politan and statewide circumstances; the contents, however, may be altered to suit the specific objectives of an agency and the need to achieve cooperation with service providers. The theoretical constructs and analytical techniques used will be more useful than the indicators selected and the intricate method for allocating the 5 percent discretionary fund.

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Transit Performance in New York State

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Over the past two years, the New York State Department of Transportation has developed a program to monitor the performance of transit operations that receive state operating assistance. The initial performance evaluation methodology has been revised to better meet a change in Department emphasis to monitor individual operator performance and encourage improvement. Past efforts are expanded by examining (a) the grouping of transit operators on the basis of mode, service type, and vehicle fleet size; (b) the relative performance of each group of operators over time; (c) the performance levels of public and private bus operators; and (d) the advantages and disadvantages of the proposed change in methodology. The results in this analysis show that grouping operators into peer groups yields more meaningful internal group comparisons and, in most cases, should help identify operators that are performing poorly. The overall change in performance between 1978-1979 and 1979-1980 seems to indicate that operator efficiency is improving while effectiveness is declining. Many of the differences seen in performance measures are found to be attributable to vehicle speed. As expected, private operators report higher levels of operating efficiency than public operators and also seem to be holding the line on rising costs better than the public operators. Future years' efforts will need to include expanded time-series analysis of the state's large operators coupled with a more in-depth review of the use of measures of transit service quality.

The New York State Department of Transportation (NYSDOT) began monitoring and evaluating the performance of the state's transit operators in 1979. This effort was undertaken to comply with a State legislative mandate to certify the economy, efficiency, and effectiveness of transit operations participating in the State operating-assistance program (1). Since 1979, the methodology used in the NYSDOT performance-evaluation program has been modified to reflect a shift in both objective and emphasis by the Department. Initial efforts to monitor and evaluate performance were research oriented in order to provide the Department with a better understanding of the problems faced by transit operators. Current efforts, however, are focused on identifying where specific operators are performing poorly and what steps can be taken to improve performance. The Department has also revised its performance-evaluation program to take advantage of new data sources and a greater understanding by the staff of the performance-evaluation process.

This report reviews the NYSDOT performance-evaluation process, beginning with a brief summary of the program's background. This is followed by a discussion of current performance-evaluation efforts, including the changes in methodology and the reasons for these changes. Trends in transit operator performance are discussed and a brief review of the differences in performance between publicly and privately owned transit operations is presented. The report concludes with a summary of findings and recommendations for future research.

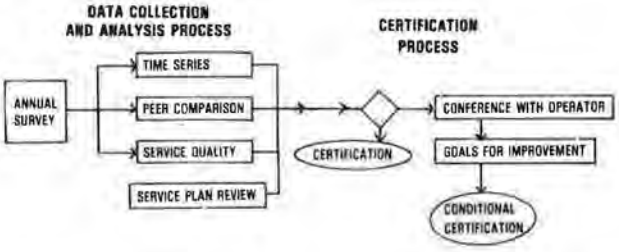
BACKGROUND

NYSDOT began its transit performance-evaluation program in 1979. The operating and financial data necessary to implement the program are collected in an annual survey of transit operators. During the first year of its performance-evaluation program, NYSDOT developed 15 multimodal performance indicators that allowed for the comparison of various modes and service types found among transit operations participating in NYSDOT's operating-assistance program. Because there was little or no theoretical base on which to determine the appropriate level of performance, acceptable and desirable levels were set empirically. Individual operators were then reviewed relative to the acceptable and desirable performance levels established.

During the second year of the performance-evaluation program, NYSDOT's focus shifted from individual operators to major regional or county public transportation systems receiving state operating assistance. A major system was defined as one that annually carried more than 1 000 000 passengers or operated more than 1 000 000 vehicle-miles of service, which could be a regional public transportation authority or a county or municipal sponsor of one or more publicly or privately operated transit operators. Of the state's 62 systems, 17 qualified as major systems in State FY 1979-1980. These 17 systems carried 99 percent of the passengers, operated 98 percent of the vehicle miles, and received about 99 percent of state operating assistance. Evaluating systems rather than individual operators better met the Department's desire to monitor major transit operators serving the same geographic area, particularly where service and financing policies were controlled by a single local agency. However, the disadvantage of this approach was that the poor performance of an individual operator could be hidden within the average system performance.

An additional development during the second year

Figure 1. NYSDOT performance-evaluation methodology.



was the use of service evaluation plans in the performance-evaluation program. The initial year's service plan questionnaire asked for information on the following topics from each major system: transit service objectives, transit system and route performance evaluation, transit service coordination, and transit service problems and needs. By attempting to determine the above information, the service plans provide a basis to begin to relate transit-system performance to local service objectives and also improve the performance monitoring of New York State's major transit systems (2).

