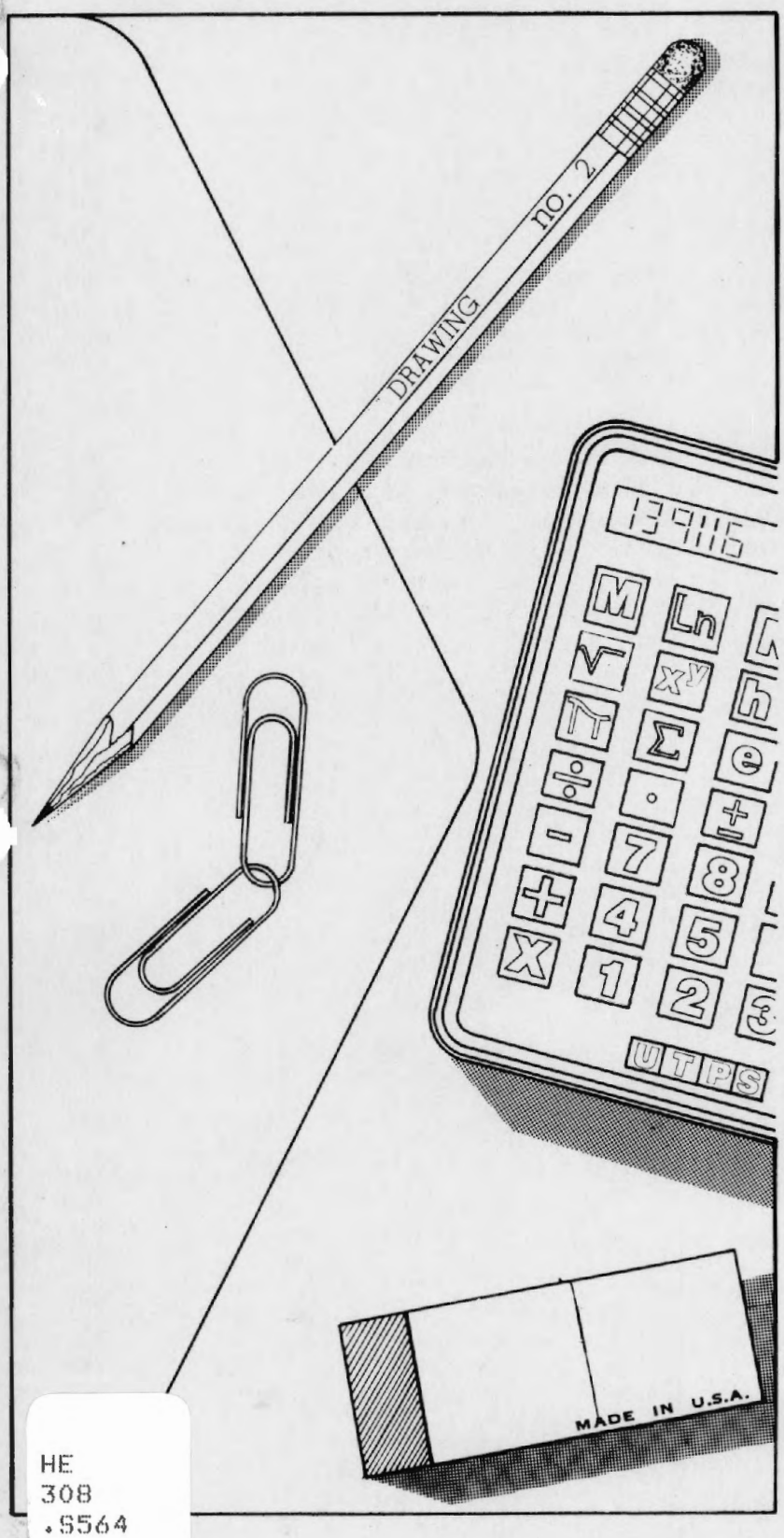

simplified aids for transportation analysis

transit route evaluation

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The evaluation procedure is best applied in systems whose overall ridership is growing. Stable or declining ridership conditions would not be satisfactorily treated by this procedure.

Because the intent of this report is to provide a simplified analysis aid, modifications, embellishments, and improvements to the suggested procedure are encouraged if local data or previous analyses suggest more appropriate methods.

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SIMPLIFIED AIDS FOR TRANSPORTATION ANALYSIS

Methodology for Transit Route Evaluation

Prepared by

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Based on Original Work Submitted by
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San Diego Transit Corporation

JANUARY 1979

Prepared for

U.S. Department of Transportation
Urban Mass Transportation Administration
Office of Planning Methods and Support

FOREWORD

Today's transportation planner confronts ever-changing issues within a variety of work environments. To assist him, UMTA's Planning Methods and Support Program researches, develops and distributes planning aids, including novel planning studies, and new design and forecasting techniques.

