework. The model expands on these relationships to develop a dynamic framework, which depicts the normative behavior of a transit consumer as suggested by these relationships as well as by other data.

Figure 1. Model of the information-source choice process.



Attitudes Toward Transit Information Sources

Attitudes toward transit information sources are influenced by a set of personal characteristics and by stored information, which reflects the personal experience of the commuter (7). Also, they are shaped by the commuter's perceptions of information-source characteristics. The perceived complexity of an information source, for example, is an important factor in the process (8). Personal characteristics of significance included sex, age, education, and race. Females, older people, and less educated individuals showed a preference for direct inquiry about information (asking the bus driver or calling for bus information on the phone) but indicated little interest in using a pocket schedule. Choice riders, those who have an automobile available for use, were also more heavily dependent on the telephone for information. Information provision involved in the marketing of public transit to automobile travelers represents a challenge to transit managers. It requires their improved understanding of the transit decision-making process.

Available Set of Information Sources

The set of information sources considered available by the transit consumer is influenced by the consumer's perceptions and attitudes toward information sources. It is also affected by the type of information desired and the availability of this information from various sources. Finally, long-term availability of the information source is dependent on the commuting habits of the individual, which influence the time in which the information is generally conceived to be needed.

Feasible Set of Information Sources

The feasible set of information sources is a subset of the available sources perceived by the commuter. The reliability of available information sources, the nature of the trip as indicated by trip purpose, and the need for bus transfer influence the consumer's perception as to the feasible set of information sources. Information-source reliability is defined as the probability of receiving correct information from a source when the source is queried about an information element. The important role of trip purpose in market-segmentation analysis has been well documented in transit consumer research (6-8). The current study further demonstrates the significance of trip purpose in delineating information-retrieval segments. Evidence of the impact of the improved bus stop sign on choice of information source was observed in the retrieval pattern for bus stop location information. Not only was the choice of the bus stop sign significantly higher in the second survey but, for school passengers in particular, it was the most frequently selected source. Bus transfer was significantly related to choice of information source primarily for bus route information. Such results confirmed the importance of providing adequate route information on the bus stop sign and over the telephone to meet the needs of a predominantly transfer-oriented ridership.

Information-Source Choice

The final source choice, determined before making a trip, depends on

1. The time available for trip planning and
2. The availability of the information source in the short-term time frame in which the decision to undertake the trip is made.

A commuter embarking on a bus trip would choose a timely, available source of information from the feasible set to obtain travel information. Experience in using the information source will augment commuters' stored information as well as update their perceptions of source availability and reliability.

IMPLICATIONS FOR TRANSIT SYSTEM MANAGEMENT

Our research has examined the significant relationships between trip and commuter characteristics and choice of transit information source. A model of the information-source choice process has been proposed based on these relationships and further analysis of the travel information-retrieval patterns. The model brings personal and trip characteristics, together with behavioral variables, into play in a time sequence consistent with the process of seeking travel information with the intention of using the transit system.

If a transit system expects to maintain or increase its ridership, it is important that it determine shortcomings in its public information system. However, the goal of providing the commuter with the information necessary to use a transit system has to be viewed within the constraints of a limited budget. In order to evaluate the effectiveness of one information source over another, in addition to ascertaining the commuter information-retrieval patterns, the cost of providing the information must be determined. The transit management can use cost information and a general knowledge of the social impacts of each information source to develop programs that will improve the transit information system and possibly enhance transit ridership.

In order to improve its information system while working within a set budget, transit management can use the proposed model to consider alternative strategies for modifying information aids. To demonstrate the use of the model, consider the following example. The management of a transit system wants to increase the bus usage of the choice-rider segment. It is considering two information-aid options:

1. Improve a currently inefficient telephone information service, or
2. Increase the availability of pocket schedules to choice riders.

Use of the proposed model helps management identify the feasible set of information sources from the viewpoint of the choice rider. Without the use of the model, the management might have been inclined to increase the availability of pocket schedules rather than to improve the telephone information service. This would have been a wasteful move—the model indicates that choice riders are less likely to use the pocket schedule and actually prefer the telephone as a source of their schedule information. Thus, management can focus on the optimal plan of increasing choice ridership either by adding additional operators or installing an electronic data retrieval system.

This example indicates the benefits to be derived from a systematic analysis and interpretation of transit consumers' information-source choice. The proposed model provides a method by which significant relationships between consumers' information-source choice and their trip and personal characteristics can be used to identify deficiencies in transit information aids. The applica-

tion of this approach places transit management in a better position to evaluate alternative strategies for improving information aids and to allocate their resources more effectively in support of the various information aids.

ACKNOWLEDGMENT

This research was supported by a grant from the Wisconsin Department of Transportation and Milwaukee County. The views expressed in this paper are ours and are not necessarily concurred with by the funding agencies.

REFERENCES

1. P. B. Everett, V. Anderson, and U. Makranczy. Transit Route Pamphlets: Do They Work? Transit Journal, Summer 1977, pp. 59-70.
2. Transit Information Aids, Mass Transportation Demonstration Project. Urban Mass Transportation Administration, INT-MTD-10, 1969.
3. S. D. Liff. Public Information Systems in Urban Mass Transit. Northwestern Univ., Evanston, IL, M.S. thesis, 1971.
4. User Information Aids, Transit Marketing Management Handbook. Office of Transit Management, Urban Mass Transportation Administration, 1975.
5. J. J. Haynes, H. Garland, and G. C. Grubb. Transit Route and Schedule Information Methods. Paper presented at the 56th Annual Meeting, TRB, 1977.
6. M. M. Bakr and R. K. Robinson. Commuter Preference for Bus Stop Sign Information. Journal of the Transportation Engineering Division, Proc., ASCE, Vol. 104, 1978, pp. 267-278.
7. C. H. Lovelock. Consumer Oriented Approaches to Marketing Urban Transit. 1973, NTIS: PB 220 781.
8. M. C. Schwartz. Consumer Reaction to Transit Marketing in Boulder, Colorado. TRB, Transportation Research Record 725, 1977, pp. 7-11.

Publication of this paper sponsored by Committee on Transit Service Characteristics.

Communication Considerations for Transit Route and Schedule Brochures

Keith M. Thelen, Knoxville-Knox County Metropolitan Planning Commission

Route and schedule brochures provide information on the specific service features of fixed-route transit. Clear, concise, and easy to understand information on these pamphlets is important to both users and prospective users of transit services. To date, insufficient attention has been directed toward development of effective communication techniques on these pamphlets. Many are difficult to interpret, incomplete, or poorly formatted, which makes them of marginal value to prospective users. The assumption that the reader is familiar with transit service characteristics, and thus able to translate any printed information, can make the brochures difficult to comprehend for automobile-oriented individuals. Nonusers cannot be expected to use the transit mode if they are uncertain about the characteristics of a specific service. The paper outlines methods by which communication techniques can be improved for route and schedule brochures. The design process should be governed by rational and systematic design principles, which are proposed and explained. The principles have been applied to the redesign of Knoxville Transit's route and schedule brochures. Each element on the brochure cover, timetable, and route map is briefly discussed in terms of desirable design practices and the rationale for each.

Route and schedule brochures provide information basic to the use of fixed-route transit services. The pamphlets show the path of a particular route, the activity centers it serves, and the arrival times of a vehicle at specific locations. A prospective or regular user can then determine whether a transit route is suited to the time and spatial characteristics of a particular trip. The type of information provided on these pamphlets is usually more detailed than such instruments as bus stop signs, systemwide maps, and other supporting information devices. Therefore, route and schedule brochures aid the user in gaining access to transit services and have an important influence on the user's understanding of those services.

ROLE OF ROUTE AND SCHEDULE BROCHURES

Although a printed information aid should not be considered a promotional device (1, pp. 52-60), the route and schedule brochure may have an important function when new users are attempting to understand transit services. A study by Liff (1, pp. 52-60) of 103 individuals who have varying amounts of transit experience indicated that 70 percent use passive information sources (the telephone or route map) or an acquaintance as their source of information to determine the correct route to take. In addition, no one would seek information from a stranger. This may reflect a desire to use passive information sources rather than to seek information from sources that one might find embarrassing or threatening. If so, it would be consistent with other consumer experiences, exemplified by self-service supermarkets and department stores.

Since route and schedule brochures provide the most basic and detailed information on fixed-route transit services, effective communication on these pamphlets is vital to user comprehension of the service and to successful promotional campaigns. Inquiries generated by promotional programs must be reinforced by readily available and easy to understand descriptions of the ser-

vice. Fare discount specials, media campaigns, and similar promotional programs may not fully achieve their objectives if the prospective user is frustrated by inadequate information devices.

Highway Versus Transit Information Systems

Traffic engineers have long recognized that a clear and functional highway information system is critical to automobile drivers. During the past 25 years, substantial resources have been allocated to test and develop an effective motorist information system. Through research, interagency communication, and technical evaluations, motorist information systems have been carefully developed to simplify driver decision making on the highway. Specific standards governing the design and placement of traffic signs, signals, and pavement markings are set forth in the Manual on Uniform Traffic Control Devices (2). The purpose of these standards is to ensure uniformity, clarity, and effective communication of traffic information to the motorist.

Relatively little attention has been focused on transit information materials, however. The content and format of transit information materials varies considerably throughout the country. On a subjective basis, their clarity and effectiveness also vary considerably (3, pp. 109-130). Many information devices seem difficult to interpret, incomplete, or poorly formatted, which makes them of marginal value to prospective users. These problems have been caused by (a) the large volume of information that must be transmitted, (b) the complexity of some transit routes, and (c) the assumption that the public is familiar with features of transit service. In fact, only frequent transit users (typically 1-4 percent of the urban population) are familiar with traveling by fixed-route bus.

Nonuser Information Needs

Prospective or occasional transit users have much different information needs than frequent users. Their lack of familiarity with transit services makes them more dependent on user information aids to learn about the service. Choice riders probably do not have unrestrained determination to use transit, particularly if the more familiar and convenient automobile is available. They are likely to be less tolerant of the obstacles posed by inadequate information materials. The prospective user may not be willing to spend even modest amounts of time in interpreting transit information materials, nor may he or she be willing to risk boarding the wrong bus and become lost or late for an appointment. These relatively severe consequences (compared to other $0.25-$0.50 consumer purchases) make clear descriptions of the service important.

