Transit Performance Measurement[1]

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Introduction

Evaluation and monitoring are as important to quality transit service as product development and marketing are to a successful business. Evaluating and monitoring service performance is essential to the efficient provision of transit to a community. Evaluation also enables managers to fine-tune services to meet the needs of riders more effectively. Likewise, monitoring the quality of transit service is an essential ingredient for good customer service. Since most systems are public-funded, the transit manager needs to improve productivity and effectiveness by providing the most rides possible with existing funds. This need for better productivity has to be balanced with maintaining a level of service that retains current riders and, hopefully, attracts new ones. Funding agencies, elected officials, and transit boards increasingly insist on performance reports to ensure that public funds are being spent wisely. A few state departments of transportation (DOTs) require performance evaluations or the reporting of performance indicators as a condition of state funding.

There are six major reasons for evaluating and monitoring transit service:

1) Control costs and ensure the integrity of the system
2) Justify changes in service levels (hours of operation, route extensions, etc.)
3) Maintain or improve the quality of service
4) Monitor subcontractors
5) Guide marketing efforts
6) Report the status of transit service performance to policy boards

Performance indicators are powerful tools for monitoring and improving transit service. While there are many possible indicators that could be used, typically a small subset is used on a regular basis to monitor the important aspects of transit system performance. The approach for using indicators to assess performance is relatively easy to implement. Some of the indicators used to evaluate service performance are readily available in most systems and others can be collected and analyzed as conditions warrant.

[1] This material is adapted from a NTI course "Improving Transit System Performance: Using Information Based Strategies" developed at the University of Wisconsin-Milwaukee 1996-98. This material was written by Jack Reilly of the Capital District Transportation Authority (Albany, N.Y.), Edward Beimborn or UWM and Robert Schmitt of RTR Associates in Pittsburg.

In this section we will examine the different types of indicators, the transit evaluation process and the role of indicators. We will also look at a hypothetical transit system and how performance indicators might be used to evaluate service and assess changes in service.

Types of Performance Indicators

A performance indicator is a measure, usually quantitative, which reveals information about certain characteristics of a service. Sometimes the measure is a ratio of two other measures. For example, miles per hour is a measure of the average number of miles traveled in an hour. It is composed of total miles traveled divided by the total hours spent in travel. In a system as complex as transit, one could probably devise hundreds of measures to assess performance. However, experience has shown that in many situations a relatively small number of measures can be used effectively.

Considering the vast number of possible indicators, it will be helpful to classify performance measures into a smaller set of categories. In a study published in 1982, a classification of performance indicators was devised.[2] An abbreviated version of this classification is given below.

Financial Indicators

Expense

- Total Operating Expense (Cost) / Total Passenger Trips: This is a measure of how well the system is serving riders with available resources.
- Total Operating Cost / Vehicle Miles (or Vehicle Hours): Measures of productivity useful in setting standards or comparing services, including the services of peer systems.
- Administrative Expenses / Total Expenses: A measure of the appropriate balance between these two cost centers. As a rule of thumb, administrative costs should not exceed 15-20 percent.

Revenue

- Total Revenue / Total Passenger Trips: A measure of the average revenue for a passenger trip.
- Total Fare Revenue / Total Revenue: An indicator of the percentage of revenue accounted for by fares.
- Revenue / Expense (Cost): Also called operating ratio or cost recovery. A measure of the degree to which operating expenses are covered by revenues.

Subsidy

- Total Subsidy / Total Vehicle Hours: The average subsidy per vehicle hour of service.
- Total Subsidy / Total Passenger Trips: A measure of the average subsidy for each passenger trip.

Non-Financial Indicators

Ridership

- Total Passenger Trips / Total Vehicle Hours: The average number of trips served per

[2] Pennsylvania Department of Transportation, Rural Public Transportation Performance Evaluation Guide, Bureau of Public Transit (Harrisburg, PA: November, 1982), pp. 4-10.

vehicle hour. A measure of productivity.
- Total Passenger Trips / Total vehicle Miles: A productivity measure useful for comparing services, especially in rural areas or on longer suburban routes.
- Elderly Passengers / Total Passengers: An indicator of the use of transit by elderly passengers. May be useful in designing stops and assigning equipment.
- Passenger Trips / Population of Service Area: An indicator of the level of transit use in an area.