CURRENT APPROACH

The results of the first two years' performance evaluations revealed that major transit systems appeared to be operating economically, both when compared with empirical guidelines and with transit systems in other states. However, it was apparent that there was indeed room for improvement in performance. To more precisely identify where improvement might be made, current performance-evaluation efforts concentrate on assessing the performance of individual transit operators instead of the evaluation of county or regional transportation systems. To make the evaluation potentially more equitable, operators have been grouped on the basis of mode, service type, and vehicle fleet size. The resulting groups allow the performance of individual operators within each group to be assessed relative to other, comparable group members.

The Department is also developing a set of transit service-quality measures to complement the traditional economy, efficiency, and effectiveness measures. The use of service-quality, reliability, and safety indicators better measures service performance as viewed by the riding public. Including service-quality measures in performance evaluations will also help explain changes seen in other performance indicators and should result in a more comprehensive analysis of overall operating performance.

Finally, NYSDOT recently completed its third annual survey of transit operators. This information will allow operator performance to be monitored over time, providing insight into trends that might affect the State's transit policy.

The methodology for NYSDOT's performance-evaluation program is illustrated in Figure 1. The performance review is carried out in two steps. The first, data collection and analysis, includes the peer comparison, service-quality, and time-series functions described above along with the review of service plans. The second phase, certification, involves the review and subsequent Department action based on the results from the data-collection and analysis phase.

The remainder of this report will describe the peer-comparison function of the first phase. The service-plan and service-quality functions have been discussed in other NYSDOT reports (2,3).

PEER COMPARISON: GROUPING OF OPERATORS

New York has a wide variety of transit services, ranging from the nation's largest subway, bus, and commuter rail system to small rural bus services. Evaluating the performance of any one operator requires a method of grouping like operations. The method chosen was to group the State's more than 110 transit properties participating in the State operating-assistance program by mode, service type, and vehicle fleet size.

By using these factors, 13 groups of operators were developed, as follows:

Group	Definition
Local bus	
L1	1-25 vehicles
L2	26-125 vehicles
L3	126-499 vehicles
L4	500+ vehicles
Commuter bus	
C1	1-20 vehicles
C2	21+ vehicles
Intercity Bus	
I1	1-20 vehicles
I2	21+ vehicles
Demand Responsive	
D1	Combined demand-responsive and fixed-route service
D2	Demand-responsive service only
Rail	
R1	Rapid transit
R2	Commuter rail
Ferry	
F1	Commuter ferry

The operator peer groups should ensure that only operators providing similar service will be grouped together. The above groups do not take into account operating conditions such as speed and urban versus rural service. This shortcoming will be studied in the future. Whether a transit system was publicly or privately owned was also not considered in setting up the above groups. It was felt that keeping public and private operators together would more accurately reflect the full range of potential performance. An analysis was performed to determine whether private operators actually performed differently from public operators, and the results of this analysis are discussed later in this report.

The above fleet size groupings were determined by a review of all transit operations. Cutoffs were made where breaks occurred in the frequency distribution of fleet size and where previous knowledge indicated similar types of operation.

To determine whether the groupings on mode, service type, and fleet size were an improvement in describing performance, the means and standard deviations of each group were calculated and compared with the means for all operators combined. The group means are shown graphically for several performance measures in Figure 2. On two of the measures shown (capacity hour per employee hour and cost per capacity mile), the mean values of each group are generally clustered around the overall mean and outlying groups can be easily explained. The groups with low capacity hours per employee hour are demand-responsive systems whose vehicle capacities are much smaller than those of other transit systems, whereas those groups on the high side are the New York City bus and rapid transit systems whose vehicle capacities are much higher than average and whose services operate 24 h/day. The NYC rapid transit system had the lowest operating cost per capacity mile whereas the demand-responsive group had the highest cost per service unit. The

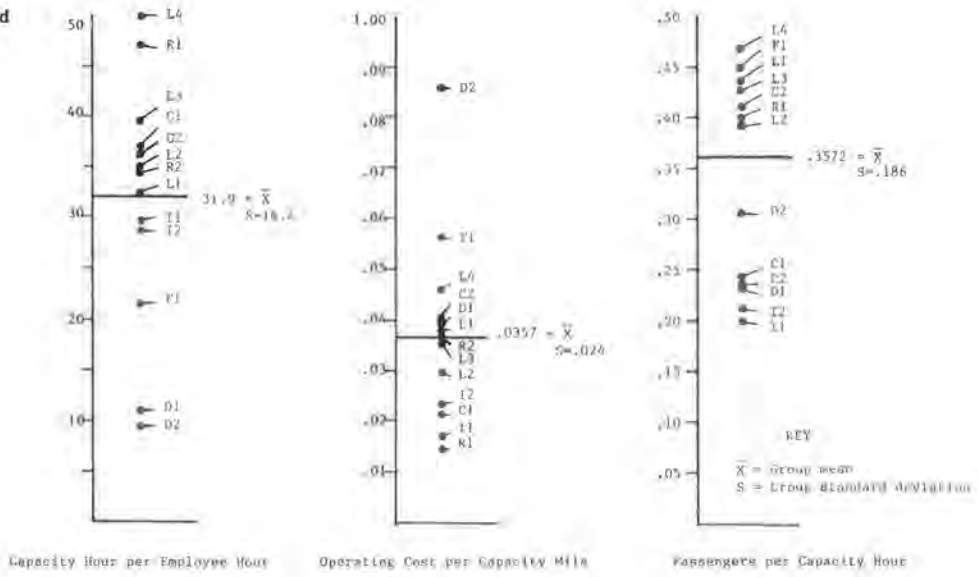


Figure 2. Variation between group means and overall means.