Since the greatest share of any significant increases in transit ridership must come from the noncaptive market, the previous nonuser attributes have special implications for designers of transit route and schedule brochures. Since nonuser access to the system depends partly on their understanding of printed information aids, the brochure must clearly convey its intended message without ambiguity. The information must also be complete, to ensure that the brochure accurately represents all aspects of the service. Finally, the brochure must be immediately interpretable so that the reader does not have to spend large amounts of time assimilating its information.

OBSERVATIONS ON THE STATE OF THE ART

The discussion that follows is not based on empirical research but rather, it is intended to generate discussion within the transit field and to point out the need for clear definitions of what constitutes an effective communication technique. Such definitions should come from systematic and empirical research that would be used to guide the communication of transit information to the public.

In order to obtain ideas that have applications to local design problems, route and schedule brochures from approximately 20 transit properties throughout the country were examined. On a subjective basis, the communication effectiveness of these pamphlets was reviewed and the following observations made.

Brochure Cover

Most brochure covers included information on the name and number of the route, effective date of the service, the name and logo of the transit property, and the telephone information number. A picture of a transit vehicle was used on some brochures to indicate that it was a transit-related information piece; other properties used decorative graphics in place of the transit vehicle.

None of the transit properties indicated where the route traveled relative to the rest of the city on the cover of the brochure. A few of the brochure covers indicated the activity centers served by a particular route; however, most did not include this information.

Timetable

The weekday time schedules were frequently located on the opposite side of the brochure from the route map, making reference between the timetable and the route map difficult. In an effort to achieve maximum space utilization and to provide a greater number of time-point locations, some properties printed the description of the time-point location at 90° from the published times. This made reading the description somewhat awkward.

Most brochures do not have reciprocating symbols between route deviations on the timetable and the route map. This is also true of time-point locations. It was often difficult to translate a written description of the time-point location to an exact location on the route map. Some timetables showed arrival times in both the inbound and outbound directions in an effort to provide the user with more precise information. This feature added to the complexity of the brochure, although the added information may be of benefit to the user.

Some properties made extensive use of letters within the timetable column to denote route deviations or special services. If a large number of deviations were involved, the timetable became complicated and attempts to establish correspondence between the route map and the timetable became difficult. Various written descriptions and explanations occurred on the timetables that may or may not have been clear to users of a particular transit system. These written descriptions were often not reinforced by corresponding information on the route map.

Route Map

The use of secondary reference streets varied by transit property. Route variations and deviations that were represented on the route map were not always clearly identified on the timetable. On complicated routes, which

had several pieces of information associated with them, there was too little use of multiple line weights, variable shade intensities, and variable letter sizes, which would indicate hierarchies of information and improve the readability of the brochure. When an effort was made to represent many transfer points, activity centers, different fare zones, or express services, the map became complex and extremely difficult to understand.

Summary

Each of the problems discussed above may not represent an insurmountable communication problem when considered individually. However, a large number of individual problems may make a particular brochure unreadable or difficult to understand.

The review of various pamphlets indicated that individual properties often used unique approaches that improved the clarity of a particular pamphlet. It was also apparent that a good deal of effort is being expended to solve communication problems. However, in the absence of formal guidelines, transit personnel have to rely on in-house experience and subjective judgment to guide their efforts. This may not be adequate in a society where most individuals are automobile oriented and have little or no transit utilization experience.

PROPOSED COMPOSITION GUIDELINES

To address communication problems on route and schedule brochures in concrete terms, the following composition guidelines are proposed. These guidelines incorporate concepts that should be considered in the design of the brochure, and they represent a systematic approach to the design process. Although research is needed to validate and refine these concepts, they represent a starting point from which to improve communication techniques on the pamphlets.

1. Establish correspondence between elements of the timetable and route map. To accomplish this (a) position the map on the same side of the pamphlet as the weekday timetable to allow comparisons between the two (since weekend riders are more likely to be captive users and, therefore, more familiar with the transit system, it may be less important to have the Saturday and Sunday schedules on the same side of the page as the route map) and (b) establish common reference points and reciprocating symbols on the route map and timetable.
2. Minimize the time required to interpret the pamphlet by using symbols, rather than written explanations, as a primary means of information conveyance.
3. Provide enough detail to explain the service sufficiently to new and unfamiliar users. This principle can be accommodated without greatly increasing interpretation time by structuring information into hierarchies of importance. The most important information should be the most prominent and the briefest. For those who need more explanation, the more detailed and lengthier descriptions should be available in smaller and less prominent print. This will enable readers to pass over items with which they are familiar and to examine more closely those aspects of the service that they do not understand.
4. Separate distinct components of the timetable and maps through spatial or graphic separation methods: (a) spatially separate route deviation information from times on the timetable and (b) graphically separate unique elements of the route map (e.g., downtown maps, landmarks, supporting streets, and the route map), through shading, variations in type faces, and variations in line weights.
5. Simplify the graphic elements of the pamphlet and avoid complicated techniques of representing the information. Minimize the number of lines and symbols that do not have a functional purpose and avoid graphic techniques that are ambiguous, confusing, or do not have a functional purpose.
6. Use graphic components to convey information. The utility of graphic elements of the brochure should be maximized: (a) cover graphics should be primarily used to convey information before fulfilling any extraneous purposes; (b) if more than one color is used, it may be possible to use color as a communication tool; and (c) if more than one shade (color intensity) is used, it should accomplish as many functional purposes as possible without causing confusion or interpretation conflicts; the meaning of shade variations should be immediately apparent.
7. Minimize the adverse impacts of format changes on existing riders. New brochures should use formats, written explanations, and letters for route deviations that will be understandable to current users. If changes in the brochures are substantial, it may be appropriate to introduce the modifications in stages.

APPLICATION OF THE COMPOSITION GUIDELINES

As part of a marketing study conducted under the Urban Mass Transportation Act of 1964, Section 9 planning funds, the route and schedule brochures used by Knoxville Transit were redesigned and prototypes printed. Nine brochures, describing 20 routes, were reformatted and their graphic qualities upgraded. This effort was undertaken for several reasons: (a) the local transit operator did not have a marketing staff or graphic personnel to revise the pamphlets, and (b) the design and layout of each brochure is necessary if the unique formatting and communication problems of individual brochures are to be adequately addressed. Finally, if relatively advanced and expensive promotional programs are to be effective, user information materials must effectively convey information on the service.

Brochure Cover

The name and number of the route should be prominently displayed on the cover of the brochure. A picture or drawing of the transit vehicle (rather than the words bus schedule) illustrates the contents and purpose of the brochure. The illustration of the vehicle requires no time for reading and can be immediately interpreted by those who are unfamiliar with the brochure. A miniature city map of Knoxville with the transit route shown relative to the rest of the city (Figure 1) gives some general indication of the location of the route within the service area. Very large cities could modify this approach by showing only a sector or well-defined geographical area within the city.

The telephone number of the transit property should appear on the cover so that it can be quickly found if more information is desired. Print the effective date of the schedule on the cover to reduce the chances that a patron will use an outdated schedule. The logo of the transit property is also helpful for the purpose of having a common recognition symbol for transit materials. If sufficient space is available, a brief list of major activity centers served by each route is desirable.

Timetable

Reverse the element (white on black) for the day of the week to visually separate it from the route name (Figure

2). By positioning it as a heading, it can be easily located by the user.

If more than one route is shown on each brochure (as is the case in Knoxville), each timetable should be clearly labeled to indicate the route to which it applies (Figure 2). Horizontal descriptions of time-point locations (rather than 90° scripts) eliminate the need to turn the brochure when reading the scheduled times or when comparing the timetable to map locations.

A numbered time point reduces the need to search for the desired time point on the map. A user can associate locations on the route map with the correct timetable headings faster and with greater ease because it eliminates the need to search for specific street intersections (Figure 3).

Figure 1. Transit routes relative to the city map.

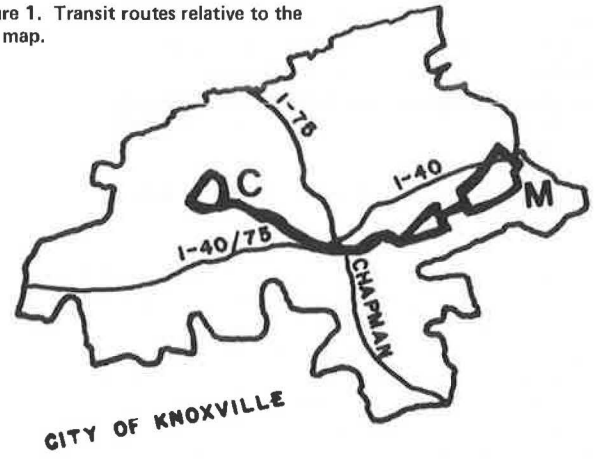
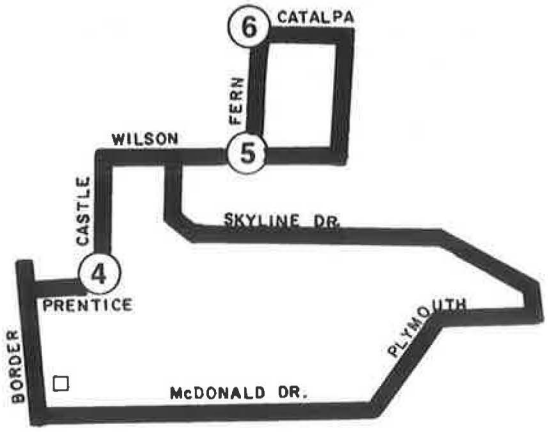


Figure 2. Day of the week and route name on the timetable heading.

Figure 3. Numbered time points on the timetable and route map.

