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A Comparison of Several Methods of Calculating Travel Time Data for Analysis of Urban Travel Demand

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A CRUCIAL DETAIL of urban transportation planning is the calculation of the travel times required to travel between various pairs of geographical points. Travel time calculations are necessary inputs to many types of transportation policy research, in particular to the various mathematical models which are used to forecast travel demand and to evaluate the costs and benefits of transportation systems. In such research, the validity of the conclusions depends, among other things, on the accuracy and appropriateness of the travel data which is input. It is therefore important that the procedures used to calculate travel times be considered carefully.

A wide variety of procedures for calculating travel time data are commonly used. An almost limitless variety of techniques and refinements could be contemplated. A researcher planning a study which requires travel time data may have a choice among several available calculation methods. Whether one method should be preferred over others, for reasons other than the costs or difficulty of actually doing the calculations, depends on answers to the following questions:

- How substantial are the differences in the values produced by the alternative methods?
- Is it possible to define and evaluate the "accuracy" of the calculations; if so, which of the methods produces the most accurate values?
- To what extent do the different calculation methods lead to different research conclusions?

The research described in this report was done to answer these questions for three methods commonly used to calculate travel times for use in transportation policy analysis. The methods were:

(1) **zonal network calculations,** based on computerized simulations of the transportation system;

(2) **ad hoc network calculations,** similar to the zonal network calculations, but with manual refinements providing geographically more precise representations of trip origins and destinations; and

(3) **manual calculations,** done by people rather than computers, using maps, bus schedules, highway travel times, and other data describing the transportation system.

Each calculation method was used to produce values of auto and bus travel times for a common sample of 213 work trips made in the San Francisco Bay Area. The data calculations are described briefly below.

Detailed descriptions of the data set and calculation methods are presented in an earlier report (Johnson, 1974).

Other than the distinction between human and computer processing, the most fundamental distinctions between the three calculation methods were the precision with which the calculations were tailored to the specific trips of each traveler in terms of location and time of travel.

For the zonal network calculations, the San Francisco metropolitan region was partitioned into 440 zones. The variables calculated for each traveler described a typical trip from the zone in which the traveler lived to the zone in which he worked. The calculations were sensitive to time of travel only to the extent of calculating different values for AM peak, PM peak, and off-peak trips.

The ad hoc network calculations, represented more closely the home and work place addresses of each traveler. This was done by a hand coding procedure that had the effect of greatly increasing the number of zones in the computerized transportation network, to correspond to the travelers in the sample. The sensitivity to time of travel was the same as for the zonal network calculations.

The manual calculations reflected most closely the location and time of each trip. The calculations were based on the specific home and work place (cross street) addresses, and the specific (to the minute) work starting time, for each traveler in the sample.

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COMPARISON OF TRAVEL TIME VALUES CALCULATED BY DIFFERENT METHODS

The first question addressed in this research was: How substantial are the differences in the travel time values produced by the alternative calculation methods? Several types of analysis were done to answer this question. Each type of analysis was done separately for each of the travel time variables.

Averages and Standard Deviations

The first type of analysis was a comparison of the averages and standard deviations of the values of each variable, as calculated by the three different methods.

- For each variable, the statistics were based on a subsample of travelers for whom values were calculated by all three methods (i.e., no missing data); the subsamples differed slightly for different variables. The statistics are listed in Table 1.

For the auto time, bus ride time, and bus walk time variables, there were appreciable differences in the average values produced by the different methods. For example, for the auto time variable the difference between the largest average value (zonal calculations) and the smallest average value (manual calculations) was 5.1 minutes, a difference equal to approximately twenty per cent of the overall average of 25.3 minutes calculated by the three methods. The patterns of the results, in terms of which calculation methods produced the highest and lowest average values, differed for the three variables.

For the three waiting time variables —bus (total) wait time, bus headway, and transfer wait time—there were sharp differences between the values calculated by the manual method and the values calculated by the two network methods. The values from the manual method were much larger on the average, and also had much larger standard deviations.

Analyses of Variance

To augment the table of means and standard deviations, and to provide a more sensitive and detailed comparison of the values calculated by the different methods, several analyses of variance were done. As before, each type of analysis was done separately for each variable in the study.