Service Quality
- Number of Complaints / Number of Drivers: A rough measure of consumer dissatisfaction.
- Stops On-Time / Total Stops: A measure of on-time performance.
- Vehicle Miles / Road Calls: A measure of miles between road calls; a surrogate for fleet age and maintenance effectiveness.

Level of Service
- Revenue Miles / Revenue Hours: A measure of the concentration of service.
- Vehicle Miles / Year: A useful measure for comparing level of service over time.
- Vehicle Hours / Year: A useful measure for comparing level of service over time and as an element in calculating additional indicators.

Safety
- Vehicle Miles / Vehicle Accidents: The number of vehicle miles between accidents, an important safety indicator.
- Avoidable Accidents per Year: A useful safety indicator and one often used for setting safety standards

The indicators may be expressed in many different ways depending on what the manager wants to measure. Total vehicle miles and revenue vehicle miles are different indices, they measure slightly different things; farebox revenue and total revenue also differ significantly in some systems. Most indicators are appropriate at the system and route level while others are useful primarily at the route level.

Performance indicators have two major uses. First, they may be employed to assess how well the system is doing with respect to the standards established by management. Second, they may be used to identify areas within the system that need attention or remedial action. Both of these approaches come together in the transit system evaluation process.

Business vs. Social Measures

Most of the transit performance work to date using on-board data has focused on **business** measures of service (cost per customer transported, etc.) The recent advent of geographic information systems has enabled transit analysts to make a number of **social** measurements of transit service. For example, coupled with a description of the service (stop lists, frequencies, etc.) an analysts can determine the proportion of households without autos served by daytime service, the proportion of households with direct access by transit to grocery stores and the proportion of jobs in the transit service territory. The social mobility measures when coupled with more traditional business measures of transit service (revenue to cost ratio, for example) provide a more complete picture of transit performance in a metropolitan areas. Through the use of these technologies one can estimate the cost to achieve certain levels of mobility.

Business Measures

Business measures of transit service can be performed at the systemwide, route or even route segment level. Most important to transit operators are resource utilization measures such as customer boardings per revenue mile or revenue hour. Other measures of some interest in this area include revenue to cost ratio or cost per customer transported. In fact, several transit systems have some type of service standards against which actual performance levels are measured.

Providing cost information below the route level requires the use of some type of cost allocation model. This can either be a short run avoidable cost model (to determine the short run impact of changes in the level of service) or fully allocated costs in which all system costs including short run avoidable costs and fixed costs are pro-rated among routes.

By using farebox data for example, one can develop business measures for routes in the system. The table below shows a set of measures for Saturday routes in a transit system.

Table 1: Example of Route Comparison

CAPITAL DISTRICT TRANSPORTATION AUTHORITY
KEY INDICATOR SUMMARY
Saturday Total

Period: May 1997

Route		Revenue/ Cost	Passengers/ Hour	Margin/ Passenger
2	West Albany	.26	14.2	$1.60
4	Pine Hills	.20	12.8	$1.98
3	Quail Street	.37	21.4	$1.23
8	Arbor Hill	.14	10.1	$3.15
14	Third Street	.28	16.1	$1.74
18	Delaware Avenue	.19	10.4	$2.24

Social Measures

While most of the work in system wide performance measures is focused on business measures, such as revenue to cost ratios, transit systems do not have good estimates of some social indicators. Examples of these would include what proportion of households without autos have transit service of a specified quality. One particularly helpful social measure is an estimate of the number of households in a transit district within .25 mile of a bus stop (this is a five minute walk at three miles per hour).

Table 2.2 shows the system wide performance measures by service period. The table shows that although the transit service territory includes only 4% of the transit district, fully 73% of the households without autos are within 0.25 miles of a transit route.

Social measures can also be made at the route level. By using geographic information systems, one can compute the number of households within 0.25 miles of the route, the distribution of auto ownership within the route's market area etc. Further, the characteristics of the **route** service can be compared with the characteristics of the **system** service area. The tables below illustrate this.