This is one of a series of six reports describing simplified aids to improve transportation decisions without resorting to computers or extensive data collection. The series, titled Simplified Aids for Transportation Analysis, presently includes the following titles:

1. Annotated Bibliography (UMTA-IT-06-9020-79-1)

2. Forecasting Auto Availability and Travel (UMTA-IT-06-9020-79-2)

3. Estimating Ridership and Cost (UMTA-IT-06-9020-79-3)

4. Transit Route Evaluation (UMTA-IT-06-9020-79-4)

5. Estimating Parking Accumulation (UMTA-IT-06-9020-79-5)

6. Fringe Parking Site Requirements (UMTA-IT-06-9020-79-6)

All are the work of recognized experts. They clearly present usable planning concepts, and add to the growing set of manual and computerized techniques comprising the UMTA/FHWA Urban Transportation Planning System (UTPS).

More important than the production and dissemination of new tools is the experience and opinion of their user. Local issues change. Better methods evolve. Or, realistically errors may appear in the final product. We depend on you, the transportation planner, to alert us to any of the above. We need your comments and your ideas. Please let us hear them, so we can continually improve our products.

You may obtain copies of any of the above reports from the National Technical Information Service (NTIS), Springfield, VA, 22161. On your request, please include the reference number in parenthesis.

Robert B. Dial, Director
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and Support (UPM-20)
Department of Transportation
Washington, DC 20590

ABSTRACT

In January 1976, the U.S. Department of Transportation issued a Technical Notice (DOT-1-76) requesting transportation planners, engineers, and transit operators to submit useful but not widely known manual techniques that could be developed and distributed as simplified aids for transportation analysis. Over 70 analytical aids were submitted in response to this request.

Based on an evaluation process conducted to determine the most useful, easily applied, and generally applicable techniques, several of these analytical aids have been selected and documented in sufficient detail to permit their immediate use. In addition to these techniques, three additional analytical aids were developed as part of the Short Range Transportation Planning project, and an annotated bibliography of each analytical aid reviewed was prepared. These individual analytical aids and the annotated bibliography have been prepared as separate technical reports and have been brought together in this manual of simplified aids for transportation analysis.

The analytical aid presented in this report provides one method for evaluating individual transit routes for a fixed-route, fixed-schedule urban transit system. Individual transit system routes are evaluated semiannually based on a comparison of nine performance factors with established route standards set for each factor. Input data used in the evaluation are recorded on a semiannual basis, and scores are computed for each of nine performance factors for each route according to an evaluation score algorithm. Scores are then added for each route, and routes are ranked by their total evaluation score. The results of the evaluation are used as the basis for route refinement and modification decisions.

The evaluation procedure is best applied in systems whose overall ridership is growing. Stable or declining ridership conditions would not be satisfactorily treated by this procedure.

Because the intent of this report is to provide a simplified analysis aid, modifications, embellishments, and improvements to the suggested procedure are encouraged if local data or previous analyses suggest more appropriate methods.

SOURCE

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I. INTRODUCTION

This report describes one of a collection of useful but not widely known manual techniques employed by local transportation planners, engineers, or transit operators. This particular technique provides a method for evaluating the performance of individual routes on a fixed-route, fixed-schedule transit system. Sufficient information is provided to permit a transportation analyst to make immediate use of this analytical aid if the necessary local input data are available. This information is presented in three sections:

- I. Introduction. This section describes the simplified aid for evaluating transit routes, identifies the input data required to use the aid, and provides a brief overview of the application procedure.

- II. Methodology for Transit Route Evaluation. This section describes the route evaluation procedure in detail and provides an example of its application.

- III. Shortcomings and Limitations. This section describes the shortcomings of this analytical aid to make the user aware of the limits of its applicability. Also discussed are ways to modify the evaluation methodology to suit the needs of an individual user.

- Appendix. The Appendix contains a list of the variables used in the analysis, including their definitions, notations, and derivations.

The technique reported here is oriented to the practical planner who requires a specific analytical technique but who has limited data and time to perform an in depth analysis. The soundness of the method described in this report, however, must be considered independently by the potential user for each specific application. The section on shortcomings and limitations is provided to assist the potential user in making this assessment. Modifications, embellishments, and improvements to this technique are encouraged should local data or post analyses suggest a more appropriate procedure.

DESCRIPTION AND APPLICABILITY

The general goal of an urban transit operation is to provide effective and efficient transit service throughout an urban area. Many transit properties have specific objectives related to this goal, including the levels of service to be provided, the segments of the population to be served, the ridership levels to be achieved, and the size of the deficits to be allowed. A monitoring program is necessary to determine progress toward these specific objectives for the system as a whole and, more importantly, to determine which elements of the transit system are contributing to or detracting from the attainment of these objectives.[1]

The monitoring program should provide data to measure the performance of the transit system (and its elements) at any given point in time and to determine changes in performance over time. The objective of an evaluation program is to relate the data provided by the monitoring program to the performance objectives established for the transit property.