group values on the measure of passengers per capacity hour are clustered at extreme values, though all are within 1 standard deviation of the overall mean. This variation is caused by the low levels of passenger use due to extremely long trip lengths by long-distance service (commuter and intercity) and the high levels by local, fixed-route service in densely developed areas.

These results indicate that the performance levels generally differ between groups. Further analysis of the groups revealed that the standard deviations of each group were considerably lower than those of the service type aggregations. Although the group means vary considerably on some measures (see Figure 2), for the most part, like service types (i.e., local, commuter, intercity, and demand-responsive) appear together on each graph, supporting earlier Department findings regarding performance levels by service type (4).

Changes in Performance Measures

In past years, NYSDOT's performance-evaluation program used a set of 15 multimodal measures. Since the measures used vehicle capacities in a number of the calculations, the performance of different types of transit operations (intercity bus, ferry, commuter rail, etc.) could be more fairly compared and aggregated into county or regional transportation systems (4). A review of the vehicle capacities of operators within each group revealed that capacities were fairly uniform within operator groups and changed by group as expected. For example, the small local bus operator group generally had lower-capacity vehicles than the larger, fleet-size groups. Therefore, the use of vehicle capacities in a number of the ratios was eliminated in favor of calculations on the more traditionally understood vehicle basis (e.g., cost per capacity mile now becomes cost per vehicle mile). The changes in measures used are shown below. This modification results in a more understandable set of measures comparable with those used throughout the transit industry (5). The pairing of measures shown below is done to account for operational differences in transit service related to vehicle speed:

Measures used in system evaluations:
Capacity hours per employee hour
Capacity miles per employee hour
Operating cost per capacity mile
Operating cost per capacity hour

Passengers per capacity hour
Passenger miles per capacity hour
Passenger miles per capacity mile

Measures used in peer-group evaluations:
Vehicle hour per employee hour
Vehicle mile per employee hour

Operating cost per vehicle mile
Operating cost per vehicle hour

Passengers per vehicle hour
Passenger miles per vehicle hour
Passenger miles per vehicle mile

Measures common to both system and peer-group evaluations:
Vehicle hours per vehicle
Vehicle miles per vehicle

Revenue-to-cost ratio
Operating revenue plus excess local aid per passenger mile

Cost per passenger mile
Deficit per passenger mile

Passengers per employee hour
Passenger miles per employee hour

In past years, measures were applied in sets to account for operational differences in transit service related to vehicle speed--a factor over which most transit systems have little control (these sets are also shown in Figure 3). This feature was retained in this year's program. The revised measures have been calculated for the previous year's data (operator fiscal year 1978-1979) to allow an analysis of trends in performance over the last two years. These measures will be used in subsequent years to allow the monitoring of changes in performance over time.

Individual Operator Performance-Evaluation Framework

The framework adopted for reviewing the performance of operators within each group is similar to that

proposed for Michigan (6). This framework establishes threshold performance levels that, if not met, serve as a triggering mechanism for additional analysis and potential state management assistance. Any individual operator whose performance is more than 1 standard deviation away from the group means is identified for further analysis. This method is being tested to determine whether it indeed achieves the intended result of identifying operations that should improve performance.

Use of this framework determines the acceptable level of performance on a statistical rather than a subjective basis. This approach has both advantages and disadvantages. The advantage is that the process is easy to document and does not rely on any one person's assessment of the data. The major disadvantage is that when a group has only a few members or when the distribution of group values is skewed, the resulting acceptable level of performance is distorted. In this case, an alternate approach such as monitoring performance over time or comparing performance to similar operations in other states will be applied. Since the setting of appropriate performance levels is the most difficult part of the evaluation, NYSDOT will continue to refine this process as needed to better measure relative performance.

This report will not review the performance of the more than 110 transit operators participating in the State operating-assistance program, since this information will be included in a NYSDOT report on transit performance. Trends in group performance have been reviewed, paying special attention to (a) whether differences exist in average performance from group to group and (b) possible explanations for these variations and changes in performance over time. This review is presented to support the De-

Figure 3. Vehicle hours per employee hour.