PREN-TICE & Castle	FERN & Wilson	FERN & Catalpa	PREN-TICE & Castle
4	5	6	4
--	605	610	620
630	--	--	645
--	650	655	700
700	--	--	715



The use of closed shading around the time point on the time schedule (a) visually separates this element from the verbal description of the time-point location and (b) highlights the importance of this element by making it graphically dominant.

Numbers within each time point convey the path of the vehicle along the route by their sequential arrangement (Figure 4). If there is some doubt about the path of a vehicle on a route (even after the words inbound or outbound have been provided), sequential numbering of time points (a) graphically illustrates the path and (b) reinforces any written descriptions.

Route deviation letters in the timetable should correspond to letters that denote route deviations on the route map (Figure 4). Graphic correspondence between the route map and timetable can be established with this technique. This permits rapid interpretation of letters on the timetable. White on black lettering is used because it is visually distinct from other elements of the route map. Offsetting typed letters in the route deviation columns (Figure 5) is done to (a) visually separate distinct deviations and (b) indicate the pattern of the deviations, if any.

Map

The use of numbered time points boldly shows time-

Figure 4. Letters denoting route deviations on the timetable and route map.

LEAVE UNION & GAY	I or M	HAYNES STERCHI & CEDAR
1	M	6
	--	620
	M	--
640	I	715
710	I	745

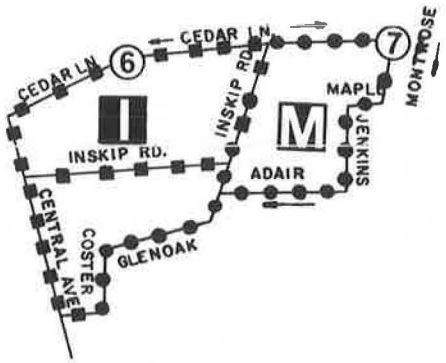
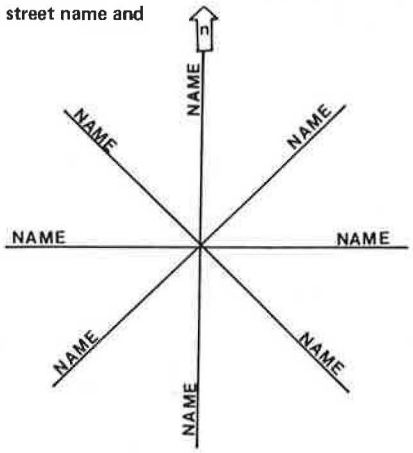


Figure 5. Route deviation column on the timetable (offset letters denote the pattern of the deviations).

I or M
M
M
M

Figure 6. Recommended street name and street line convention.



point locations and establishes graphic correspondence between the timetable and map. If possible, maps should be positioned on a page in the following manner:

1. North-south routes positioned vertically, with the northernmost section at the top of the page, and
2. East-west routes positioned horizontally, with the westernmost section at the left of the page.

The objective is to achieve some standardization between different route maps and to follow standard mapping layouts.

The use of white on black lettering to designate route deviations establishes graphic correspondence between the timetable and the route map. Route deviations that are periodic in nature or complex can be shown by dots or dashes to illustrate their variation from the regular route. However, more than three line variations (a solid line and two route-deviation lines) become difficult to interpret and could cause confusion. A large number of route deviations, directional variations, and transfer points can be difficult to understand and may warrant division of the map into components. The designer should recognize limits on a reader's ability to absorb complicated information. All route deviations referenced in the timetable should be shown on the map in some manner. One-time deviations to activity centers can be shown by simply locating the activity center on the map.

Secondary streets provide points of reference for users who may not be familiar with specific streets on the transit route. Street names should be positioned on the map in a consistent and easy to read manner. The reader should not have to alternately turn the brochure when comparing the route map and timetable. The street-name line convention shown in Figure 6 should be used when labeling street lines.

Landmarks provide additional points of reference for those who may not remember street names. It may be necessary, however, to omit landmarks if the route is complicated or the map is congested with higher-priority graphics. Landmarks should be presented by using less bold and prominent graphics than more important information on the map. A downtown map is needed to display directional paths through the downtown area to aid users in knowing on which side of the street to board.

SUMMARY AND IMPLICATIONS

A rational and systematic approach to the design of route and schedule brochures is necessary to achieve the effective communication of transit service information. Empirical data that describe the best methods of depicting transit services for the public are needed to form the basis for such an approach.

Other communication tools, such as bus stop signs, how-to-ride brochures, and systemwide maps, should also receive this kind of attention. Methods of clearly transmitting information on these devices should also be identified. Unless each element within the information-dispersal network achieves its purpose, access to transit services will be hindered by communication devices that are difficult to understand.

REFERENCES

1. S. D. Liff and R. M. Michaels. Public Information Systems in Urban Mass Transit. Northwestern Univ., Evanston, IL, Aug. 1971.
2. Manual on Uniform Traffic Control Devices for Streets and Highways. Federal Highway Administration, 1971.
3. Marketing Strategies for Fixed Route Transit. Knoxville-Knox County Metropolitan Planning Commission, Knoxville, TN, Feb. 1978.

Publication of this paper sponsored by Committee on Transit Service Characteristics.

Plan for Transit Fare Prepayment Promoted by Employers

Beth F. Beach, Sacramento Regional Transit District

This paper outlines a plan for the marketing program and the selection and solicitation of employers and their employees for participation in a transit-fare-prepayment program. Participating employers will make monthly transit passes available to their employees at their workplaces. The information in this paper was gathered from the experience of four transit systems and was applied to transit-fare-prepayment programs aimed at promoting a monthly transit pass through employers for single mode and multimode systems. The methods described in this paper yielded the most positive response, from employers and their employees, of the methods tested. The plan described can be used as an aid for assisting transit systems in initiating similar programs.

The objective of the Sacramento Transit Fare

Prepayment Demonstration is to increase transit ridership and to improve transit marketing through employer involvement. It is part of the Urban Mass Transportation Administration (UMTA) Service and Methods Demonstration (SMD) Program and is jointly funded by UMTA and the Sacramento Regional Transit District (SRTD). Preliminary demonstration activities began in November 1977, and passes went on sale in May 1978. From July 1, 1978, to June 30, 1979, 52 employers in the Sacramento area sold monthly transit passes to their employees, through either payroll deduction or some other procedure designed to improve the convenience of purchasing transit passes. Employers were also encouraged to develop an internal marketing program and to subsidize the cost of the passes. During the months of October, November, and December of 1978, employer-sold passes were offered at a 25-percent price discount as a promotional device.

This paper outlines various marketing tools used to obtain employee and employer participation in the transit-fare-prepayment program and as aids in the selection and solicitation of employers.

MARKETING PROGRAM

The marketing program used was threefold:

1. It created awareness and communicated information about the program to the general public,
2. It attempted to induce employers to participate in the program, and
3. It encouraged the employees of participating employers to purchase monthly passes.

The first step taken was to create a booster committee, made up of business and government leaders in the community. Endorsements were obtained from the members, and extensive efforts were made to generate media coverage of the meetings. If endorsements could be obtained from the members of the committee, they usually agreed to participate in the program and, because of their status in the community, it had a positive effect on other employers. The booster committee also served as an effective kick-off for creating public awareness through the media. Both radio and television coverage were obtained, and press releases were sent to all the local newspapers. In conjunction with the initiation of the booster committee, a spokesperson for the transit district made public-service announcements for the local radio stations, appearances on local television shows, and interviews with the local newspapers. The spokesperson also spoke at local association meetings in an effort to obtain written endorsements of the program from them. In each case this resulted in obtaining the endorsement desired and created interest in the program among employers who were members of the associations.

Another approach that proved effective in creating public awareness and interest in the program was to distribute a flyer on board the buses during the peak hours of operation. The flyers supplied information on the program and requested that riders supply the name and address of their employers and return the flyers to the driver. It also suggested that riders inform their employer of their interest. The original plan was that the information obtained would be used as an aid in selecting the employers to be solicited; however, this approach resulted in numerous employers contacting the SRTD because of the interest in the program expressed by their employees, and a final tabulation of the results was never completed.

Next, a strong advertising campaign was begun. This included teaser ads placed in the local newspapers, on large signs on the exterior of the buses, on mini-posters inside the buses, and on bus benches. It was felt that this coverage would ensure exposure to riders and nonriders. Prior to the discount period, a decal was attached to the exterior bus signs announcing the discount period and amount. These proved so effective in getting employee and employer response that they had to be removed, as the demonstration was limited in the number of employers and employees that could participate in the discount. In conjunction with the appearance of the decal, another advertisement appeared in the local newspapers, which listed the names of the firms participating in the program that would be eligible for the discount. The purpose of this ad was twofold: (a) it created interest among people who did not work for participating employers, and (b) it was another way to notify employees of participating employers that their employer was part of the program.

Efforts continued throughout the solicitation phase of the program to keep the public informed through newspaper coverage, which announced the participation of any new employers and any additional endorsements that were obtained. After sufficient public awareness and interest were created, employer solicitation began.

A direct correlation was found between employer participation in the program and the level of public awareness. Also, as more public information was dispersed, employers knew of the program by the time they were approached and already had some feeling for the interest level of their employees and whether or not the program was appropriate for their needs.

For the second step, a letter was sent to the chief executive of selected employers within the SRTD service area. The letter was designed to create employer interest and to note the advantages the program offered to the company and its employees. The program was referred to as a no-cost benefit. In some cases information obtained from the on-board flyer was used to point out to the employer the current transit use by the company's employees and their interest in purchasing monthly transit passes at work. A brochure was developed that explained the mechanics of the program in detail, introduced the employer to the forms involved, and contained copies of endorsements the program had received from organizations in the area, members of the booster committee, and other participating employers. The brochure was designed in a manner that allowed it to be produced at a low cost in house and allowed for ease in making changes or additions should they become necessary. Also, although the brochure explained the program in detail to the employer, it was kept as brief and concise as possible.