In the first type of analysis of variance, the total variation of values for each variable was partitioned into two components: (1) the variance due to differences in the travelers' work trips

Means and Standard Deviations of Values of Trip Description Variables Calculated by Different Methods (minutes)

Variable	Calculation Method: Manual	Ad Hoc Network	Zonal Network	N
Auto time	22.9 (15.0)	25.0 (15.8)	28.0 (16.0)	213
Bus total time	50.2 (24.2)	49.2 (21.5)	51.0 (24.1)	198
Bus ride time	35.7 (18.6)	31.9 (18.5)	30.9 (18.8)	198
Bus walk time	9.1 (6.1)	7.4 (4.6)	11.6 (5.1)	200
Bus wait time	15.2 (12.8)	9.9 (7.0)	8.5 (6.8)	199
First bus headway	18.6 (13.8)	11.8 (8.7)	11.0 (8.6)	200
Transfer wait time	5.6 (8.4)	4.0 (4.6)	3.0 (4.5)	199

Standard deviations are in parentheses.

TABLE 1

("between-persons" variance), and (2) the variance due to differences in the calculation methods ("within-persons" variance). The purpose was to determine the proportion of the total variation of values that was attributable to differences in the calculation methods.

Several subsequent analyses of variance were done to investigate whether the within-persons variance observed in the first analysis (that is, variance due to differences in the calculation methods) could be explained by estimating some simple bias effects. One such analysis examined constant-bias effects, that is, tendencies of any calculation method to produce values higher or lower, on the average, than those of the other methods. Another analysis examined distance-bias effects, that is, tendencies of any of the calculation methods to produce values which were, on the average, higher or lower per mile than the values produced by the other calculation methods. A final analysis examined the combination of both constant-bias and distance-bias effects.

The formal statistical models on which these four types of analysis were based are shown in equations (1), (2), (3), and (4).

(1) $x_{ij} = T_i + r_{ij}$

(2) $x_{ij} = T_i + A_j + r_i{}^*{}_j$

(3) $x_{ij} = T_i + B_j(\text{Distance})_i + r_i{}^*{}_j{}^*$

(4) $x_{ij} = T_i + A_j + B_j(\text{Distance})_i + r_i{}^*{}_j{}^{**}$

where,

x_{ij} = the calculated value of variable x for traveler i, based on calculation method j

T_i = the trip effect for traveler i

A_j = a constant-bias effect for calculation method j

B_j = a distance-bias effect for calculation method j

r_{ij}, $r_i{}^*{}_j$, $r_i{}^*{}_j{}^*$, and r $r_i{}^*{}_j{}^{**}$ = residual effects for the four models

The results of each of the four analyses for each variable are presented in Table 2 which indicates, for each variable, the extent to which variations in the calculated values were determined by the different components represented in equations (1) to (4). The columns of Table 2 are grouped in pairs. Each pair of columns pertains to a particular set of parameters, as indicated at the head of the columns. The first column in each pair, labeled "p," indicates the proportion of the total variance of the values of each variable which was explained by estimating the set of parameters indicated. The second column in each pair, labeled "SD res," indicates for each variable the standard deviation of the residual components, that is, the standard deviation of the portions of the observed values which were not accounted for for the estimated parameters.

The first pair of columns in Table 2 pertain to the trip effect parameters (T_i). The entries in the first column indicate the proportion of the total variance of each variable which was accounted for by the trip effect component. For

Variance Analyses of Calculated Values of Trip Description Variables Showing, for Different Sets of Estimated Parameters[1], the Proportion of Variance Explained and the Standard Deviation of Residuals[2]

Variables	Estimated Parameters: T_i		T_i, A_j		T_i, B_j		T_i, A_j, B_j	
	p	SD Res	p	SD Res	p	SD Res	p	SD Res
Auto time	.94	3.79	.96	3.15	.96	3.23	.96	3.10
Bus total time	.90	7.23	.90	7.20	.91	7.13	.91	7.07
Bus total-auto time	.74	8.40	.75	8.20	.75	8.27	.76	8.10
Bus ride time	.92	5.14	.94	4.72	.93	4.94	.94	4.70
Bus walk time	.58	3.58	.68	3.14	.68	3.13	.69	3.08
Bus wait time	.60	6.14	.69	5.44	.65	5.78	.69	5.41
First bus headway	.63	6.80	.72	5.88	.67	6.41	.73	5.82
Transfer wait time	.52	4.28	.54	4.16	.54	4.21	.54	4.16

[1] The complete model was: $X_{ij} = T_i + A_j + B_j\,(\text{Distance})_i + (\text{residual})_{ij}$, for respondent i and calculation method j.