Table 2: Proportion of Population in Service Area by Service Period

Characteristic	Total	Peak	Midday	Evening	Saturday	Sunday
Total population	100%	42%	39%	27%	37%	23%
Total households	100%	44%	42%	29%	39%	24%
Elderly population	100%	47%	45%	30%	42%	24%
Employment	100%	62%	62%	50%	60%	46%
Households (0 cars)	100%	73%	71%	58%	70%	52%
Households (0,1 car)	100%	57%	55%	41%	53%	35%
Workers	100%	44%	42%	29%	40%	24%
Area	100%	5%	4%	2%	3%	2%

Table 3: Performance Measures of Route 50 -Burnt Hills

Business Measures

Passengers per hour	8.5	
Cost per passenger	6.55	
Public support cost (annual)	$105,633	

Social Measures

Households in service area	3,191	
Households without autos in service area	270	
Public support cost per household		$33
Public support cost per household w/o autos		$391

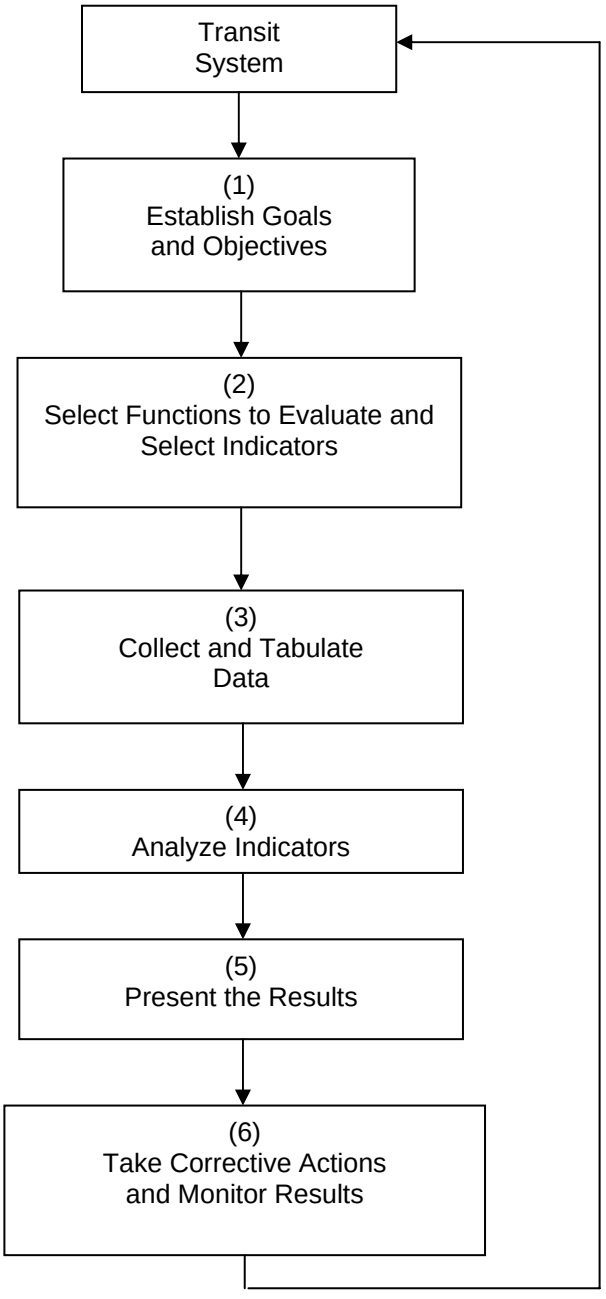
Table 4: Residential Route Analysis - Route 50 Burnt Hills

	CDTA Service Area	Route 50 Service Area	Route Percent of Total
Key Indicators			
Population density (pop/sq.mi.)	4,105	2,116	-
Percent of households without autos	13%	2%	-
Percent of households with 0,1 auto	43%	12%	-
Percent of population over age 65	13%	4%	-
Households without autos per sq. mi.	415	26	-
Percentage of region's workers living in route service area using transit	6%	0.2%	
Supplemental Indicators			
Total population	468,719	8,377	2%
Total area (sq. mi.)	264	7	3%
Total population over age 65	68,667	1,333	2%
Total households without autos	30,310	270	0.9%
Total workers	187,283	3,190	2%
Population over age 65 per sq. mi.	575	345	-
Workers per sq. mi.	1,675	236	-