In the third phase, materials were directed to the employees of the participating employers. Posters, announcing the program, were made available for placement at strategic locations at the workplace. Three flyers, for distribution to the employees, were designed so the type could be changed and developed for the specific employer, and all printing could be done in house, using the SRTD's facilities. The first flyers were used to notify the employee of the program, describe the type of participation by the employer (i.e., payroll deduction, over-the-counter sales, or subsidized passes), and to tell the employee where to go within the workplace for more information. A second flyer was developed for use by the employer to announce the possibility of participation in the program to employees and request employee feedback. A third flyer was used to announce the discount period to employees. In many cases firms had an employee publication in which articles announced the program and gave the necessary information. Pay-

roll inserts were also used to get information about the program to the employees. Efforts were made to get the employer involved in the marketing of the monthly passes to their employees. System books, system maps, and wallet timetables were supplied by SRTD to all employers. In some cases the employers set up mini-transit centers for employees, which displayed the transit route map and had system books and wallet timetables available for specific routes. Conclusions drawn from pass sales indicate that the level of support by top management has a direct effect on the degree of participation by employees. During this phase, it was important that the advantages of transit use and the convenience of the monthly pass were clearly communicated to the employees.

In all cases, the employers were willing to distribute materials to their employees as long as they were delivered in a timely fashion by the transit system. Initial distribution of the materials began approximately one month before the passes became available.

EMPLOYER SELECTION AND SOLICITATION

The selection of employers for initial contact was based on a careful screening procedure. Employers were chosen based on the following criteria:

1. Size of establishment as determined by the number of employees,
2. Availability of transit service to the site during working hours,
3. Type of industry,
4. Geographic location within SRTD's service area, and
5. Availability of parking.

Consideration was also given to employers who subsidized employee parking by offering free parking or paying part or all of the cost of their parking fee and promotion of carpooling by the employer.

Based on the information collected, employers were contacted initially by a letter directed to the chief executive of the firm. This was followed by a personal telephone call from an SRTD representative in which more information on the program was supplied and attempts were made to set up a meeting to discuss participation in the program. If requested, specific information regarding the transit service available to the employer location at the time needed, a procedure brochure, and samples of the flyers and payroll inserts were sent. At the initial meeting the program was explained in greater detail to the employer with emphasis placed on the convenience and advantages. Also, the concept of a no-cost benefit was emphasized. If the employer had not already received one, he or she was supplied with a procedure brochure that explained the mechanics of the program and introduced the forms that would be used. Samples of the other marketing material available were also supplied.

Knowledge of similar companies participating in this program or other programs of this type in other parts of the country was necessary in order to assist the employer in setting up internal procedures. By supplying examples of the internal procedures used by other firms, it was possible to find a system that would work for each employer. An important consideration for all employers approached was that their internal system be as simple as possible and their additional administrative costs be kept at a minimum. Employers wanted some idea of the time and cost that would be incurred by the company if it became involved in the program.

The necessary information was obtained in several ways:

1. Employer contact forms were completed by the transit personnel after each employer contact;
2. Information was requested from other transit systems that have similar programs; and
3. Procedures used by other firms were obtained from employers that were involved in this type of program.

The most efficient method found for obtaining the information from other transit districts was to mail a brief questionnaire to the transit systems. The questionnaire requested information on the internal procedures used by participating firms; estimates on the costs and time incurred by the firms; and the firm's name, address, and a contact person so SRTD could contact the firm directly in case additional information was needed. If additional information was needed from the transit district, the returned questionnaire was followed up by a telephone call.

The main reasons given by firms for not participating in the program were the following:

1. Concern about the administrative cost and time involved;
2. Although transit service was available at their site, they did not feel it was adequate for their hours of operation;
3. The majority of their employees were seasonal, and the employer did not want to get involved in an on-off situation;
4. The majority of their personnel needed their automobiles available to conduct business;
5. They were at a remote location from where payroll is done or company policy only allowed companywide deductions;
6. They did not have cashier facilities available; and
7. Due to conflicts with their labor union, the program could be perceived as an unequal benefit in that not all employees could take advantage of it.

Employers tended to agree to participate if they currently subsidized all or part of their employees' parking expense or if the firm promoted carpooling for its employees. Companies were more inclined to participate if they faced the prospect of having to build additional parking for their employees or if they were pressured from their employees or local government to alleviate the parking problem in their area. From the majority of contacts, we determined that the employer (a) needed an incentive to offer the program to employees and (b) did not want to become involved in the program unless it offered employees something that they could not obtain elsewhere at the same cost or, at the least, the company would not incur any additional cost by offering it.

SRTD supplied this incentive by offering the monthly transit pass at a 25 percent discount for three months if it was purchased through the employer. Although this proved an excellent incentive for obtaining employer and employee participation in the SRTD program, it created some ill will among pass purchasers who were unable to receive the discount either because their employers were not participating in the program or because they purchased their passes at a public outlet. (Statistical data on those employees who previously purchased passes at SRTD's public outlets and switched over to purchase the pass from their employer during the 25 percent discount period were not yet available.)

Incentives offered by other transit districts include (a) making the monthly pass available through participating employers only or (b) offering the employer a discount rate per monthly pass sold, which can either be passed on to the employee or kept by the employer to help cover administrative cost.

Efforts to institute a program of this type and require that the employer subsidize part or all of the cost of the monthly transit pass have not been encouraging. Employers who may be interested in encouraging transit use by their employees by making the monthly transit pass available at the place of employment are not necessarily willing to assume the additional cost of subsidizing the program. It was also found that the procedures for the program must be somewhat flexible. Due to internal systems and procedures, an employer may not be able to meet some requirements set out by the transit system, although the company is interested in participating. In these cases, it was usually possible to make minor alterations that would satisfy the needs of the employer and SRTD.

CURRENT TRANSIT FARE PREPAYMENT PROGRAMS

Chicago

As of December 1978, 115 employers were participating in the Chicago Transit Authority (CTA) employer program, which had a sales volume of 6472 passes/month. Due to publicity the project received in December, the number of participating employers jumped to 253 for January 1979; of these, 9 subsidize the cost of the pass. The pass is nontransferable and costs $25. This represents no savings to the rider if he or she does not transfer, but with a transfer CTA estimates a savings of approximately $1.40. The pass is only available through employers and the previous subsidy requirement has been removed.

Boston

The most successful and extensive program of this type is offered by the Massachusetts Bay Transportation Authority (MBTA) in Boston. This program has been in effect for 4.5 years. Currently 780 employers are participating, and they sell 32 000 passes/month through their program. About 20 of the employers subsidize the pass 50-100 percent. The major incentive offered by the MBTA is that the pass is only available through participating employers; however, this changed as of January 1979, when the MBTA opened their first public pass-sales outlet. Additional benefits offered by the MBTA are discounts allowed to pass holders by area attractions.

Pittsburgh

As of December 1978, 42 employers are involved in the Port Authority of Allegheny County (PAT) employer pass program. They sell approximately 4000 passes/month just through employers. PAT offers an incentive by offering the employer a discount rate per monthly pass sold that can either be passed on to the employee or kept by the employer to assist in covering the company's administrative costs. PAT is no longer actively pursuing their program; however, it is still in effect. They found, after what they considered an extensive promotion, that the response rate among employers was relatively low. The main reason given for the lack of interest was that the companies were hesitant to participate due to the additional administrative cost involved. This was especially the case for the larger companies. Two other factors that might discourage participation by employers is that PAT offers the pass for sale through public outlets and there was a minimum requirement of 10 participating employees placed on the employers.

Sacramento

Pass sales through the SRTD employer pass program have been available since May 1978. Currently 52 employers are participating in the program, and they sell approximately 2950 passes/month. SRTD sells an additional 2850 through its 39 public outlets. The two main factors that have discouraged employer participation are (a) passes are available at the same price at the 39 public outlets, and (b) the additional administrative costs incurred by companies participating in the program.

CONCLUSION

To date the SRTD employer pass program, Monthly Passport, has proved to be extremely successful. During the month of November 1978, 51 percent of the total of the SRTD pass sales were through the employer pass program. Exact data on the number of new riders obtained through the program has not yet been ascertained. However, complete data will be available regarding the number of new pass purchases and those switching from the public purchases to their employers when the analysis is completed of the survey done in December 1978.

The type and size of the companies involved is varied: 40 percent of the companies are private and 60 percent are state, local, and federal agencies. The size of the firms runs from 6 to 15 000. The cost and time required by SRTD has been higher than should be required to institute a program of this type in another transit district. The main reasons for this are the three surveys that were conducted as part of the demonstration and the experimentation in marketing tools used in order to test their effects on the employers and their employees. The marketing budget was $20 000. The time required by SRTD personnel was extremely heavy during the initial setup phase of the program and during employer solicitation. To continue this type of program would require at least one full-time person if continued growth is desired. Additional SRTD personnel time is required in the continuing contact of those employers participating in the program. It has been found that, for an employer to continue participation in the program, it is important to establish a rapport between the employer and the transit representative.

ACKNOWLEDGMENT

The preparation of this document was financed in part by funds provided from the Urban Mass Transportation Administration through the Integrated Grant Administration Program.

Publication of this paper sponsored by Committee on Transit Service Characteristics.

Financing Urban Mass Transportation Systems: A Study of Alternative Methods to Allocate Operating Deficits

Paul A. Dierks, University of Texas, Arlington

This study examines allocation procedures to apportion transit operating deficits among user communities. These allocations were formulated in terms of allocation plans that incorporate factors to identify, accumulate, and distribute costs to a final cost objective. For urban transit systems such a plan combines an allocation performed within the system for cost determination purposes with an allocation that assigns deficit amounts to parties external to the system. External deficit allocations consist only of an allocation base; internal allocations consist of a cost hierarchy, an accounting technique, and an allocation base. An experimental environment is created to apply alternative allocation methods under identical operating conditions by using a computer model to simulate a transit system. Deficit amounts assigned to each community served are then examined to determine the effects of alternative allocation plans for the computation and distribution of transit system operating deficits. An analysis that focuses on the amounts allocated to individual communities shows that a high degree of variation is produced by alternative plans for allocating a transit operating deficit. Another analysis, which views each allocation plan as a single variable, reveals that plans that employ only an external deficit allocation and plans that use a systemwide average operating cost produce results distinctly different from plans that do not employ such procedures.