This analytical aid provides one method for evaluating route performance on a fixed-route, fixed-schedule transit system. Transit properties use variations of this method and other evaluation procedures, variables, and measurement techniques to evaluate route performance.

In this method, standards are established for each of nine performance factors, and each route is given a score based on a comparison of its performance in relation to these factors. The evaluation is performed semiannually using data collected for the previous six months.

An individual route can be evaluated by comparing its performance with that of other routes as well as with its own performance in previous periods. A positive score in the evaluation means that a route is generally achieving the established route standards; a negative score indicates that it is performing poorly. Improvement efforts can thus be focused on those performance areas in which the route receives negative ratings.

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[1] Route monitoring programs vary considerably among transit properties, ranging from comprehensive, ongoing programs to no program whatever. Due to the type of input data required for implementing the route evaluation methodology described here, a minimum monitoring program will be necessary. No attempt is made here, however, to outline the procedure for implementing such a route monitoring program.

INPUT DATA REQUIRED

To conduct the route evaluation analysis, the following data are required for each route:

- monthly ridership[1] for each month over a six-month period for the current year (for route k: R_{1k}, R_{2k}, ... R_{6k});[2]
- monthly ridership for each month over a six-month period for the prior year (P_{1k}, P_{2k}, ... P_{6k});
- seating capacity of buses used on the route (K_k);
- total number of bus trips made in six month period for the current year (N_k);
- total route-miles (revenue plus non-revenue) operated over a six-month period for the current year (M_k);
- total route-hours (revenue plus non-revenue) over a six-month period for the current year (H_k);
- total number of transfer passengers over a six-month period for the current year (T_k);
- total operating revenue over a six-month period for the current year (I_k);
- total operating cost over a six-month period for the current year (C_k); and
- established route standards for evaluation.

All of these data can be obtained from a basic transit data collection program. Passenger data, for example, can be collected in counts reported by traffic checkers or drivers or can be derived from daily

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[1] Ridership includes revenue passengers only and excludes passengers boarding with a transfer.

[2] The notation indicated here, and for each data item defined, is used to describe the evaluation procedure presented in the next section.

fare collection reports and information on the average fare for each route. Most transit properties maintain fare collection data by day, some by route, and some request drivers to maintain transfer counts. Likewise, data on route-miles, route-hours, and number of trips are often routinely summarized by route as a step in developing driver schedules. Cost data are typically available from monthly financial statements, where data are often tabulated by route.

OVERVIEW OF THE APPLICATION PROCEDURE

The route evaluation procedure is performed in four steps:

- Compute nine performance factors for each route and record on an evaluation table.
- For each performance factor, rank each route from high to low.
- For each performance factor, compute factor scores for each route based on the established standards.
- Add scores for each route over all performance factors and rank each route by this composite score.

Detailed instructions for performing each of these steps are presented in Section II, and an example is provided to illustrate the procedure.

II. USING THE TRANSIT ROUTE EVALUATION METHODOLOGY

This section presents detailed instructions for conducting a transit route evaluation. An example is presented to illustrate the procedure and the resulting output is illustrated for each of the four steps in the evaluation procedure.

STEP 1: COMPUTE AND RECORD PERFORMANCE FACTORS FOR EACH ROUTE

A form (such as the one illustrated in Figure 1) should be prepared for the transit route evaluation. As shown in this figure, transit routes are listed in the first column. Two columns are required for each of the nine performance factors, and the total score and rank for each route are entered in the last two columns.

Performance factors are computed and entered on this form as described below. The mathematical notations for the input variables are those defined in Section I. Individual entries are recorded in whole numbers unless otherwise specified.

Performance Factor 1: Average Revenue Passengers per Month

For each route, compute the average monthly revenue ridership over the past six months and enter in the appropriate column in the evaluation form:

$$R_k = R_{1k} + R_{2k} + R_{3k} + R_{4k} + R_{5k} + R_{6k}$$

$$F_{1k} = \frac{R_k}{6}$$

where: R_k = total six-month revenue ridership for route k for the current year

F_{1k} = average monthly revenue ridership for route k for the current year (performance factor 1)

TRANSIT ROUTE	PERFORMANCE FACTORS																		TOTAL	RANK
	1. Average Revenue Passengers Per Month		2. Average Monthly Passenger Growth		3. Percent Growth Per Month		4. Total Passengers Per Trip		5. Average Capacity Utilization Factor		6. Percent Transfers		7. Operating Revenue Per Mile		8. Operating Revenue Per Hour		9. Net Operating Cost Per Passenger			
	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score		
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				