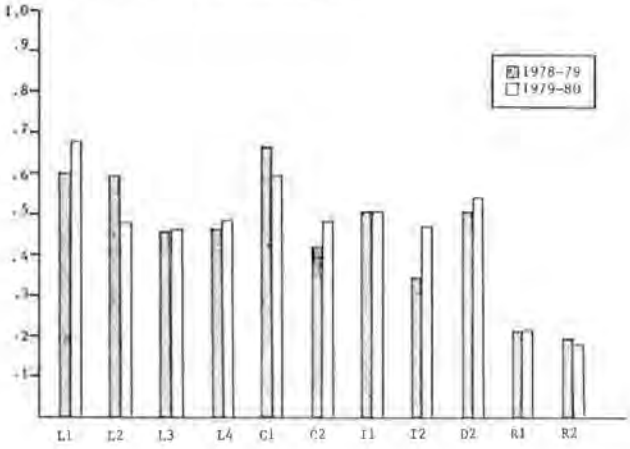


Figure 4. Vehicle miles per employee hour.

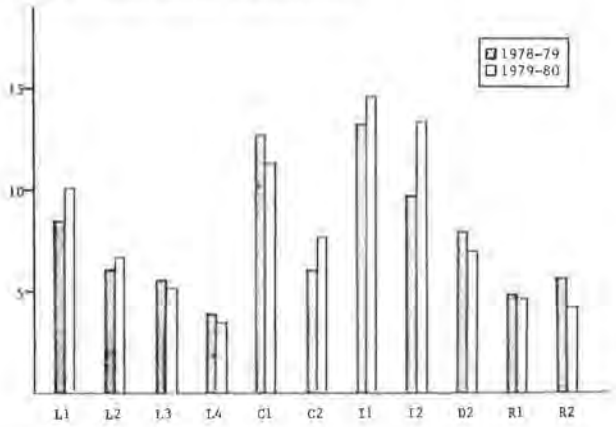


Figure 5. Operating cost per vehicle mile.

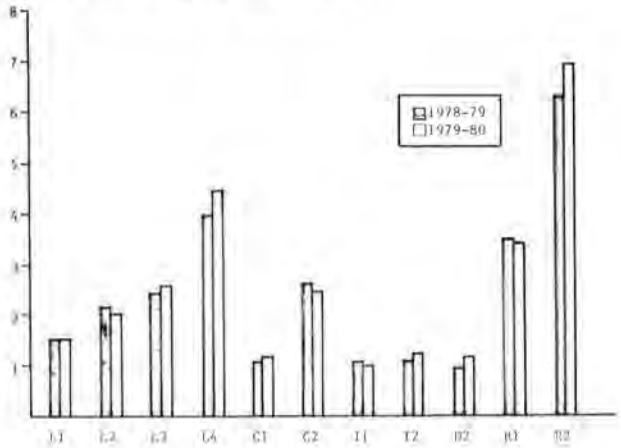


Figure 6. Operating cost per vehicle hour.

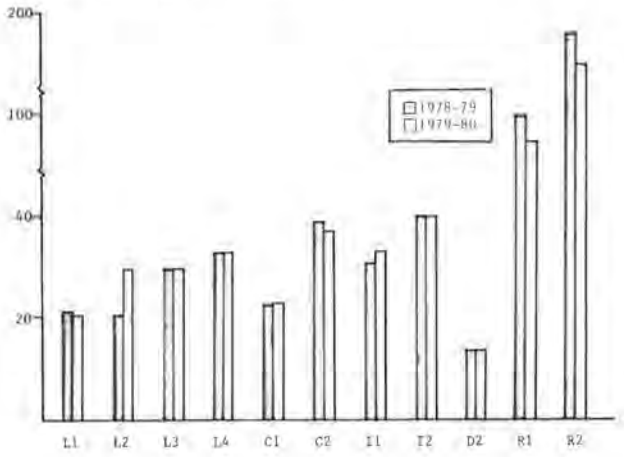
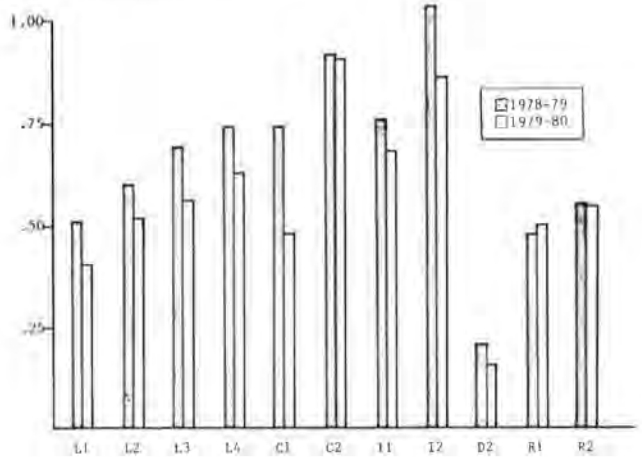


Figure 7. Revenue-to-cost ratio.



partment's approach of grouping operators into peer groups. It should not be construed as an attempt to compare the performance levels of the various groups of operators.

Review of Operator Group Performance

Selected performance measures for a number of groups of operators studied are presented graphically in Figures 3-11. These graphs are useful in that they present the absolute levels of performance for each group and show the change in performance from 1978-1979 to 1979-1980. The percentage of change on each measure by group is shown in Table 1 along with two factors that affect performance measures--speed and passenger trip length. It should be noted that the group levels are operator averages and do not reflect weighting by operator size.