Cooperative agreements between communities in a metropolitan area to share the burden of a transit system's operating deficit is one alternative for financing urban transit systems. Through these agreements, financial support of a transit system is based on farebox revenues as well as on the assessment of an operating deficit to individual communities in the system's service area. The dollar amount assessed to a community is determined by an allocation procedure that is based on a factor or combination of factors descriptive of either the service provided or the community served. Proper selection of the allocation procedure is important because it affects not only the amount of system operating deficit calculated for a period of operations but also the portion of the deficit assigned to individual communities in the urban area.

In general, the allocation of a transit system's operating deficit among communities should include factors that describe the level of costs incurred in operating the transit service as well as factors that relate revenues directly to the service provided. The accumulated costs reflect the level of service provided and the operating characteristics of vehicles for different speeds and terrain. Revenues reflect the fare schedule and the demand for transit based on the social and economic makeup of each community and the density of its population. Where possible, determination of the factors that will represent costs and revenues should be made at the route level of an urban transit system. At this level, a proper accounting can be made of the results of providing service to each community on a route; that is, an amount of deficit can be identified with a specific community that received a defined level of transit service. This is a desirable objective because each route or community may possess characteristics that result in the accumulation of costs or revenues at rates different from those of other routes or communities.

The allocation of operating deficits among user communities is currently practiced in the field of urban transportation; however, the allocation procedures employed differ markedly in each instance. Industry practices can be categorized into two general forms: (a) an overall or systemwide approach for calculation and allocation of the deficit amount and (b) a more limited approach based on calculation of the deficit for a single segment of a system. The former is found in the regional approach to calculation of an allocation percentage; the latter approach focuses on identifying losses where they were incurred (i.e., cost reimbursement for individual routes or within specified geographic subdivisions of the urban area).

The allocation of operating deficits is basically a cost-allocation procedure, and information on cost allocations applied to the cost-determination process of private sector profit-seeking firms is available in the literature of accounting. In this study, cost allocations in the private sector were conceptualized in a framework that identified the specific factors that make up an allocation. A set of alternative operating deficit allocations were then applied by employing a computer model to simulate the operation of an urban transit system. Two approaches for allocating an operating deficit were compared: a highly aggregated one, which allocated at the system level, and a more detailed one, which made allocations at the route level. Analysis of the data revealed a degree of variation greater than anticipated in the allocation percentages assigned to communities when the only variable altered in calculating those percentages is the allocation applied. Further examination of the amounts of deficit assigned to individual communities showed that they are dependent on the specific factors of the allocation used. Given such results, it is important for transit administrators to understand the allocation process more clearly in order to foresee the implications of selecting an allocation procedure.

CONCEPTS OF COST ALLOCATION

As an ideal, every item of cost incurred should be assigned to the cost objective that benefited from the cost or, alternatively, that caused the incurrence of the cost. In practice, though, this ideal is rarely attained because many costs are incurred at a point significantly removed from the cost objective that ultimately benefited or that caused its incurrence. Intermediate cost objectives, or cost centers, are then used to pass the cost through an organization to the final cost objective—the product produced. Costs not directly identified with final cost objectives are grouped into logical and homogeneous cost pools and assigned through a hierarchy of intermediate cost objectives by employing an allocation procedure at each hierarchical level. Thus, cost allocation is basically the accumulation of costs into cost pools and assignment of those costs to other cost pools or final cost

objective through the use of an allocation procedure.

Many factors are considered in deciding on the use of a particular cost-allocation procedure, including (a) selection of a cost-accounting technique, (b) designation of the cost objectives, (c) identification of the allocation bases, and (d) formulation of the allocation ratio to be applied.

The cost-accounting technique encompasses the principles and practices of accounting that make up the basic means of associating costs with units produced. Variation in unit costs can result due to the use of different cost techniques.

A cost objective is an activity or transaction for which a cost is to be determined. It can be a product, business activity, or department or other administrative unit of an organization. The cost objective represents the purpose for which a particular cost has been incurred, and different levels of cost objectives exist in an organization, corresponding to the administrative hierarchy. Cost objectives within the hierarchy are called intermediate cost objectives when the output produced is at the lowest level of the hierarchy. The number of intermediate cost objectives directly affects the number of cost allocations made internally, which can result in accumulating different dollar amounts for each final cost objective.

The allocation of costs to defined cost objects requires the selection of a surrogate to measure the amount of cost to be assigned. This surrogate measure is an allocation base, which is a quantitative measure, that bears a relationship to both the amount of cost accumulated and the activity levels of the cost object. A number of potential bases exist in any situation, and the one that is most appropriate in the circumstances must be selected. Difficulties arise when an association between a cost and the cost object is indirect and unclear, or perhaps when the relationship is multiple, and often impossible to measure. Inequitable allocations result if the proper allocation base is not determined.

The allocation ratio establishes the form of a relation between the dollar amount allocated and the quantity of allocation base for each activity or product charged. Improper definition of this relation can produce discrepancies in allocated amounts through disproportionate weighting of factors, erroneous measurement of allocation base amounts, or use of an incorrect number of activities or products to be charged.

All of the above factors are interdependent and must be considered simultaneously in a cost-allocation decision. This study considers these interrelationships within a single framework, called a cost-allocation plan, which is defined as a complete enumeration of the factors included in identification, accumulation, and distribution of costs to final cost objectives. Given the objective of determining the full cost of final cost objectives, a conceptual cost-allocation-plan model can be formulated as follows:

$$A = A \text{ function of } (T, H, B, R) \quad (1)$$

where

A = the allocation plan,
T = the cost-accounting technique,
H = the cost-objective hierarchy,
B = the allocation base, and
R = the allocation ratio.

After all necessary data are input, an allocation plan can be applied to determine the unit cost for the products produced. Various combinations of the basic factors of an allocation plan can be evaluated according to their effect on the unit cost of the output produced. This is the objective of experiments performed as part of this study—to ascertain the effects of different cost-allocation plans on final cost objectives of an urban transit system.

The cost-allocation framework was then applied to urban public transportation by matching the parameters of a cost-allocation plan with descriptive features of urban transit systems. Public transportation was viewed as part of a hierarchy of systems in a metropolitan area as follows:

1. Urban area,
2. Transportation system, and
3. Cities or communities.

The second level of the hierarchy would consist of the specific modes of transportation provided in the urban area, including the automobile, public transit systems, and even walking. If the second-level cost objective is a transit system, the intermediate cost-objective hierarchy within the system might appear as follows:

1. System,
2. Department,
3. Route, and
4. Vehicle trip.

The system level is the transit organization taken as a whole. The department level entails separating the system into the various functions performed (i.e., segregating administrative activities, centralized services, and operational activities). Administrative departments consist of the business manager, accounting and data processing, and other activities such as legal, marketing, and public relations. Centralized services are scheduling, maintenance and repair, and equipment servicing. Operational activities include everything under the heading of transportation, which generally includes operators, supervision, dispatching, and operator training. Individual cities and communities that receive transit service in an urban area are the final cost objectives of the urban transit system hierarchy.

With this hierarchy, the operating deficit allocation problem of an urban transit system can be categorized in two parts:

1. Allocations performed within the transit system itself and
2. Allocation of transit system operating results to cities or communities.

Allocations within the transit system assign system overhead to various segments of the system. Such allocations are hereafter referred to as internal allocations. These allocations would be made in a manner similar to the cost allocations performed by a business entity operating in the private sector. Assigning results of transit system operations to communities served is referred to as external allocation and results in charging to participating communities a portion of the cost of providing transportation in the urban area.

The specific cost-allocation techniques applied in this study fall into two categories: average costing and joint costing.

The average-costing technique assigns costs to output by using an average unit cost, which is obtained by dividing the total amount of cost by the total number of units produced. The logic behind such an approach is that all products turned out by the same process should receive a proportionate share of the total costs based strictly on the quantity of units produced. Average costing is the prevailing practice of the urban transit industry for cost

determination. Calculation of the average operating cost consists of dividing the total amount of an operating characteristic accumulated over a period of transit operations into the total cost of operating the system during the same time period. The characteristic employed is either vehicle distance or vehicle hours operated. The average cost per unit (e.g., vehicle kilometers or vehicle hours) is then applied to the amount of base units actually used in a time period to determine the operating cost of the period.

The joint-costing approach recognizes that the cost of producing products involves both direct costs and overhead costs. The direct costs are identified readily with individual products or processes. Overhead costs are incurred for the general benefit of the organization as a whole. The problem of allocating this overhead can generally be looked on as one dealing with the assignment of joint costs. A joint cost is one incurred for a combination of products or processes, but the amount of cost applicable to any one item or process cannot be traced by direct observation. Joint costing is the process of assigning the amount of cost incurred for a process to the products produced by that process.

The specific elements of allocation plans applied in the experimental phase are as follows:

Allocation Plan	Element
Cost-accounting technique (T)	Average costing
	Joint costing
Cost-objective hierarchy (H)	Level 1-transit system
	Level 2-individual routes
	Level 3-communities
Allocation bases applied (B)	
In external allocation	Population
	Assessed value
	Total dwellings
	Total employment
	Vehicle trips scheduled
	Passenger revenue
	Boarding passengers
In internal allocation	Vehicle hours
	Vehicle kilometers
	Passengers carried
	Revenue collected

The allocation ratio (R) is determined by the decision of whether to use a one- or two-step allocation procedure. External allocations assign the transit system's operating deficit directly to communities. Internal allocations first reassign costs within the transit system by using a cost-accounting technique before applying an external allocation. Thus, deficit allocations based solely on external allocations are a one-step process of selecting the allocation plan to apply, but deficit allocations that use internal allocations are a two-step process where system operating costs are first allocated to individual routes of the transit system and revenues earned on the route are matched against these costs. The route operating deficit determined by this matching process is then allocated to communities served on the route by using an external allocation method.