The Performance Evaluation Process

The performance evaluation process consists of six steps as shown in Figure 2.1. Because the process of identifying problems and solving them is a continuous one, the performance evaluation framework described here is a loop whereby the results of specific actions are further evaluated using the performance measures that are used to quantify the goals and objectives set for the system. An overview of the six steps is presented in this chapter; more detailed descriptions of each performance measure, data collection, and diagnostic information are presented later.

Figure 1 Performance Evaluation Process.



Steps in the Process

1. Establish Goals and Objectives

The first step in setting up a performance evaluation process is to define overall system goals and objectives. While each system may have specific local goals and objectives, most often the overall goal of a system can be stated as follows:

Goal: to provide, safely and reliably, the greatest number of trips to the greatest number of persons at the lowest possible cost within the budget provided.

After the general goal of a transit system is established, more specific, quantifiable objectives must be defined so that the specific measures necessary to a performance evaluation methodology can be determined. In the case of the general goal stated above, a number of more quantifiable objectives are implicit within this overall goal statement. These objectives can be grouped into categories such as financial, safety, ridership, and service quality. Specific indicators can then be selected to measure accomplishment of these specific objectives.

A sample set of measurable objectives that logically follow from the previously stated goal statement are given on the table 2.5:

This sample set of objectives is not meant to be comprehensive; many other worthwhile quantitative and qualitative objectives can be defined. However, this set encompasses the major, ***measurable*** objectives that might be established by a paratransit system that serves a specialized or general market.

Measurability is an essential attribute of objectives formulated for use as part of a performance evaluation framework. Certain qualitative aspects of a system, such as the degree to which the transportation service affords individuals the opportunity to lead a "full life," while laudable, are nonetheless difficult or impossible to measure. Therefore, a list of the objectives of a transit system such as the one presented above must be limited to financial and operating attributes of the system that can be measured unambiguously.

Data availability and data collection costs also limit the range of objectives that can be considered since transit systems typically have few resources available to support extensive data collection efforts. Ideally, the performance evaluation framework should be workable using readily available or easily collectable information. Fortunately, experience has shown that a small number of objectives, measured by clearly defined performance statistics, provides for the most effective evaluation process and, therefore, the resource limitations of a system do not preclude an effective evaluation process

Table 5: Sample Performance Indicators (paratransit)

Operating Efficiency

Operating expense per vehicle hour should not exceed the statewide average and should annually increase by no more than the rate of inflation.

Administrative expense as a percentage of total operating expense should not exceed 15 percent.

The percentage of live hours (when passengers are in the vehicle) **to total paid driver hours** should be at least 50 percent.

Effectiveness

A minimum of 3.5 **one-way passenger trips per vehicle hour** should be provided.

A minimum of 4.0 **one-way passenger trips by senior citizens** should be provided annually for each senior citizen within the service area.

Service Quality

Service-related complaints by customers should not exceed one complaint **per 1,000 one-way passenger trips**.

Ninety-five percent of all pickups will be made within +/- 15 minutes of the promised time.

Financial

The **expense per one-way passenger trip** should increase by no more than the Consumer Price Index and should not exceed the maximum rate allowed by the State DOT.

The **revenue per one-way passenger trip** should be set to recover, on average, 100 percent of the operating expense per trip.

Safety

The system should have no more than one **avoidable accident per 100,000 vehicle miles**.

2. Selection of Performance Indicators

After the system's objectives have been clearly defined, the next step in the performance evaluation process is the selection of the specific performance indicators that will measure accomplishment of the objectives. Three sub-issues related to the selection of indicators include:

1. The extent to which a specific indicator has a generally agreed upon meaning, permitting cross-system comparisons, can be calculated using readily available or easily collectable data, and is unambiguous as to its meaning.