The group levels for two efficiency measures are shown in Figures 3 and 4. Overall, the group levels for vehicle hours per employee hour are fairly uniform except for the rapid rail and commuter rail groups (R1 and R2). The group levels differ considerably for vehicle miles per employee hour; longer-distance commuter and intercity services (C1, C2, I1, I2) perform better than local services. Clearly, accounting for service speed in the measure of vehicle hours per employee hour results in a narrower difference between group levels. Within service types, there are also interesting differences between groups. The small urban bus operators (L1 and L2) have been more successful in improving efficiency than have larger bus operators (L3 and L4). The very opposite is seen among commuter bus operators, where the larger operations (C2) have improved efficiency but smaller operations have experienced declining performance. However, in absolute terms, the smaller operators in the urban, commuter, and intercity groups show higher performance levels on these measures than the larger operators. Figures 3 and 4 show that, overall, bus service efficiency declines as operating speed decreases.

The levels of several economy measures are shown in Figures 5-7. Cost per unit of service generally increases as fleet size increases within each service type, reflecting decreases in operating speed that typically occur as fleet size increases (and urban areas become larger and more dense). However, revenue-to-cost ratios increase as fleet size increases (a favorable change), which is a result of increases in passenger-carrying effectiveness as discussed below. As Table 1 shows, there is no clear trend in performance change. Only the small commuter bus operators (C1) fail to improve their performance on at least one economy measure.

Several effectiveness measures are shown in Figures 8 through 11. The effectiveness levels gener-

Figure 8. Cost per passenger mile.

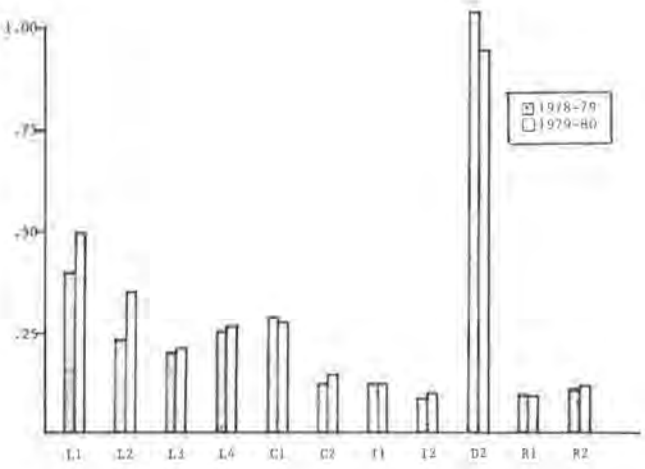


Figure 9. Passenger miles per vehicle hour.

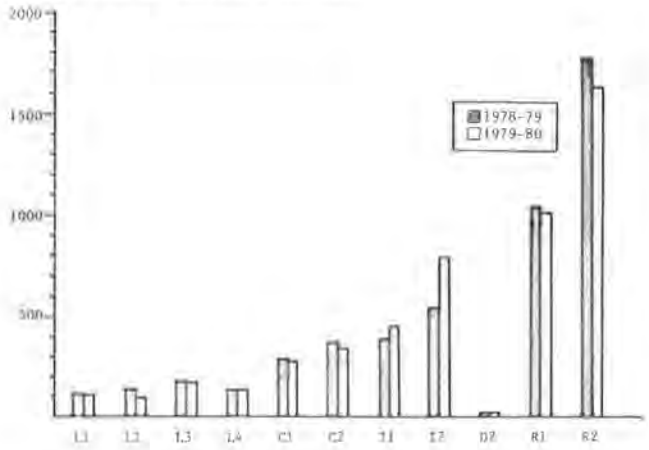


Figure 10. Passenger miles per vehicle mile.

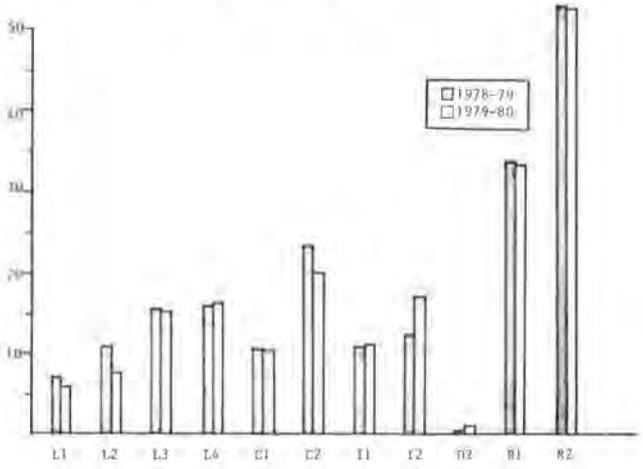


Figure 11. Passengers per vehicle hour.