[2] Values shown for standard deviations of residuals are in minutes.

TABLE 2

example, the table indicates that 94 percent of the total variance of the calculated values of auto travel time was accounted for by the trip effect. This implies that the remaining 6 percent of the variance of the calculated values was due to residual differences, reflecting differences in the calculation methods.

The entries in the second column of Table 2 indicate the standard deviation of the residual component, i.e., variation in values not explained by the trip effect component. For example, the table indicates that for auto travel time the standard deviation of the residual component was 3.79 minutes. (In essence, this means that the three calculated auto time values for a typical traveler varied by about 3.79 minutes from an average, or "trip effect," auto time value for that traveler.)

Examination of the first pair of columns of Table 2 reveals two groups of variables, which differ with respect to the proportion of variance attributable to differences in the calculations. For the variables measuring primarily in-vehicle travel time (auto time, bus ride time, bus total time) the "within persons" differences in the calculations were moderate, accounting for less than 10 percent of the total variation for each variable. The standard deviations of the residuals not accounted for by the trip effect parameter (3.79, 7.23, and 5.14 minutes) were equal to approximately 15 percent of the average value of each variable (25.3, 50.1, and 24.7 minutes, respectively).

For the variables measuring walk and wait times (bus ride time, bus walk time, bus wait time, first bus headway, and transfer wait time) the within-persons differences in the calculations were large. They accounted for varying amounts—from approximately 25 to 50 percent, depending on the variable—of the variance of each variable. The standard deviations of the residuals varied from approximately one-third of the average value of the variable (for bus walk time) to over one hundred percent of the average value of the variable (for transfer wait time).

The remaining columns in Table 2 indicate the extent to which the within-persons variance for each variable—the variance not explained by the trip effect component—could be explained by estimating additional parameters, reflecting bias effects of the different methods. For each set of additional parameters, this can be seen by comparing the "p" values for the parameters (columns 3, 5, and 7) with the "p" values for the trip effect only (column 1), and by comparing the "SD res" values for the parameters (columns 4, 6, and 8) with the "SD res" values for the trip effect only (column 2).

For example, column 3 of the table indicates that estimating a constant-bias parameters A_j along with T_i explained an additional two percent of the variation of the auto time values—from 94 percent to 96 percent. Estimating the additional parameter also slightly reduced the standard deviation of the residuals, from 3.79 to 3.15 minutes.

As the table entries indicate, estimating the additional bias parameters did not have much success in explaining the within-persons variation of the values calculated by the different methods. For only three of the variables (bus walk time, bus wait time, and first bus headway), did estimating the bias effects explain any appreciable amount (about 10 percent for each variable) of the within-persons variance. There was little difference between estimating constant-bias or distance-bias parameters in terms of success in explaining within-persons variance. And estimating both additional parameters simultaneously was only negligibly better than estimating either of the additional parameters without the other.

The question addressed in this section of the report was: How substantial are the differences in the travel time values produced by the alternative calculation methods? In brief, the analyses discussed indicated that for the bus waiting and walk time variables the differences were very substantial. For auto and bus in-vehicle time variables the differences, though not negligible, were not as large. Simply correcting for tendencies of different methods to be biased higher or lower, or higher or lower per mile, than the other methods did not appreciably reduce the differences.

COMPARISONS OF REPORTED TRAVEL TIME VALUES WITH VALUES CALCULATED BY DIFFERENT METHODS

The second question addressed in this research was: Is it possible to define and evaluate the "accuracy" of the calculations; if so, which of the calculation methods produced the most accurate values? This is really a three part question, requiring a three part answer.

Accuracy in this research was defined as the extent to which data corresponded to "true" objective descriptions of the trips made by the research sample. "True" objective descriptions were defined as very accurate objective measurements, of the type that could be obtained if each traveler were accompanied by a technician who carefully measured and recorded the characteristics of the trip. A justification of this definition has been presented in an earlier report (Johnson, 1974).

Description of the Analyses

Unfortunately, no "true" objective measurements were available for the present research. This presented an interesting problem in research design: How could the accuracy of the values produced by the different calculation methods be compared, if there were no true objective values to use as a standard of comparison? The problem was solved by substituting for the true objective values reported values obtained from the research sample in home interviews. That is, relationships of the calculated values to reported values were used to infer the relationships of the calculated values to true objective values.