FIGURE 1: TRANSIT ROUTE EVALUATION FORM

Performance Factor 2: Average Monthly Passenger Growth

For each route, compute the total revenue ridership over the six-month period for the current year. Subtract the total revenue ridership over the corresponding six month period for the previous year. Divide the result by six and enter the result in the appropriate column in the evaluation form:

$$P_k = P_{1k} + P_{2k} + P_{3k} + P_{4k} + P_{5k} + P_{6k}$$

$$F_{2k} = \frac{R_k - P_k}{6}$$

where: P_k = total six-month revenue ridership for route k for the prior year

F_{2k} = average passenger growth per month for route k (performance factor 2)

Performance Factor 3: Percent Growth Per Month

For each route, compute the average monthly revenue ridership over six months for the prior year. Divide the average monthly passenger growth by the average monthly revenue ridership for the previous year. Multiply by 100 and enter the result in the appropriate column in the evaluation form:

$$V_k = \frac{P_k}{6}$$

$$F_{3k} = (F_{2k} / V_k) \times 100 = (XX.X\%)$$

where: V_k = average monthly revenue ridership for route k for the prior year.

F_{3k} = average percent growth per month for route k (performance factor 3)

Performance Factor 4: Total Passengers Per Trip

For each route, compute total passengers (both revenue and transfer) over the six-month period for the current year and divide by the total number of one-way revenue trips made on the route over this

period. Enter the result in the appropriate column in the evaluation form:

$$F_{4k} = \frac{R_k + T_k}{N_k} = (XX.X \text{ passengers})$$

where: F_{4k} = total passengers per trip for route k (performance factor 4)

Performance Factor 5: Average Capacity Utilization Factor

For each route, divide total passengers per trip by the seating capacity of the type of bus primarily used on the route and multiply the result by 100. Enter the result in the appropriate column in the evaluation form:

$$F_{5k} = \frac{F_{4k}}{K_k} \times 100 = (XX.X\%)$$

where: F_{4k} = average capacity utilization factor for route k (performance factor 5)

Performance Factor 6: Percent Transfers

For each route, determine the total number of passengers who board with a transfer over the six-month period for the current year. Divide this estimate by the total number of passengers (both revenue and transfer) over this period. Multiply by 100 and enter the result in the appropriate column in the evaluation form:

$$F_{6k} = \frac{T_k}{T_k + R_k} \times 100 = (XX.X\%)$$

where: F_{6k} = percent transfers for route k (performance factor 6)

Performance Factor 7: Operating Revenue Per Mile

For each route, divide the total operating revenue generated over the six-month period for the current year by the total route-miles operated during this period. Enter the result in the appropriate column in the evaluation form:

$$F_{7k} = \frac{I_k}{M_k} = (\$X.XX)$$

where: F_{7k} = revenue per mile for route k (performance factor 7)

Performance Factor 8: Operating Revenue Per Hour

For each route, divide total operating revenue generated over the six-month period for the current year by the total route-hours operated during this period. Enter the result in the appropriate column in the evaluation form:

$$F_{8k} = \frac{I_k}{H_k} = (\$XX.XX)$$

where: F_{8k} = revenue per hour for route k (performance factor 8)

Performance Factor 9: Net Operating Cost Per Passenger

For each route, compute the total net operating cost over the six-month period for the current year by subtracting total operating revenue over this period from total operating cost for the same period. Divide the total net cost by the total six-month revenue ridership over the period and enter the result in the appropriate column in the evaluation form:

$$F_{9k} = \frac{C_k - I_k}{R_k} = (\$X.XX)$$

where: F_{9k} = net cost per passenger for route k (performance factor 9)

With the completion of this step in the route evaluation procedure, the evaluation form should appear as it is illustrated in Figure 2.

STEP 2: RANK DATA FOR EACH PERFORMANCE FACTOR

For each performance factor, construct a performance factor worksheet as shown in Figure 3. The columns on the worksheet indicate route number, performance measure value, and evaluation scores. For a given performance factor, routes are ranked by performance measure from high to low, except for performance factor 9. For this factor, routes are ranked from low to high.

STEP 3: COMPUTE PERFORMANCE SCORES FOR EACH ROUTE BASED ON SPECIFIED PERFORMANCE STANDARDS

This step requires a set of performance standards established for the transit property. The standards for each of the nine performance