2. The operating level at which the indicator will be applied; for example, will the indicator be used to measure overall system performance, or will it be used to measure sub-service performance, such as by time of day or service sector area?

3. The time period to be measured (e.g., annual, quarterly, or monthly).

Dozens of indicators can be calculated using readily available information; however, a few key measures that meet the characteristics listed above are all that is needed to carry out an effective evaluation process. Gordon Fielding found that a preliminary list of 48 indicators could be reduced to 7 "marker variables" that captured the essential aspects of fixed-route performance.[3] A similar, selective list of indicators for paratransit systems is proposed in this guide. A short, focused list of indicators not only reduces the data collection required, but will encourage managers and external constituencies to focus on the overall condition of a system before delving into detailed aspects of sub-functional areas.

The first step in selecting indicators is to identify measurable indices for each objective developed in the framework of goals and objectives established in step one. After an overall list has been compiled, the list should be screened to eliminate indicators that measure the same performance attribute. For example, indicators with miles or hours in the denominator generally can be substituted for each other (e.g., expense per mile and expense per hour both track overall efficiency so that only one of these indicators is needed in an evaluation framework to measure the efficiency of a system).

Data availability and data collection costs will undoubtedly be the most important determinants of whether a performance indicator can be considered for inclusion in the evaluation methodology. For example, an excellent measure of services delivered is passenger miles; however, calculation of the average trip length data needed to estimate passenger miles is very time consuming, and therefore may limit use of this measure.

The system level at which the indicators are calculated and the frequency with which they are reported will determine the resources required to conduct the recommended evaluation. The recording of financial and operating data by service sector, or time of day, not only requires maintenance of more detailed data files; it also requires that cost information usually maintained

[3] Fielding, Gordon J., Managing Transit Strategically, pp. 64-65. The seven performance indicators include: revenue vehicle hours per operating expense, unlinked passenger trips per revenue vehicle hour, corrected operating revenue per operating expense, total vehicle hours per total employees, total vehicle miles per peak vehicle, total vehicle miles per maintenance employee, and total vehicle miles per collision accident.

at the system level be allocated to sub-services. Monthly or quarterly analysis also requires that accrual accounting systems be used to report financial data. While the record-keeping and additional procedural issues increase the complexity of the performance evaluation process, both transit and paratransit systems need the type of data that this evaluation provides. Therefore, a primary goal of this guide is to assist system staff in developing and implementing such an evaluation scheme by providing easy-to-understand explanations and examples of the recommended approach.

3. Collection and Tabulation of Data

After the overall goals and objectives of the transit system have been determined and the specific performance indicators are selected, the data elements needed to calculate each indicator must be collected. Nearly all of the data required to conduct the performance analysis can be obtained from basic financial and operating records normally maintained by a system. For example, except for accident and complaint statistics, all data required to calculate the performance indicators listed earlier in this chapter could be obtained from the driver's log and the system's financial accounting system. Furthermore, the accident and complaint data can be obtained through a simple record-keeping system that tabulates these events.

While the basic data for the performance evaluation can be obtained from readily available sources, these data must be analyzed and aggregated before they can be used to calculate the required measures. Before aggregating the raw data into the performance indicators, the time period must be established for the analysis and the operational level being considered. Typically, a performance evaluation such as the one described in this guide covers a 12-month period of operation so that annual financial and operating data are required. While the manager may wish to calculate some indicators on a monthly or quarterly basis to spot problems or to monitor how the system is moving toward its 12-month objectives, annual reporting of results is usually sufficient for funding agencies and other external constituencies. Furthermore, even with a good accrual accounting system that assigns costs and revenues to the proper time period, wide variations in month-to-month cost, revenue, and performance could unnecessarily complicate the interpretation of performance results. Therefore, the 12-month performance period is recommended.

The level of system detail to be included in the evaluation also must be determined prior to data collection and tabulation. For example, as will be demonstrated in a case study, an important use of the performance framework described in this guide is the analysis of individual service sectors or subcontractors within a transit or paratransit system. This type of detailed analysis helps the manager identify services within the overall operation that are unproductive and that need special attention. Also, special analysis of the services provided by subcontractors can aid a manager in monitoring the quality and performance of services provided by these outside vendors.