The inferences made did not require assuming that the reported values were equal to true objective values. The inferences did depend, however, on the appropriateness of a conceptual model which was postulated to describe the nature of the reported and calculated values (Johnson, 1974). In the model, both reported and calculated and reported values of a variable were postulated to contain two components: a true objective component and an error component. The error component reflected the extent to which the observed value obtained by a particular method (calculated or reported) differed from the true value for that traveler.

Several sets of statistics were computed to indicate the relationships of the reported and calculated values of the travel time variables. Using the conceptual model and some associated assumptions it is possible to show that the statistics can be interpreted as indications of the relative amounts of error in the values calculated by the different calculation methods.

One set of computed statistics were the means and standard deviations of the values of each variable, computed separately for the reported values and for the values calculated by each of the calculation methods. Three other sets of statistics were computed for each variable to reflect, separately for each calculation method, the interrelationships of the reported and calculated values. The statistics were: (1) Pearson product-moment correlation coefficients; (2) root mean square differences, that is, the square roots of the average squared difference between the reported and calculated values; and (3) the proportion of respondents for whom there was a "large discrepancy" between reported and calculated values.

The "large discrepancy" statistics require some additional explanation. A "large discrepancy" was defined as a difference between a reported and calculated value which satisfied two criteria: (1) the difference was at least one-fifth of the sum of the two values. (This implied that the larger of the two values be at least one and one half times the smaller.) (2) The absolute value of the difference was at least five minutes. A second set of discrepancy statistics were also calculated for which the five minute criterion was replaced by ten minutes.

The "large discrepancy" statistics reflected essentially the same information as the root mean square differences, but were less likely to be dominated by differences in large values of the variables.

All of the statistics computed for each variable were based on a subsample of usual users of the mode described by the variable. These sample restrictions were made partially because of data availability and partially because it was felt that the conceptual model and assumptions were most appropriate for usual users. The statistics computed for the auto time variable were based on a subsample of 156 regular auto users. The statistics computed for the various bus variables were based on a subsample of 42 regular bus users. The small size of the bus user subsample reduced the generality of the results for the bus variables and, because of large estimated sampling errors, blurred some of the distinctions between the statistics computed for different bus variables and different calculation methods.

Before any of the statistics described above were computed, scatter plots were created to display, for each variable, the set of reported values against each of the sets of calculated values. The plots revealed no outliers or curvilinear effects large enough to threaten the appropriateness, or require adjustments, of the computed statistics.

RESULTS

The statistics computed to indicate the relationships of the reported and calculated values of each variable are presented in Tables 3, 4, 5, and 6. Several general conclusions can be drawn from these tables.

The first conclusion is that the differences between the reported and calculated values were considerable.

The root mean square difference statistics give a good feeling for the size of the differences. These statistics indi-

Means and Standard Deviations of Reported and Calculated Values of Trip Description Variables for Usual Users of the Travel Mode Described by Each Variable (minutes)

Variable	Report	Data Collection Method: Manual	Ad hoc Network	Zonal Network
Auto Time	22.7 (11.8)	22.5 (13.6)	24.9 (14.6)	27.8 (14.3)
Bus total time	46.2 (19.1)	49.2 (18.9)	50.5 (17.0)	51.6 (21.5)
Bus ride time	27.8 (16.6)	34.4 (15.2)	34.3 (16.2)	33.6 (17.9)
Bus walk time	10.2 (7.6)	11.2 (6.9)	8.9 (4.7)	12.5 (5.2)
Bus wait time	9.7 (8.8)	9.9 (9.2)	7.1 (5.5)	5.3 (4.6)
First bus headway	11.9 (11.0)	12.1 (8.6)	10.5 (8.0)	8.8 (7.8)
Transfer wait time	3.5 (5.8)	3.5 (6.0)	1.9 (3.5)	.9 (1.8)

Standard deviations are in parenthesis.

TABLE 3

cate, essentially, the extent to which the reported and calculated values of the variables disagreed for a typical traveler in the sample. The statistics ranged from 5.21 minutes (for transfer wait time, ad hoc calculations) to 14.26 minutes (for bus ride time, manual calculations). One way to evaluate the size of these differences for each variable is to relate them to the average of the reported values. For the three variables measuring in-vehicle time, the root mean square differences ranged from 25 percent (for bus total time, ad hoc calculations) to approximately 50 percent of the average reported values of each variable (for bus ride time, manual calculations).