TRANSIT ROUTE	PERFORMANCE FACTORS																		TOTAL	RANK
	1. Average Revenue Passengers Per Month		2. Average Monthly Passenger Growth		3. Percent Growth Per Month		4. Total Passengers Per Trip		5. Average Capacity Utilization Factor		6. Percent Transfers		7. Operating Revenue Per Mile		8. Operating Revenue Per Hour		9. Net Operating Cost Per Passanger			
	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score		
1	79,705		-9,078		-4.9%		44.5		87.2%		16.6%		1.08		9.22		0.22			
2	40,068		2,239		5.9%		32.4		72.0		28.3		0.46		5.34		0.59			
3	16,880		5,105		43.4		27.6		138.0		28.4		0.20		2.64		1.70			
4	91,461		19,842		27.7		36.5		74.4		20.6		0.19		4.78		0.94			
5	4,510		976		27.8		8.2		41.0		34.4		0.16		2.29		1.79			
6	15,430		2,935		23.5		19.4		97.0		33.2		0.26		4.03		1.09			
7	28,202		565		2.0		28.0		62.2		19.5		0.50		7.01		0.47			
8	33,484		7,945		31.1		20.4		45.3		21.9		0.22		3.72		1.13			
9	2,490		973		64.2		7.5		37.5		19.6		0.08		1.49		3.20			
10	1,125		–		–		7.0		35.0		49.3		0.06		1.00		4.91			

FIGURE 2: STEP 1 OUTPUT

ROUTE	PERFORMANCE MEASURE	EVALUATION SCORE
4	91,461	
1	79,705	
2	40,068	
8	33,484	
7	28,202	
3	16,880	
6	15,430	
5	4,510	
9	2,490	
10	1,125	

FIGURE 3: PERFORMANCE FACTOR WORKSHEET

factors used by San Diego Transit are presented in Table 1. Since route performance varies widely, each property should develop and use its own standards. Preliminary standards can be developed, however, to begin implementing the route evaluation procedure; these can then be modified to reflect local requirements for service quality and local policies regarding transit costs, subsidies, and level of service.

Once standards have been established, the guidelines for conducting the scoring procedure for each performance factor are as follows:

- Routes which exceed the standard are given a positive score. Those which perform below the standard are given a negative score (the opposite holds for performance factor 9, for which routes with a value less than the standard receive a positive score).

- For each performance factor, the routes with the highest and lowest performance measures, and those falling immediately above and below the standard, are assigned scores equal to their respective ordinal ranks in relation to the standard.[1]

- "Average intervals" are then computed (1) between the route with the highest measure above the standard and the first route which just exceeds the standard, and (2) between the route with the lowest measure below the standard and the first route which performs just below the standard.

- These average intervals provide scales which are used to assign evaluation scores to the remaining routes:

    - Routes which perform above the standard are assigned evaluation scores based on the relation between their own performance measure and the measure of the route which just exceeds the standards.

---

[1]Ordinal indicates order of succession. Thus, for a performance factor for which five routes rank above the standard, the route with the best performance measure receives a score of 5.0.

TABLE 1

ROUTE STANDARDS USED BY SAN DIEGO TRANSIT CORPORATION

Performance Factor	Unchanged Routes Over 2 Years Old	New Routes and Routes With Major Revisions in Last 2 Years
1. Ridership (average monthly revenue passengers)	25,000	10,000
2. Ridership Growth (average monthly growth in revenue passengers)	450	750
3. Percentage Growth (average monthly growth)	3%	5%
4. Passengers per Trip (monthly average)	25	10
5. Average Capacity Utilization Factor	75%	40%
6. Percent Transfers (monthly average)	20%	20%
7. Revenue per Mile	$0.35	$0.15
8. Revenue per Hour (monthly average)	$5.00	$2.00
9. Net Cost per Passenger	$1.00	$1.75

- Routes which perform below the standard are assigned scores based on the relation between their own performance measures and the measure for the route which falls just short of the standard.

This procedure is explained in detail below and is illustrated in the example shown in Table 2 for performance factor 1. Specification and notation of each variable in Table 2 are given in the appendix.

First, for routes which perform above the standard, scores are assigned according to the following steps:

- The first route which exceeds or meets the standard is assigned a score of +1.0. In Table 2, for example, the first route to exceed the ridership standard of 25,000 monthly revenue passengers is route 7. This route, therefore, receives a score of +1 for performance factor 1.

- The number of routes which exceed the standard is noted, and the route which exceeds the standard by the greatest amount is assigned this number as its score. In Table 2, for example, five routes exceed the ridership standard. The route which exceeds the standard by the greatest amount, route 4, therefore receives a score of +5 for performance factor 1.

- The scores for the remaining routes which exceed the standard are determined in two steps:

    - First, the average interval between the route which most exceeds the standard and the route which just meets or exceeds it is computed by calculating the difference between the performance measures for these two routes and dividing the difference by one less than the total number of routes exceeding the standard. In Table 2, the route which exceeds the ridership standard by the greatest amount has a ridership performance measure of 91,461. The first route which just exceeds this standard has a ridership performance measure of 28,202. Altogether, five routes exceed the standard. Using this information, the following average interval is computed between these two routes for performance factor 1:

$$\frac{91{,}461 - 28{,}202}{5 - 1} = 15{,}814$$

- Next, the scores for each of the other routes which exceed the standard are computed by (1) calculating the difference between the performance measure of the particular route and the measure of the first route to meet or exceed the standard, (2) dividing this difference by the average interval described above, and (3) adding +1 to the result. An example of this procedure is illustrated in Table 2 for performance factor 1.