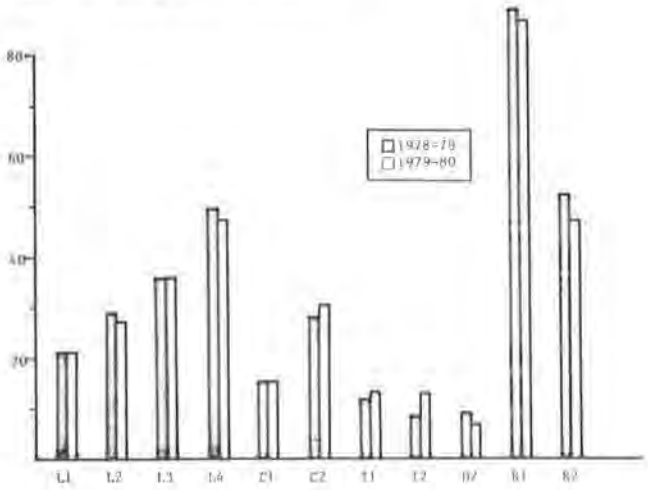


Table 1. Economy, efficiency, and effectiveness indicators: percentage of change, 1978-1979 to 1979-1980.

Performance Measure	Direction of Favorable Change[a]	Percentage of Change											Total Group Performance Change (no. of groups)		
		Local Bus				Commuter Bus		Intercity Bus			Rail				
		L1	L2	L3	L4	C1	C2	I1	I2	D2	R1	R2	Improve	Decline	No Change
Efficiency															
Vehicle hours per employee hour	+	13.68	-18.49	1.19	5.83	-6.47	14.57	0.36	40.50	3.36	1.24	-9.66	8	3	1
Vehicle miles per employee hour	+	19.89	0.96	-3.47	-6.41	-10.35	28.50	8.90	36.59	-11.96	-2.27	-22.80	4	7	1
Vehicle hours per vehicle	+	16.09	6.50	3.57	-1.88	-1.98	23.27	3.34	-26.99	11.54	7.86	14.10	9	3	0
Vehicle miles per vehicle	+	12.73	50.70	-4.10	-12.48	-4.36	31.47	4.10	-36.60	-12.20	7.37	5.37	7	5	0
													28	18	2
Economy															
Operating cost per vehicle mile	-	-0.34	-6.18	4.58	12.37	6.30	-5.07	-5.98	-6.44	24.80	-2.90	8.46	5	6	1
Operating cost per vehicle hour	-	-1.45	48.47	-1.22	-0.44	1.82	-5.48	5.80	-3.07	-1.28	-4.10	-3.41	8	3	1
Revenue-to-cost ratio	+	-18.05	-12.97	-18.37	-10.80	-36.75	-0.49	-9.25	-16.28	-19.70	5.20	0.67	2	8	2
Operating revenue and excess local aid per passenger mile	+	-42.77	103.60	8.09	2.12	-16.64	24.72	20.26	26.20	-17.44	1.24	67.27	9	3	0
													24	20	4
Effectiveness															
Passengers per vehicle hour	+	-2.47	-4.20	-0.44	-4.60	1.74	9.45	5.09	58.96	-24.45	-2.80	-9.25	4	7	1
Passenger miles per vehicle hour	+	-6.33	-26.37	-5.41	-4.57	-6.47	-22.95	16.23	42.34	-25.08	-3.40	-6.22	3	9	0
Passenger miles per vehicle mile	+	-15.91	-36.69	-8.36	8.07	-1.39	-25.75	6.60	31.32	23.65	-1.01	-1.19	5	7	0
Cost per passenger mile	-	25.43	51.05	9.10	5.10	-4.60	17.66	0.80	16.27	-8.30	-1.79	10.76	4	7	1
Deficit per passenger mile	-	56.53	67.55	63.24	38.10	28.99	34.38	19.15	107.70	-8.30	-4.76	0	3	8	1
Passengers per employee hour	+	13.96	-21.30	-1.98	0.10	-0.75	18.76	6.17	105.30	-18.42	-0.40	-20.44	4	5	3
Passenger miles per employee hour	+	-0.18	-38.30	-10.80	0.10	-3.63	-4.20	23.20	52.69	-12.14	-3.11	-25.42	3	7	2
													26	50	8
Total performance change															
Improve		6	3	4	3	2	9	10	9	6	9	4	77		
Decline		7	11	10	9	12	5	3	6	9	5	9		89	
No change (<1 percent)		2	1	1	3	1	1	2	0	0	1	2			14
Factors affecting performance[b]															
Avg vehicle speed (mph)		15.10	15.92	11.42	7.47	21.53	15.95	30.89	30.36	13.28	27.21	28.88			
Avg trip length (miles)		5.45	3.47	4.51	2.70	15.93	12.53	31.50	45.82	5.80	11.50	36.43			

[a](+) = increase; (-) = decrease. [b]Numbers reported are actual values for 1979-1980, not percentage of change between 1978-1979 and 1979-1980.

ally increase (or improve) within each service type as fleet size increases. It should be noted, however, that effectiveness levels have declined for most groups over 1978-1979 levels. As Figures 8-11 and Table 1 illustrate, all groups have declined in performance on at least two effectiveness measures. Only intercity bus operators (I1 and I2) improved effectiveness on a majority of the measures. As would be expected, the rail systems carry many more passengers per vehicle mile and hour, yet on almost all passenger measures the rail systems declined in effectiveness in 1979-1980.