For the four variables measuring out-of-vehicle time, the relative size of the root mean square differences were much larger. They ranged from approximately 70 percent (for bus walk time, ad hoc calculations) to nearly two hundred percent (for transfer wait time, manual calculations) of the average reported values.

The comparisons of the calculated and

Correlations of Reported and Calculated Values of Trip Description Variables, for Usual Users of Travel Mode Described by Each Variable (Pearson product-moment correlation coefficients)

Variable	Calculation Method: Manual	Ad hoc Network	Zonal Network
Auto time	85	85	83
Bus total time	73	83	82
Bus ride time	67	74	73
Bus walk time	47	43	42
Bus wait time	38	48	36
First bus headway	23	37	46
Transfer wait time	30	51	27

TABLE 4

Root Means Square Differences Between Reported and Calculated Values of Trip Description Variables, for Usual Users of the Travel Mode Described by Each Variables

Variable	Calculation Method: Manual	Ad hoc Network	Zonal Network
Auto time	7.24	8.03	9.42
Bus total time	14.20	11.36	13.45
Bus ride time	14.26	13.23	13.87
Bus walk time	7.47	7.06	7.46
Bus wait time	9.90	8.16	9.33
First bus headway	12.13	10.95	10.95
Transfer wait time	6.84	5.21	6.08

TABLE 5

reported values provided a basis for evaluating the relative accuracy of the different calculation methods. The general conclusion drawn from Tables 4, 5, and 6 was that the ad hoc network calculations tended to be the most accurate, for most of the variables. However, the differences between the statistics for the different calculation methods were slight. For the correlation coefficients analyses were done to determine the statistical significance of differences between pairs of correlations for each variable. In only a few cases were the differences significant.

Specifically, for the bus total time variable the difference between the correlations for the ad hoc and manual methods was significant at better than the .05 level; the difference between the correlations for the zonal and manual methods was significant at better than the .10 level. For the bus ride time variable, the difference between the correlations for the ad hoc and manual methods was significant at better than the

Frequencies of Large Discrepancies* between Reported and Calculated Values of Trip Description Variables, for Usual Users of the Travel Mode Described by each Variable (sample percentages)

Variable	Minimum Difference	Calculation Method: Manual	Ad hoc Network	Zonal Network
Auto time	5	21	29	34
	10	11	17	24
Bus total time	5	21	14	31
	10	19	12	31
Bus ride time	5	33	38	45
	10	31	26	36
Bus walk time	5	43	36	48
	10	17	19	19
Bus wait time	5	48	36	43
	10	29	17	29
First bus headway	5	57	48	52
	10	38	29	26
Transfer wait time	5	31	21	29
	10	14	12	14

* "Large discrepancies" are defined as differences which are at least one-fifth of the sum of the two values, and either: (a) at least five minutes (frequencies shown on top line for each variable), or (b) at least ten minutes (frequencies shown on bottom line for each variable).

TABLE 6

.10 level. No other differences were statistically significant at the .10 level or better. Given the 21 different pairs of correlations to compare, this many statistically significant differences might reasonably be expected by chance.

For the root mean square differences and large discrepancy statistics no formal tests of significance were done; however, the differences between the statistics for different calculation methods were generally small relative to the size of the statistics themselves.

COMPARISONS OF STATISTICAL MODELS EXPLAINING MODE CHOICE BASED ON DATA CALCULATED BY DIFFERENT METHODS

The third question addressed in this research was: To what extent do the different calculation methods lead to different research conclusions? Analyses were done to answer this question for one important research issue, the choice between auto and bus for commuting to work. The analyses attempted to explain the choices between auto and bus commuting made by the research sample by relating these choices to the calculated values of the travel time variables. Separate analyses were done for the values obtained from each of the calculation methods.

The method used was maximum likelihood multiple logit analysis (McFadden, 1972). Each logit analysis produced a set of coefficients for combining the travel time variables into a function that estimated, for any traveler, the probability of commuting by either bus or auto. The coefficients were chosen to best explain the commute mode choice of the sample. The coefficients could be thought of as weights indicating the relative importance of the different variables as influences on commute mode choice.