The complete specification of an allocation plan actually involves a sequence of decisions to identify each of the basic factors included in the plan. This decision process can be graphically illustrated in the form of a decision tree. Starting at the origin, decisions are made at branching points, or nodes, of the tree. Only one branch can be selected at each node, and, by following the selected branch, another decision point is reached. Proceeding along a series of selected branches leads eventually to an end point of the tree and the complete determination of an allocation plan for apportioning a transit system's operating deficit. Figure 1 presents a decision tree and identifies basic elements of the allocation plans examined in the experiment phase of this study.

EXPERIMENT PHASE

As indicated in Figure 1, six different internal allocations are applied in addition to one plan in which only an external allocation is performed. Each plan employs one of the seven possible bases of external allocations; thus, 49 different allocation plans were examined. These allocation plans were applied through the use of a computerized simulation model called BUSMAN, an acronym for bus system management analysis. This model takes into account the interdependencies and interactions that occur within the transit system and between it and the people of the communities it serves. The principal factors represented are

1. Prediction of the travel pattern and total volume of travel in an urban area,
2. Level of transit service provided,
3. Cost-behavior patterns of system operation, and
4. Accounting system for accumulating and reporting financial information.

The interaction of these factors influences the amount of revenue earned and the cost of system operation; thus, the profitability of the system and the system's need for supplemental revenues is thereby established. Another portion of the model applies the different allocation plans for apportioning the amount of operating deficit incurred in a period of transit operations. Output of this segment is the shares of deficit charged to each community served by the transit system.

Data generated for each allocation plan applied are accumulated in the allocation plan matrix (APM). The cells of this matrix, formed across the top by internal allocations and along the side by external allocations, consist of results produced by applying an allocation plan—the unique combination of an internal cost allocation with an external deficit allocation. More specifically, each APM cell contains the percentage amounts of a transit operating deficit allocated to the final cost objectives of the allocation plan (i.e., individual communities in the urban area). The allocation plan matrix is shown in Table 1.

Analysis of Results

Examination of the APM data was organized into two parts:

1. Effects of alternative allocation plans on individual communities and
2. Comparison of results by viewing each allocation plan as a whole.

In the first part, with a community as the cost object, the focus is on allocation percentages of each community rather than the allocation process used in order to identify the extent of variation present in the results. In the second part, the results assigned under each allocation plan are viewed as a unique combination of results and sets of results are compared in order to disclose those allocation plans that produce substantially similar results and those that generate highly divergent results.

Results by Individual Communities

The third column in Table 2 gives the overall range of

percentage results assigned to each community. Thomas, in his study of the allocation problem in financial accounting, referred to this form of variation produced by applying a variety of allocation methods as the range of ambiguity. He defined this range as follows (1): "The range of ambiguity of an allocation with respect to an individual input is the extent to which the amounts attributed to that recipient may vary by virtue of choice of allocation method." In other words, the allocated percentages assigned to a community could vary anywhere within its range of ambiguity. Table 2 shows the largest range of ambiguity to be slightly over 30 percent, and the smallest range is just under 10 percent.

The coefficient of variation describes variation found in data distributions. This coefficient expresses the standard deviation of a distribution as a percentage of its mean. It is a relative measure of variation where the

Figure 1. Decision tree identifying the basic elements of allocation plans examined.

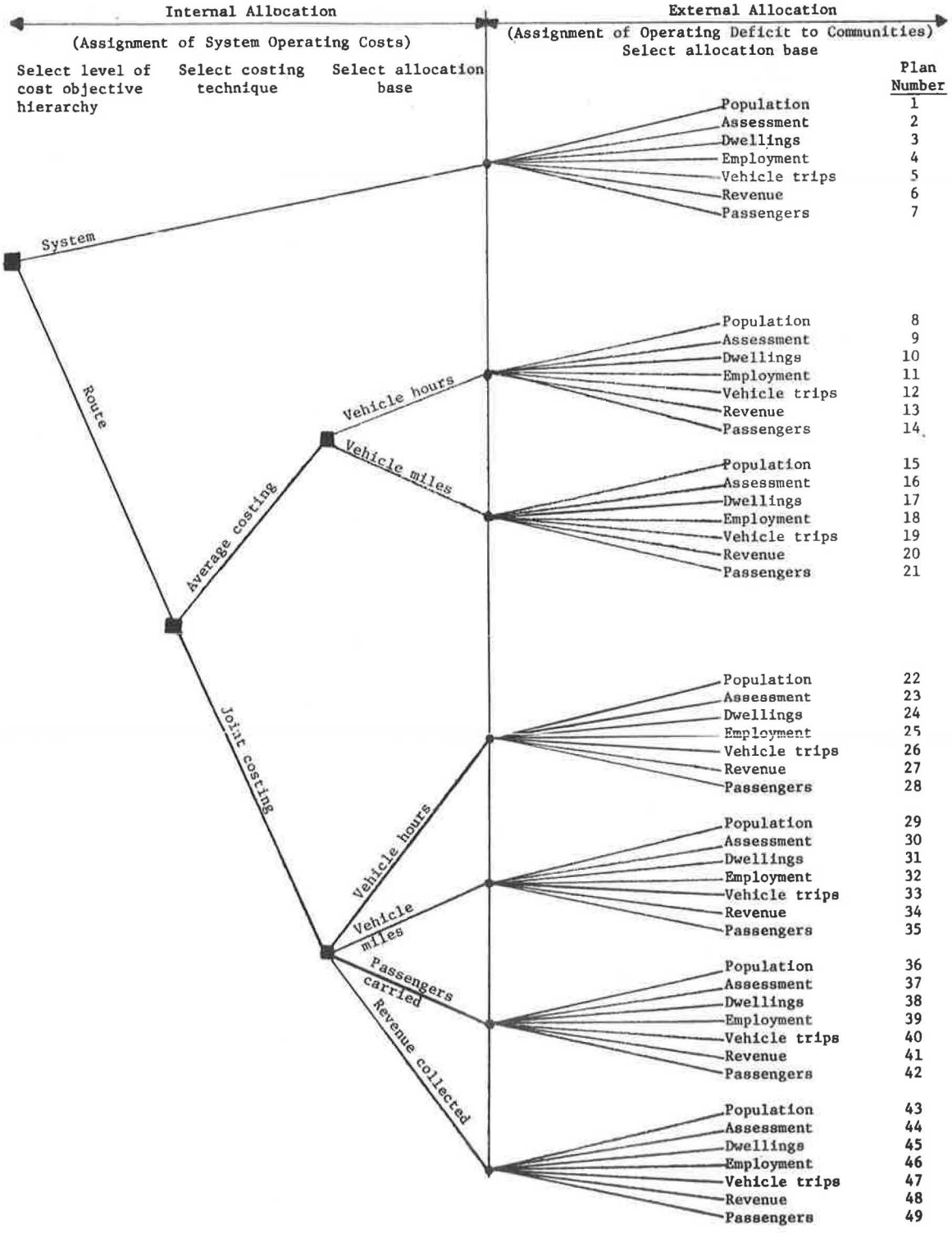


Table 1. Allocation plan matrix.

External Deficit Allocation Base	City Number	Internal Cost Allocation						
			Average Cost (¢)		Joint Cost (¢)			
		None	Vehicle Hours	Vehicle Kilometers	Vehicle Hours	Vehicle Kilometers	Passengers	Revenue
Population	2	8.22	7.22	10.08	4.12	4.85	3.47	5.19
	3	2.56	2.24	3.15	1.28	1.51	1.08	1.61
	4	5.65	4.96	6.93	2.83	3.33	2.39	3.57
	5	12.33	10.83	15.13	6.19	7.27	5.22	7.79
	6	6.47	10.43	10.37	10.47	10.46	11.22	9.29
	7	22.61	36.42	36.27	36.58	36.54	39.21	32.44
	8	4.31	6.95	6.91	6.98	6.97	7.48	6.19
	9	6.98	3.85	2.04	5.81	5.35	5.51	6.25
	10	30.83	17.03	9.04	25.67	23.64	24.34	27.60
Assessed value	2	7.48	5.87	8.20	3.35	3.95	2.83	4.22
	3	3.44	2.70	3.77	1.54	1.81	1.29	1.94
	4	8.98	7.05	9.84	4.02	4.73	3.40	5.07
	5	12.27	9.63	13.46	5.51	6.47	4.65	6.93
	6	4.94	7.68	7.65	7.71	7.70	8.27	6.84
	7	25.44	39.59	39.43	39.77	39.73	42.63	35.27
	8	4.19	6.52	6.48	6.54	6.53	7.01	5.80
	9	10.77	6.77	3.59	10.21	9.40	9.68	10.97
	10	22.45	14.12	7.49	21.27	19.59	20.17	22.87
Total dwellings	2	9.32	7.90	11.04	4.51	5.30	3.81	5.68
	3	2.04	1.72	2.40	0.98	1.15	0.83	1.23
	4	4.47	3.78	5.29	2.16	2.54	1.82	2.72
	5	13.99	11.85	16.56	6.77	7.97	5.72	8.53
	6	5.83	10.02	9.98	10.06	10.05	10.79	8.93
	7	22.15	38.09	37.93	38.26	38.22	41.01	33.94
	8	3.30	5.67	5.65	5.70	5.69	6.11	5.05
	9	6.60	3.54	1.87	5.35	4.92	5.07	5.75
	10	32.26	17.34	9.20	26.13	24.07	24.77	28.09
Employment	2	11.95	6.89	9.63	3.94	4.63	3.32	4.96
	3	1.71	0.98	1.38	0.56	0.66	0.47	0.70
	4	3.23	1.86	2.60	1.06	1.25	0.90	1.33
	5	26.90	15.51	21.68	8.87	10.43	7.49	11.17
	6	6.47	9.16	9.13	9.20	9.20	9.87	8.17
	7	29.39	41.62	41.45	41.81	41.77	44.82	37.09
	8	2.11	2.99	2.98	3.00	3.00	3.22	2.67
	9	4.73	5.43	2.88	8.18	7.54	7.76	8.80
	10	13.45	15.46	8.20	23.29	21.45	22.08	25.03
Vehicle trips	2	11.11	6.31	8.82	3.60	4.24	3.04	4.54
	3	11.11	6.31	8.82	3.60	4.24	3.04	4.54
	4	11.11	6.31	8.82	3.60	4.24	3.04	4.54
	5	11.11	6.31	8.82	3.60	4.24	3.04	4.54
	6	11.11	17.92	17.85	18.01	17.99	19.30	15.97
	7	11.11	17.92	17.85	18.01	17.99	19.30	15.97
	8	11.11	17.92	17.85	18.01	17.99	19.30	15.97
	9	11.11	10.44	5.54	15.74	14.49	14.92	16.92
	10	11.11	10.44	5.54	15.74	14.49	14.92	16.92
Passenger revenue	2	7.03	4.43	6.20	2.53	2.98	2.14	3.19
	3	2.26	1.42	1.98	0.80	0.95	0.68	1.01
	4	6.77	4.27	5.97	2.44	2.87	2.06	3.07
	5	23.98	15.13	21.14	8.65	10.16	7.30	10.89
	6	6.08	11.39	11.34	11.44	11.43	12.26	10.15
	7	19.17	35.90	35.75	36.06	36.02	38.65	31.99
	8	3.46	6.49	6.46	6.52	6.51	6.99	5.78
	9	5.17	3.46	1.83	5.21	4.80	4.94	5.60
	10	26.03	17.44	9.25	26.27	24.20	24.90	28.24
Boarding passengers	2	10.45	7.16	10.00	4.09	4.81	3.45	5.15
	3	2.57	1.76	2.46	1.00	1.17	0.85	1.26
	4	6.49	4.44	6.20	2.53	2.98	2.14	3.20
	5	17.36	11.89	16.62	6.79	7.99	5.73	8.56
	6	7.36	11.55	11.50	11.60	11.59	12.43	10.29
	7	23.31	36.56	36.41	36.73	36.69	39.37	32.58
	8	3.62	5.67	5.65	5.70	5.69	6.10	5.05
	9	5.97	4.33	2.30	6.52	6.01	6.19	7.01
	10	22.83	16.56	8.78	24.95	22.99	23.66	26.83