In summary, this brief analysis has revealed that the efficiency of most transit operators has increased while effectiveness declined in 1979-1980. As has been shown in an earlier report, efficiency measures are not highly correlated to economy or effectiveness measures (4). The graphs have also shown that group comparisons (especially within service types) can yield insight into the factors that contribute to changes in performance. In general, measures calculated on the basis of vehicle hours result in more homogenous group levels than do vehicle-mile measures. A further finding is that differences in vehicle speed can explain much of the difference in group levels for efficiency measures.

PUBLIC VERSUS PRIVATE OPERATOR PERFORMANCE

A significant amount of fixed-route transit service in New York State is provided by private operators, especially in the New York City metropolitan area where the privately owned bus systems serving the 12-county New York Metropolitan Transportation District annually carry more than 150 million passengers. The levels of performance of public and private bus systems often differ due more to inherent characteristics of each rather than the characteristics of the area they service. An understanding of these differing performance levels and their causes can aid in understanding the range of transit performance and the potential for improvement. Table 2 presents the average level of performance for two groups of public and private fixed-route local bus systems serving the metropolitan New York region. The table shows the 1979-1980 average level of performance on each of NYSDOT's 15 performance measures as well as the percentage of change in performance over the previous operating year. Several factors that have been shown to influence the levels of performance measures are also presented.

As Table 2 illustrates, the levels of labor efficiency in terms of vehicle miles and hours per employee hour are slightly higher for small private bus operations (less than 25 buses) than small public operations. Performance levels for large public and private bus systems are identical on the measure of vehicle hours per employee hour, whereas private operators perform better in terms of vehicle miles per employee hour. This result as well as the reason for differing levels of vehicle use between

Table 2. Performance levels at downstate local bus systems.

Performance Measure	Downstate Small Local Bus System				Downstate Medium and Large Local Bus Systems				Direction of Favorable Change
	1979-1980 Level		Percentage of Change, 1978-1979 to 1979-1980		1979-1980 Level		Percentage of Change, 1978-1979 to 1979-1980		
	Public	Private	Public	Private	Public	Private	Public	Private	
Efficiency									
Vehicle hours per employee hour	0.53	0.74	0	19	0.43	0.42	-12	-16	Increase
Vehicle miles per employee hour	6.51	12.88	-22	37	4.18	5.20	-12	-5	Increase
Vehicle hours per vehicle	2 592	2 159	5	18	2 509	2 090	24	-1	Increase
Vehicle miles per vehicle	34 364	37 022	-9	22	23 314	26 574	19	14	Increase
Economy									
Cost per vehicle mile	1.33	1.33	13	3	4.03	2.78	38	-6	Decrease
Cost per vehicle hour	16.72	19.63	-11	0	38.70	33.96	38	8	Decrease
Revenue-to-cost ratio	0.27	0.51	59	-19	0.61	0.64	0	-21	Increase
Revenue and excess local aid per passenger mile	0.16	0.24	160	9	0.18	0.25	6	57	Increase
Effectiveness									
Passengers per vehicle hour	16.19	24.77	54	10	45.86	35.82	16	-4	Increase
Passenger miles per vehicle hour	100.60	98.70	-17	-30	200.10	136.60	46	-29	Increase
Passenger miles per vehicle mile	7.42	6.07	0	-31	18.76	13.63	40	-28	Increase
Cost per passenger mile	0.31	0.45	48	15	0.22	0.35	-8	59	Decrease
Deficit per passenger mile	0.24	0.27	40	58	0.08	0.14	-20	180	Decrease
Passengers per employee hour	9.25	18.24	53	32	19.81	15.46	5	-18	Increase
Passenger miles per employee hour	47.88	70.45	-32	-11	78.63	60.07	39	-41	Increase
Speed (mph)	12.80	16.80	-18	2	10.30	13.80	3	14	
Avg trip length (miles)	7.60	5.00	-30	-39	4.50	3.70	25	-32	
Avg fare ($)	0.28	0.39	-10	-32	0.47	0.62	30	-5	

public and private systems can be attributed to the greater amount of express service provided by the private operators, which results in more vehicle miles of service per hour of operations. Labor efficiency generally declined for both public and private bus systems in the second year (an unfavorable change).

A review of economy measures shows that private operations in the medium-large bus group perform more favorably than public operations. Small private bus systems were reported to have higher operating costs per vehicle mile and hour but nearly twice the revenue-to-cost ratio of small public systems. Both private operator groups reported more favorable changes in cost per mile and hour over the previous year than did the public operators. The decline in revenue-to-cost ratios for the private operators was due to the delay in fare increases for this group until after their operating year covered by these data. The large increase in operating revenue plus voluntary local assistance per passenger mile for both groups was due to increased local government support for transit. It should be noted that the numerical values of the measures of cost per vehicle mile and hour are slightly higher for the downstate bus operators than for upstate New York bus systems (not shown) due to the higher general cost of living in the New York Metropolitan area.