For those routes which perform below the standard, scores are assigned by proceeding according to a similar but slightly modified procedure, as follows:

- The first route which just falls short of the standard is assigned a score of -1.0. In Table 2, for example, the first route to fall short of the ridership standard of 25,000 monthly revenue passengers is route 3. This route, therefore, receives a score of -1.0 for performance factor 1.

- The number of routes which fall short of the standard is noted, and the route which falls short by the greatest amount is assigned this number as its score. In Table 2, five routes fall short of the ridership standard; the route which falls short by the greatest amount, route 10, therefore receives a score of -5 for performance factor 1.

- The scores for the remaining routes which fall short of the standard are determined in two steps:

  - First, the average interval between the route which falls short of the standard by the greatest amount and the route which just falls short of the standard is computed by calculating the difference between the performance measures for these two routes, and dividing this difference by one minus the total number of routes falling short of the standard. In Table 2, the route which falls short of the standard by the greatest amount has a ridership performance measure of 1,125; the first route falling just short of the standard has a ridership performance measure of 16,880. Altogether, five routes fall short of the standard. Using this information, the following average interval between these two routes is computed for performance factor 1:

$$\frac{1{,}125 - 16{,}880}{1 - 5} = 3{,}939$$

- Next, the scores for each of the other routes which fall short of the standard is computed by (1) calculating the difference between the performance measure of the first route to fall short of the standard and the measure for the individual route, (2) dividing this difference by the average interval described above, and (3) adding -1 to the result. An example of this procedure is illustrated in Table 2 for performance factor 1.

As each route is assigned a score for a performance factor, the score should be entered on the transit route evaluation form.

STEP 4: ADD SCORES FOR EACH ROUTE AND RANK ROUTE PERFORMANCE

To complete the evaluation process, algebraically add the scores received by each route for all performance factors to obtain the route evaluation score. Record the result for each route in the "total" column. Rank the routes and record each route's evaluation rank in the last column. Figure 4 shows a completed transit route evaluation form. Note that route 10 is a new route evaluated with the new route standards and a zero score for the two growth performance factors.

All routes finishing with a positive score are generally achieving the objectives established for the transit system. Routes finishing with a negative score are performing poorly and those areas where negative scores indicate their performance is the poorest should be examined.

TRANSIT ROUTE	PERFORMANCE FACTORS																		TOTAL	RANK
	1. Average Revenue Passengers Per Month		2. Average Monthly Passenger Growth		3. Percent Growth Per Month		4. Total Passengers Per Trip		5. Average Capacity Utilization Factor		6. Percent Transfers		7. Operating Revenue Per Mile		8. Operating Revenue Per Hour		9. Net Operating Cost Per Passenger			
	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score	Number	Score		
1	79,705	4.3	-9,078	-1.0	-4.9%	-2.0	44.5	5.0	87.2%	1.4	16.6%	-3.0	1.08	3.0	9.22	3.0	0.22	4.0	14.7	2
2	40,068	1.8	2,239	1.6	5.9	1.0	32.4	2.1	72.0	-1.4	28.3	2.6	0.46	1.0	5.34	1.0	0.59	2.5	12.2	3
3	16,880	-1.0	5,105	2.7	43.4	4.9	27.6	1.0	138.0	3.0	28.4	2.6	0.20	-2.8	2.64	-4.4	1.70	-1.8	4.2	4
4	91,461	5.0	19,842	8.0	27.7	3.2	36.5	3.1	74.4	-1.0	20.6	1.0	0.19	-3.1	4.72	-1.0	0.94	1.0	16.2	1
5	4,510	-4.1	976	1.1	27.8	3.3	8.2	-4.6	41.0	-6.1	34.4	3.9	0.16	-4.0	2.29	-5.0	1.79	-1.9	-17.4	8
6	15,430	-1.4	2,935	1.9	23.5	2.4	19.4	-1.3	97.0	1.4	33.2	3.6	0.26	-1.0	4.03	-2.2	1.09	-1.0	2.4	6
7	28,202	1.0	565	1.0	2.0	-1.0	28.0	1.1	62.2	-2.9	19.5	-1.1	0.50	1.1	7.01	1.9	0.47	3.0	4.1	5
8	33,484	1.3	7,945	3.7	31.1	3.6	20.4	-1.0	45.3	-5.4	21.9	1.3	0.22	-2.2	3.72	-2.7	1.13	-1.1	-2.5	7
9	2,490	-4.7	973	1.1	64.2	7.0	7.5	-4.9	37.5	-6.6	19.6	-1.0	0.08	-6.4	1.49	-6.2	3.20	-3.8	-25.5	9
10	1,125	-5.0	-	0	-	0	7.0	-5.0	35.0	-7.0	49.3	7.0	0.06	-7.0	1.00	-7.0	4.91	-6.0	-30.0	10

FIGURE 4: COMPLETE TRANSIT ROUTE EVALUATION FORM

III. SHORTCOMINGS AND LIMITATIONS

This section describes the shortcomings of the route evaluation methodology presented in this report so that the user can be aware of the method's limits and can improve upon the methodology to suit the needs of a particular transit property.