Table 2. Summary of results.

Community		Allocation (¢)				Standard Deviation	Coefficient of Variation
Number	Name	High	Low	Range	Mean		
2	Nearnorth City	11.95	2.14	9.81	5.86	2.61	0.446
3	Midnorth City	11.11	0.47	10.64	2.22	2.01	0.907
4	Northmost City	11.11	0.90	10.21	4.18	2.32	0.555
5	Northeast City	26.90	3.04	23.86	10.43	5.36	0.514
6	South City	19.30	4.94	14.36	10.51	3.31	0.315
7	Midsouth City	44.82	11.11	33.71	33.12	8.65	0.261
8	Southeast City	19.30	2.11	17.19	7.02	4.40	0.627
9	Southwest City	16.92	1.83	15.09	6.82	3.53	0.518
10	Farwest City	32.26	5.54	26.72	19.78	6.84	0.346

Table 3. Summary of the elements of the allocation plans that form the final clusters.

Internal Allocation			External Allocation Base	Plan Number	Final Cluster Assignment										
Hierarchy Level	Costing Technique	Allocation Base			1	2	3	4	5	6	7	8	9	10	11
System	None	None	Population	1			x								
			Assessment	2										x	
			Dwelling	3			x								
			Employment	4						x					
			Vehicle trips	5							x				
			Revenue	6									x		
			Passengers	7										x	
Route	Average	Vehicle hours	Population	8			x								
			Assessment	9			x								
			Dwellings	10			x								
			Employment	11			x								
			Vehicle trips	12				x							
			Revenue	13			x								
			Passengers	14			x								
Route	Average	Vehicle kilometers	Population	15								x			
			Assessment	16								x			
			Dwellings	17								x			
			Employment	18								x			
			Vehicle trips	19					x						
			Revenue	20								x			
			Passengers	21								x			
Route	Joint	Vehicle hours	Population	22	x										
			Assessment	23											x
			Dwellings	24	x										
			Employment	25											x
			Vehicle trips	26		x									
			Revenue	27	x										
			Passengers	28	x										
Route	Joint	Vehicle kilometers	Population	29	x										
			Assessment	30											x
			Dwellings	31	x										
			Employment	32											x
			Vehicle trips	33		x									
			Revenue	34	x										
			Passengers	35	x										
Route	Joint	Passengers carried	Population	36	x										
			Assessment	37											x
			Dwellings	38	x										
			Employment	39											x
			Vehicle trips	40		x									
			Revenue	41	x										
			Passengers	42	x										
Route	Joint	Revenue collected	Population	43	x										
			Assessment	44											x
			Dwellings	45	x										
			Employment	46	x										
			Vehicle trips	47		x									
			Revenue	48	x										
			Passengers	49	x										

higher the percentage, the greater is the variation existing in the data.

For the simulated urban area of this study, the highest coefficient of variation observed was 0.907, or 91 percent; the lowest value was 0.261, or 26 percent. City number 3 experienced the highest coefficient of variation and city number 7 experienced the smallest value. Criteria have not been established for objective evaluation of the range of ambiguity or the coefficients of variation for each community; but logically, it seems unusual that the lowest range of ambiguity would be as high as 10 percent and that one community's results could vary by as much as 34 percent of the operating deficit incurred and that the relative variation could range from 26 to 91 percent. The impact of this variation is apparent when these percentages are expressed in dollar terms by assuming that a transit system's annual operating deficit was $100 000. Then the amounts allocated would vary from a maximum of $44 820 down to a minimum of $11 110—solely dependent on the choice of allocation plan applied. It would be most likely that this degree of variation in the amounts assigned would be considered significant.

Effects of Allocation Plans

Given the degree of variability that exists in individual amounts assigned to a community, it is desirable to determine the extent of difference, or similarity, between allocation plans viewed as a single variable instead of as a combination of factors. Homogeneity of allocation plans was tested by using cluster analysis applied in a simulation-type procedure where the number of clusters is increased by one in each successive run of the program. The objective of the procedure is to group data into clusters such that data sets within a cluster have a high degree of likeness among themselves, but each cluster is relatively distinct from one another.

Data input to the clustering program were the percentage amounts of operating deficit assigned to each community (given in Table 1). The 49 allocation plans that form the first cluster in the cluster-analysis program were numbered sequentially (as shown in Figure 1).

The simulation procedure terminated when substantial variation was removed from the data. This occurred after 10 iterations when 11 clusters had been formed and more than 88 percent of the total variation in the original data had been removed. Table 3 summarizes these results by disclosing the elements of the allocation plans included in each cluster.

Several patterns of allocation plans are observable from a review of these final clusters. For example, 5 of 11 clusters (3, 6, 7, 9, and 10) consist of allocation plans

that use only external allocations—no internal cost allocation is performed. Three clusters (2, 5, and 7) contain all those allocation plans that use vehicle trips as the basis of external allocation. The remaining clusters consist of plans that have common internal cost-allocation techniques. For example, clusters 4 and 8 consist of plans that use average costing as the technique for performing internal allocations. Six of the plans in cluster 4 use a vehicle-hours base; however, in cluster 8, 6 of the 7 plans use vehicle kilometers as the allocation base. Cluster 11 is formed by 7 plans that use joint costing, and cluster 1 consists of 17 plans, all of which use joint costing for internal cost allocations.

Thus, after a cluster-analysis technique has removed substantial variation from the APM data, the resulting clusters are each homogeneous over the cost-accounting technique employed. Several clusters even contain identical internal cost allocations, notably clusters 4 and 8. The largest number of plans (17) are included in cluster 1, where 16 plans result from a permutation of the four bases for joint costing with four specific bases of external allocation: vehicle hours, vehicle kilometers, passengers carried, or revenue collected. Each of the above are combined with an external allocation by using population, total dwellings, passengers carried, and revenue collected for the allocation base. Thus, cluster 1 consists of a distinct combination of allocation plan elements that are basically homogeneous (i.e., there would be small differences between the results produced if any one of these plans were selected).

The implication of this final pattern of data sets is that the joint-costing technique provides results that are distinctly different from the transit industry's preferred method of cost determination, average costing. Finally, the fact that a large block of homogeneous joint-costing plans (24 plans) remained together in cluster 1 through 10 iterations can be viewed as an indication that joint costing provides more homogeneous results over a fairly wide selection of allocation plan elements. Therefore, a conclusion that can be drawn from the final pattern of data sets is that deficit allocation plans can be distinguished on the basis of the internal costing technique employed.

In a cluster-analysis routine, the amount of variation remaining in the data is reduced with each new cluster formed. The allocation plans removed earliest from the main grouping of data sets, therefore, are those that reduce variation by the greatest amount. An alternative statement would be that the first plans segregated from the main body of data sets are those plans that differ by the greatest degree from all other plans. A summary of the movement of each allocation plan and the amount of variation removed from the data by each successive iteration appears in Figure 2. Of the 10 iterations performed, 5 resulted in minor changes in the variation removed and were generally of little significance. The largest amounts of variation were removed in the first three iterations, the seventh, and the last iteration. The second cluster was initially formed around the allocation plan that made no internal allocations and used vehicle trips as the base in the external allocation. Since these were the first plans removed from the main body of data sets, they are the ones that are most divergent from all the other allocation plans examined. (Note that an option of using no internal allocation is considered as a choice of cost-accounting technique.)

On the second iteration, cluster 3 included six of seven possible plans that made no internal allocation of costs. The single plan missing from this cluster was the one that uses vehicle trips as the base for external allocations previously included in cluster 2 in the first iteration. Thus, the absence of an internal allocation of costs was a significant element of allocation plans, which caused a lack of homogeneity in this experiment. This condition is due to the fact that vehicle trips are based on demand, which is fairly uniform throughout the simulated urban area. Using vehicle trips as an external allocation base results in near-equal allocation to communities and eliminates the effect of factors representing various levels of transit activities.