One purpose of the logit analyses in this research was to evaluate the extent to which the variable coefficients differed when the variable values were obtained from different calculation methods. A second purpose of the analyses was to compare how well the variable values produced by each of the calculation methods explained commute mode choice. This comparison can be interpreted to indicate the relative accuracy, or absence of random error, in the values obtained by the different methods, since it has been proven theoretically that random measurement error decreases the explanatory ability of variables in logit statistical models (McFadden, 1972).

For each of the calculation methods, separate logit analyses were done using each of two sets of variables: (1) bus riding time, bus walking time, bus waiting time, and auto time, and (2) bus riding time, bus walking time, first bus headway, transfer wait time, and auto time. The results of the analyses for the two sets of variables are presented in Tables 7 and 8, respectively. Each table contains, separately for each calculation method, the set of estimated variable coefficients and corresponding t statistics (which indicate the statistical significance of the estimated coefficients).

Each table also contains, for each calculation method, two goodness of fit statistics to indicate how well the variable values explained commute mode choice. The first goodness of fit statistic is the likelihood ratio statistic, which can range from zero, indicating that the set of variables had no explanatory ability, to one, indicating that the variables explained the choices perfectly. The second goodness of fit statistic is the proportion of the sample correctly explained, obtained by assigning each person in the sample to the mode for which his estimated probability of use was highest.

The tables indicate that, for both sets of variables, the coefficients differed considerably for the values produced by the different calculation methods. Thus, conclusions regarding the relative importance of the variables as influences on commute mode choice depended on how the variable values were calculated.

On the other hand, the goodness of fit statistics did not differ appreciably for the different calculation methods. Thus, the analysis did not indicate clearly which of the calculation methods led to the best prediction of mode choice, or which produced the most accurate values of the variables.

The goodness of fit statistics for the ad hoc calculations were slightly lower than for the other two calculation methods, suggesting that the ad hoc calculations were slightly less accurate. To the extent these differences are meaningful, they conflict with the comparisons of reported and calculated values, described in the previous section, which indicated that the ad hoc calculations were slightly more accurate than the other two methods.

DISCUSSION

Overall, the research results were discouraging. Comparisons of the values produced by the different calculation methods indicated substantial discrep-

Logit Analyses to Explain Choice of Auto or Bus for Commuting, Calculated Travel Time Variables—Set 1 (logit function coefficients, t statistics in parentheses)

	Calculation Method					
Variables	Manual		Ad hoc Network		Zonal Network	
Auto time	–0.76	(–3.31)	–.033	(–1.52)	–.078	(–2.54)
Bus ride time	–.070	(–3.28)	–.022	(–1.13)	–.044	(–1.72)
Bus walk time	.044	(1.19)	.030	(.72)	–.097	(–1.74)
Bus wait time	–.024	(–1.06)	–.112	(–2.90)	–.164	(–3.34)
Constant	.583	(.97)	.476	(.71)	–.356	(– .51)
Likelihood ratio	.33		.29		.33	
Percent correct	79		77		79	

TABLE 7

ancies. These discrepancies led to large differences in variable coefficients in a statistical model explaining commuter mode choice. However, it was not possible to reach clear conclusions regarding the relative accuracy of the discrepant values. What conclusions were suggested were inconsistent: one type of analysis indicated that the ad hoc calculations were slightly more accurate than the other two methods; another type of analysis suggested that the ad hoc calculations were slightly less accurate.

The researchers were left in the disconcerting position of knowing that there were important differences in the values obtained from the different calculation methods, but having little reliable evidence regarding which method to prefer. More research is needed to resolve this dilemma.

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Logit Analyses to Explain Choice of Auto or Bus for Commuting, Using Calculated Travel Time Variables—Set 2 (logit function coefficients, t statistics in parentheses)

	Calculation Method					
Variables	Manual		Ad hoc Network		Zonal Network	
Auto time	–.072	(–3.13)	–.030	(–1.39)	–.067	(–2.16)
Bus ride time	–.071	(–3.33)	–.016	(– .79)	–.031	(–1.19)
Bus walk time	.040	(1.07)	.029	(.68)	–.078	(–1.40)
First bus headway	–.039	(1.48)	–.022	(.87)	–.052	(–1.80)
Transfer wait time	.016	(.44)	–.208	(–2.98)	–.329	(–2.87)
Constant	.188	(.27)	.713	(1.05)	–.019	(– .03)
Likelihood ratio	.34		.30		.35	
Percent correct	79		77		79	

TABLE 8