The methodology presented in this report is designed to permit quick and easy manual computations using generally available data. It provides the transit analyst with an overview of the transit system's performance and a general comparison of all routes in the system. If the user desires a more comprehensive route evaluation, this methodology can be used as a framework on which to build a more formal and rigorous procedure.

The specific shortcomings of this particular route evaluation methodology include the following:

- Performance measures are not related to objectives.
- Specification of performance factors is not analytically rigorous.
- Performance measures are equally weighted.
- The scoring procedure is arbitrary.

PERFORMANCE MEASURES RELATED TO OBJECTIVES

Nine performance measures are suggested for use in this evaluation procedure. In a formal procedure, such measures should be derived from specific local performance objectives, and should be carefully defined to measure performance in relation to a specific objective. The performance measures used in this particular analysis may be used directly if they relate to locally established objectives for the transit system, or they may be used to suggest objectives which can be established for the transit system. The particular set of measures suggested in Chapter II, however, should not be considered fixed, and the user

is encouraged to add, delete, or modify any of them to bring them into conformance with locally established objectives.[1]

SPECIFICATION OF PERFORMANCE FACTORS

In a more formal evaluation procedure, performance measures should account for all significant costs and benefits of the various alternatives being evaluated. Performance measures should measure individual benefits and costs independently, if possible, and no benefit or cost should be double counted, thus biasing the evaluation. In this evaluation methodology, however, partonage is measured directly by two performance factors and indirectly by five others. The evaluation may therefore be considered biased toward ridership factors.

WEIGHTING OF PERFORMANCE MEASURES

Each performance measure in this evaluation methodology contributes equally to the evaluation score, implying that each has the same importance. In practice, and in more formal evaluation methodologies, each individual objective and its associated measure is assigned a weight which expresses its significance in relation to all other objectives. For example, ridership may be considered twice as important as growth and ten times as important as number of transfers. The scores for each of these objectives and measures should reflect this difference in importance.

Weighting must be done carefully, however, since it must be based on subjective judgments. The assigned weights should relate to established regional transportation planning objectives and should reflect the interests of diverse groups including planners, transit operators, transit users, non-users, businesses, employers, and citizen groups.

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[1]The temptation to base performance measures on the data available from an existing route monitoring program should be avoided. Similarly, the evaluation methodology should not necessarily be formulated to use all available input data. Rather, it should be formulated to indicate how well a particular route or system is performing and what should be modified to improve its performance. In most cases, a route monitoring program should be designed to satisfy the needs of the evaluation program.

ARBITRARY SCORING PROCEDURE

In the evaluation methodology presented here, performance scores are developed based on the ordinal ranking of routes above and below a performance standard. As a result, the final evaluation score for each route is determined as the sum of performance scores based on ranks and is not related directly to the overall achievement of objectives.

In a more formal evaluation approach, individual route scores would be based on the relative achievement of objectives by directly relating performance measures to the standards set for each objective.

APPENDIX

VARIABLE DEFINITION, NOTATION, AND DERIVATION

Table A-1 provides a list of all variables used in the transit route evaluation analysis. The table includes the following for each variable:

- definition of the variable;
- notation used to describe the steps in the analysis process; and
- the derivation of each variable for the analysis.