The third iteration resulted in the movement of 13 data sets to the new cluster, number 4. Twelve of these plans shifted from cluster 1, all of which employed average costing in performing internal cost allocations. Half of these used vehicle hours as the base, and half allocated on the basis of vehicle kilometers. These 12 plans remained clustered together through six iterations. Thus, the use of the average-costing technique for internal allocation appears to produce results that are substantially similar, whether vehicle kilometers or vehicle hours are used as the allocation base. The average-costing plans in cluster 4 were divided into two equal groups. In the seventh iteration, 6 plans that use vehicle kilometers as the basis of allocation shifted to cluster 8, and 16 percent of the remaining variation was removed; however, this division of average-costing plans into separate clusters is not as significant as the initial segregation of these plans from the main body of data sets.

The last significant movement of data sets removed 17 percent of the remaining variation in the 10th iteration and resulted in the formation of cluster 11 by the removal of seven joint-costing plans from cluster 1. All of these plans used either assessed value (four plans) or employment (three plans) as the basis of external deficit allocation.

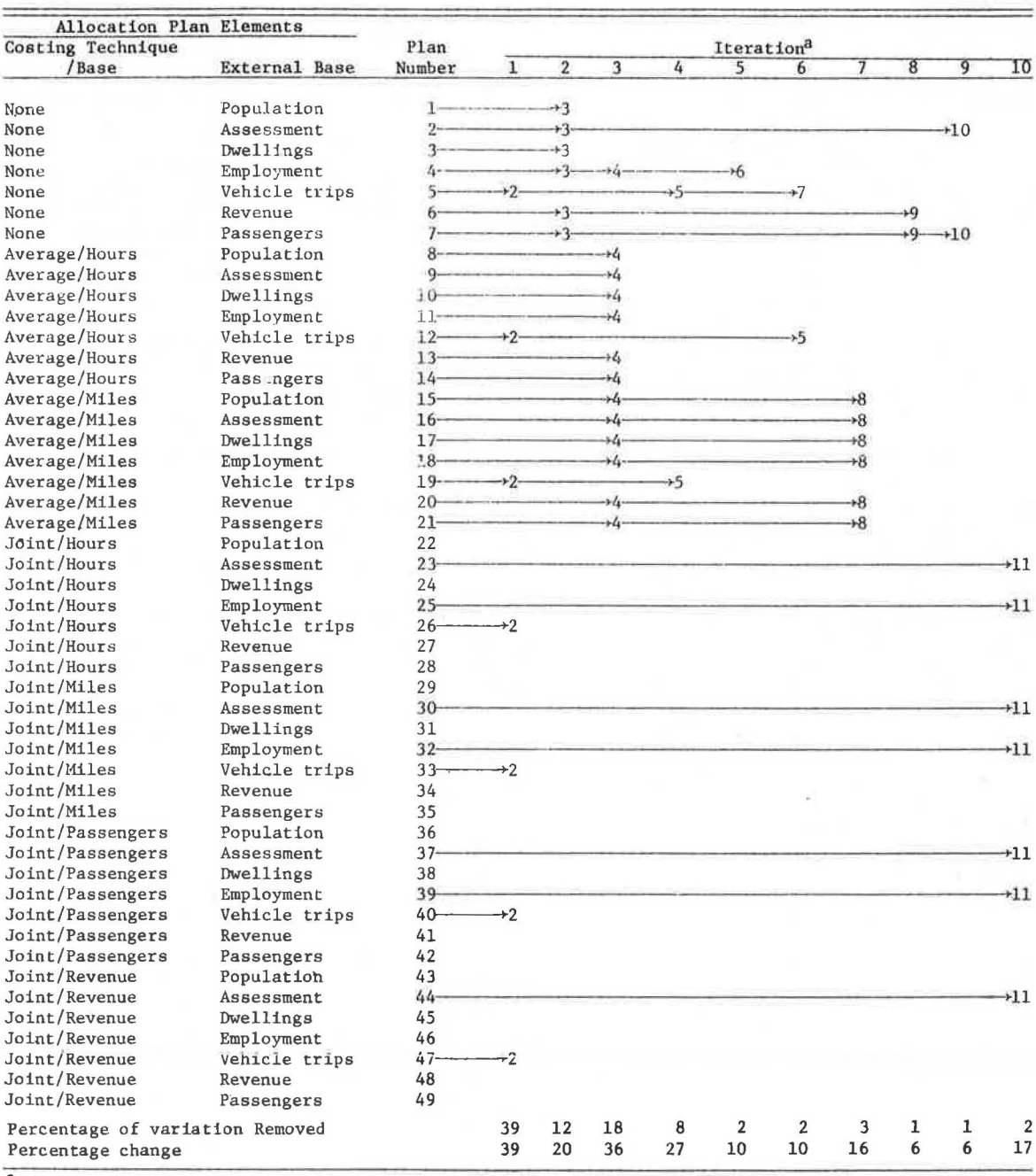
CONCLUSIONS

This study has made a logical evaluation of the results of applying alternative deficit-allocation plans. Attention was focused on the homogeneity of allocation plans, given a greater amount of variation in results than anticipated. Analysis of the experiment results confirmed that the allocation plans examined were not homogeneous, but homogeneity did exist within the clusters generated. The final clusters and the process of forming these clusters revealed that certain allocation plans may introduce disparities into the process of allocating an operating deficit among participating communities. Given such a condition, it is important for transit administrators to understand the allocation process more clearly in order to foresee the implications of selecting an allocation plan.

The finding of primary interest is that the method preferred by the transit industry for allocating an operating deficit among user communities leads to results that are fairly distinct (nonhomogeneous) from other methods examined. The industry's preferred practice of performing only an external deficit allocation produced results significantly different from those allocation plans that first employed an internal allocation of operating costs in that all such plans were among the earliest to be removed from the main body of allocation plans (by the second iteration).

Another finding of interest concerns the industry's preferred method of calculating the unit cost of operation. The prevailing practice of averaging total costs over a descriptive operating characteristic (e.g., vehicle kilometers) was not included among those plans that demonstrated the greatest degree of homogeneity, as indicated by the bulk of the joint-costing plans that remained intact in clusters 1 through 10 iterations.

Figure 2. Movement of allocation plans for each iteration of the cluster-analysis program.



Allocation Plan Elements: Costing Technique /Base	External Base	Plan Number	Iteration[a] 1	2	3	4	5	6	7	8	9	10
None	Population	1	1	3								
None	Assessment	2	2	3								10
None	Dwellings	3	3	3								
None	Employment	4	4	3	4		6					
None	Vehicle trips	5	5	2			5		7			
None	Revenue	6	6	3						9		
None	Passengers	7	7	3						9	9	10
Average/Hours	Population	8	8		4							
Average/Hours	Assessment	9	9		4							
Average/Hours	Dwellings	10	10		4							
Average/Hours	Employment	11	11		4							
Average/Hours	Vehicle trips	12	12	2				5				
Average/Hours	Revenue	13	13		4							
Average/Hours	Passengers	14	14		4							
Average/Miles	Population	15	15		4				8			
Average/Miles	Assessment	16	16		4				8			
Average/Miles	Dwellings	17	17		4				8			
Average/Miles	Employment	18	18		4				8			
Average/Miles	Vehicle trips	19	19	2			5					
Average/Miles	Revenue	20	20		4				8			
Average/Miles	Passengers	21	21		4				8			
Joint/Hours	Population	22	22									
Joint/Hours	Assessment	23	23									11
Joint/Hours	Dwellings	24	24									
Joint/Hours	Employment	25	25									11
Joint/Hours	Vehicle trips	26	26	2								
Joint/Hours	Revenue	27	27									
Joint/Hours	Passengers	28	28									
Joint/Miles	Population	29	29									
Joint/Miles	Assessment	30	30									11
Joint/Miles	Dwellings	31	31									
Joint/Miles	Employment	32	32									11
Joint/Miles	Vehicle trips	33	33	2								
Joint/Miles	Revenue	34	34									
Joint/Miles	Passengers	35	35									
Joint/Passengers	Population	36	36									
Joint/Passengers	Assessment	37	37									11
Joint/Passengers	Dwellings	38	38									
Joint/Passengers	Employment	39	39									11
Joint/Passengers	Vehicle trips	40	40	2								
Joint/Passengers	Revenue	41	41									
Joint/Passengers	Passengers	42	42									
Joint/Revenue	Population	43	43									
Joint/Revenue	Assessment	44	44									11
Joint/Revenue	Dwellings	45	45									
Joint/Revenue	Employment	46	46									
Joint/Revenue	Vehicle trips	47	47	2								
Joint/Revenue	Revenue	48	48									
Joint/Revenue	Passengers	49	49									
Percentage of variation Removed			39	12	18	8	2	2	3	1	1	2
Percentage change			39	20	36	27	10	10	16	6	6	17

[a]Columns represent an iteration of the clustering program. Arrows indicate the movement of a plan between clusters while the numbers in the body of table identify the clusters involved. Plan numbers without movements remained in cluster 1.

Thus, inequities may exist in the use of a systemwide average cost in lieu of a more accurate determination of unit costs, where variable operating costs are assigned directly and then indirect costs, such as system overhead, are allocated by using an operating characteristic related to a route or segment of the system (i.e., joint costing as applied in this study).

These findings suggest the need for further study and evaluation of the transit industry's practice of applying only an external deficit-allocation plan and the use of a systemwide average cost per kilometer in decision-making situations, especially decisions involving changes in service levels such as adding, deleting, or extending a route.

In closing, a general observation about allocation should be noted. This study has contrasted two approaches for deficit allocation: a highly aggregated one, which allocated at the system level, and a more detailed one, which made allocations at the route level. In evaluating which approach to follow, note that the difficulty of application and the number of variables involved increases in moving from system-level to route-level allocation plans. But, at the same time, the relevancy and validity of the amounts assigned increases. Also, the amount of time, effort, and expense of administering the allocation process increases with the amount of detail required by the plan selected.

REFERENCE

1. A. Thomas. The Allocation Problem in Financial Accounting Theory. American Accounting Assn., Evanston, IL, Studies in Accounting Research No. 3, 1969.

Publication of this paper sponsored by Committee on Public Transportation Planning and Development.