A review of effectiveness levels reveals that large public systems generally perform better than private systems in terms of passengers and passenger miles of use. A factor contributing to this is an unexplained decline in passenger trip length for a number of private operators affecting all measures containing the passenger-mile component. Private operations in the small bus group generally performed as well as or better than public systems for most effectiveness measures. Declines in second-year performance can be attributed to changes in average passenger trip length. Increases in measures containing revenue passengers were due to the general increase in transit ridership in New York State in the late 1970s.

Overall, this analysis indicates that private operators generally provide transit service more efficiently and reported more favorable changes in the second year's performance data for private than for public operators. This reflects the greater ability of these for-profit oriented businesses to enact belt-tightening strategies. However, public bus systems usually achieve greater levels of passenger-carrying effectiveness than private operators. Despite their low passenger-carrying levels, private transit operators in New York continue to report higher revenue-to-cost ratios than public systems. Though comparisons of public and private systems are not always proper, this presentation has shown the areas in which each group performs well and provides a target for possible performance improvement for operators performing at low levels.

CONCLUSION

Grouping transit operators on the basis of mode, service type, and number of vehicles provides insight into the effect of operating conditions on operator performance. In general, measures calculated on the basis of vehicle hours result in more homogenous group levels than did vehicle-mile measures, indicating the importance of vehicle speed on some performance measures.

Analyzing transit operators by peer group has proved to be only a partial solution to the problem of determining which transit operators are performing efficiently and effectively. For groups with a large number of operators (Ll, small urban bus, for example), this methodology yields meaningful results. The performance of any one operator has only a minimal impact on the group mean, and the large number of group members assures that groups will include a cross section of operating conditions. For groups with only a few members (Rl, rapid transit, for example), in-state peer-group comparisons are not practical. Comparing individual group members to overall group statistics does not make sense when there are few operators in the group. This shortcoming is particularly significant since it

occurs most frequently with the state's larger transit operators, those in the New York City area. Improved performance of these operators could have the biggest payoff due to their size and offer the greatest potential for easing the need for public subsidy.

Several alternative approaches are possible as a means of addressing this particular problem. One alternative calls for comparing the larger New York City operators to operators in other large urban areas in the United States and perhaps the world. Although the age of equipment and operating conditions vary drastically from city to city, this comparison should still help describe New York's relative performance on selected indicators. Now that data from Section 15 of the Urban Mass Transportation Act of 1964 have become available, this approach will be studied further. A second alternative is to focus on the time-series analysis of individual operators described earlier. Even if an operator cannot be compared with other similar operators, a review of the operator's performance from year to year should indicate whether performance is improving or declining.

The review of public and private bus operators revealed that there were differences in performance, as suspected. Admittedly, the private operators often operate with fewer bureaucratic constraints, but the usually more cost-effective performance of the private operators provides a target for performance improvement of public operators.

A major drawback of a strictly quantitative performance-evaluation program like the peer comparison described above is that the measures in no way reflect the quality of service being provided as perceived by the rider. This problem is particularly true in the New York City area where traditional efficiency and effectiveness measures do not capture the drastic deterioration in service reliability, quality, and safety seen in the last few years. To address this problem, NYSDOT is developing a set of service-quality measures to monitor for each of the major transit operators in New York State. These service-quality measures, coupled with the traditional efficiency and effectiveness measures, should provide a more comprehensive picture of the level of performance and quality of transit service throughout the state.

FUTURE RESEARCH EFFORTS

Future research in the field of transit-performance evaluation should concentrate on integrating the quantitative performance evaluation presented in this paper with the evaluation of transit service quality. It is clear that only by combining several approaches--time series, group comparison, and service quality--can an accurate and comprehensive picture of transit service be presented.

Additional work should focus on further analysis of performance measures to develop indicators that best identify services that would benefit from in-depth study, determination of the transferability of the performance measures developed in New York State to other areas, more in-depth study of the factors that can be used to group operators for analysis, and more in-depth study of methods to determine acceptable levels of performance.

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Potential Role of Decision Support Systems in Transit Management

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The potential of microcomputer-based decision support systems in transit management is explored. Although computers are now used quite widely in the transit industry, their role tends to be predominantly in highly structured activities such as financial management and record keeping. These functions are provided on main frame computers requiring expensive technical support. Microcomputers, however, have the potential to be used directly by the transit manager to assist in decisionmaking. It is suggested that microcomputer-based decision support systems should be the focus of future computer use in the transit industry. Significant potential exists for the development of transferable software to support a wide range of transit management functions. A case study of the Cairo Transport Authority is presented to show how a decision support system can be based on the ideas advanced in this paper.