TABLE A-1

VARIABLES USED IN TRANSIT ROUTE EVALUATION ANALYSIS

VARIABLE	DEFINITION OF VARIABLE	DERIVATION OF VARIABLE
$R_{1k}, R_{2k}, R_{3k}, R_{4k}, R_{5k}, R_{6k}$	Ridership in each month over a six-month period in the current year on route k; includes revenue passengers only; excludes passengers boarding with a transfer.	Input data
$P_{1k}, P_{2k}, P_{3k}, P_{4k}, P_{5k}, P_{6k}$	Ridership in each month over a six-month period in the prior year on route k; includes revenue passengers only; excludes passengers boarding with a transfer.	Input data
K_k	Seating capacity of buses used on route k.	Input data
N_k	Total number of bus trips made in six-month period for the current year on route k.	Input data
M_k	Total route miles (revenue plus non-revenue) operated over a six-month period for the current year on route k.	Input data
H_k	Total route hours (revenue plus non-revenue) over a six-month period for the current year on route k.	Input data
T_k	Total number of boarding transfer passengers over a six-month period for the current year on route k.	Input data
I_k	Total operating revenue over a six-month period for the current year on route k.	Input data
C_k	Total operating cost over a six-month period for the current year on route k.	Input data
F_{1k}	Performance factor 1: average monthly revenue ridership over a six-month period for the current year for route k.	$F_{1k} = \frac{\sum_{i=1}^{6} R_{ik}}{6}$
F_{2k}	Performance factor 2: average last year to this year passenger growth per month for route k.	$F_{2k} = \frac{\sum_{i=1}^{6} R_{ik} - \sum_{i=1}^{6} P_{ik}}{6}$
V_k	Average monthly revenue ridership over a six-month period for the prior year on route k.	$V_k = \frac{\sum_{i=1}^{6} P_{ik}}{6}$
F_{3k}	Performance factor 3: average last year to this year percent passenger growth per month for route k.	$F_{3k} = \left(\frac{F_{2k}}{V_k}\right) X\ 100 = XX.X\%$
F_{4k}	Performance factor 4: total passengers per trip over a six-month period of current year on route k.	$F_{4k} = \frac{\sum_{i=1}^{6} R_{ik} + T_k}{N_k}$
F_{5k}	Performance factor 5: average capacity utilization over a six-month period of the current year on route k.	$F_{5k} = \frac{F_{4k}}{K_k} X\ 100.0$

TABLE A-1 (Continued)

VARIABLE	DEFINITION OF VARIABLE	DERIVATION OF VARIABLE
F_{6k}	Performance factor 6: percent of boarding passengers with transfers over a six-month period of the current year for route k.	$F_{6k} = \left(\frac{T_k}{T_k + \sum_{i=1}^{6} R_{ik}} \right) X\ 100 = XX.X\%$
F_{7k}	Performance factor 7: operating revenue per bus mile (revenue plus non-revenue) over a six-month period for the current year on route k.	$F_{7k} = \frac{I_k}{M_k} = \$X.XX$
F_{8k}	Performance factor 8: operating revenue per bus hour (revenue plus non-revenue) over a six-month period for the current year on route k.	$F_{8k} = \frac{I_k}{H_k} = \$X.XX$
F_{9k}	Performance factor 9: net operating cost per passenger over a six-month period for the current year on route k.	$F_{9k} = \frac{C_k - I_k}{\sum_{i=1}^{6} R_{ik}} = \pm\ \$X.XX$
Z_j	Standard for performance factor j.	Input data
X_j	Number of routes with performance measures which meet or exceed standard for performance factor j.	X_j = count over all k for which $F_{jk} \geq Z_j$
L_j	Performance measure for route which just meets or exceeds standard for performance factor j.	$L_j = \min_{\text{all k}} \left(F_{jk} \right)$, where $F_{jk} \geq Z_j$
G_j	Performance measure for route with highest performance above standard for performance factor j.	$G_j = \max_{\text{all k}} \left(F_{jk} \right)$ where $F_{jk} \geq Z_j$
A_j	Average interval for performance measures above the standard for performance factor j.	$A_j = \frac{G_j - L_j}{X_j - 1}$
Y_j	Number of routes with performance measures below the standard for performance factor j.	Y_j = count over all k for which $F_{jk} < Z_j$
K_j	Performance measure for route just below standard for performance factor j.	$K_j = \max_{\text{all k}} \left(F_{jk} \right)$ where $F_{jk} < Z_j$
J_j	Performance measure for route with lowest performance below standard for performance factor j.	$J_j = \min_{\text{all k}} \left(F_{jk} \right)$ where $F_{jk} < Z_j$
B_j	Average interval for performance measures below the standard for performance factor j.	$B_j = \frac{J_j - K_j}{1 - Y_j}$
S_{jk}	Evaluation score for route k for performance factor j.	If performance measure meets or exceeds standard ($F_{jk} \geq Z_j$): . route with highest performance measure above standard (G_j): $S_{jk} = X_j$. route with performance measure which just meets or exceeds standard (L_j): $S_{jk} = 1.0$

TABLE A-1 (Continued)

VARIABLE	DEFINITION OF VARIABLE	DERIVATION OF VARIABLE
		. other routes with performance measures which exceed the standard: $S_{jk} = \left(\frac{F_{jk} - L_j}{A_j} \right) + 1$ If performance measure is less than the standard ($F_{jk} < Z_j$): . route with lowest performance measure below the standard (J_j) $S_{jk} = -Y_j$. route with performance measure just below the standard (K_j): $S_{jk} = -1.0$. other routes with performance measures below the standard: $S_{jk} = \left(\frac{F_{jk} - K_j}{B_j} \right) - 1$

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