One common pitfall that should be avoided when collecting and tabulating financial and operating data is inconsistency of the data with respect to time period or level of aggregation. For example, annual ridership figures should not be divided into a one-month sample of vehicle hours to calculate the rides-per-vehicle-hour productivity measure. Such an error often occurs when a data element such as vehicle hours or trip length is not available for the entire year, so that only a sample measure of the data is available. This sample data may be used; however, adjustments to the data would be required to allow for proper calculation and interpretation of

the resulting measures.

A similar inconsistency error is also possible in the analysis of a specific service sector. Here the common error is to compare data, such as ridership for a particular portion of the service area, with costs or other performance data for the entire system. Obviously, the resulting calculation is meaningless. Recommendations for addressing these data collection and tabulation issues are presented in chapter 3.

4. Analysis and Interpretation of Indicators

Though most of the time required to conduct a performance evaluation will be spent collecting and organizing the required data, this step, analyzing and interpreting the indicators, is the most important one. In each case, the indicator must be analyzed to determine if the system's performance is satisfactory relative to the goals set for the system, or with respect to an external norm. One or more of the following three approaches may be employed to analyze the results. All three may be used as part of a system's evaluation and reporting procedure.

The first and most common method of analysis is to compare similar statistics for the system over time. Time-series analysis for a single system allows a manager (or external evaluators such as funding agencies or governing boards) to see how a system is progressing toward the system's own goals and whether its performance is improving or deteriorating over time. Some systems set annual goals at the beginning of a year so that the year-end performance evaluation includes a comparison of how the system performed relative to the established goals. For example, if in the prior year, a system achieved a productivity of 2.5 one-way passenger trips per vehicle hour, then the system's goal for the next year might be set at 2.7 one-way passenger trips per vehicle hour to increase overall efficiency. Even if specific goals are not set (e.g., the 2.7 goal), a time-series analysis of the system will allow the manager and others to identify areas of performance that need improvement and allow for an overall assessment of the system's condition.

A second way to interpret performance indicators is to compare the value obtained for a particular system to that of other, peer systems. Peer systems would include those systems that are comparable in key aspects such as size, operating environment (e.g., urban, suburban, rural), and type of operation (e.g., contracted, directly provided). Another operational characteristic that must be considered when selecting peers for valid comparison are the characteristics of the riders and the type of service provided. For example, a system that primarily transports ambulatory senior citizens to senior centers in a many-to-one operating mode will display significantly different performance characteristics than a system that transports disabled persons in wheel chairs to medical facilities in a many-to-many mode of operation. Also, for financial indicators, it is important to compare cost data for the same period or to use cost indices to adjust data from different years.

The third approach that may be used to analyze performance indicators involves comparing a particular statistic for the individual system to an industry norm or standard. However, few such norms exist unless there are funding agency-imposed minimum standards. Some states may require, for example, a certain minimum cost recovery, or a maximum cost per passenger trip. Certainly if such norms or standards exist, the performance analysis must acknowledge them.

In practice, a complete performance evaluation will include all three types of comparisons, with

the time-series presentation of results being the most common and achievable for all indicators. Peer group comparisons will likely be possible for some indicators, but may not be possible or appropriate for others, such as safety or customer satisfaction measures where data is not collected or reported in the same way for a group of peer systems. Finally, the comparison of performance measures against norms or standards will be very limited since few such norms exist.

5. Presentation of Results

Effective presentation of the results of a performance evaluation is an integral part of the evaluation process because it not only helps the manager to interpret the results (the previous step), but it also allows the manager to communicate the results to outside constituencies. Because people think in terms of pictures rather than words or numbers, graphical presentations are often the most effective way to accomplish both objectives. While modern microcomputer hardware and software (spreadsheet and business graphics programs) allow for cost-effective production of professional graphics and can greatly speed the analysis and presentation of evaluation results, the techniques described in this guide can also be effectively implemented manually. The case study example presented later demonstrates several graphical formats for presenting performance results.

6. Take Corrective Action and Monitor Results

The final and most important step in the evaluation process is the corrective actions that will be taken by the manager and/or policy board to increase the efficiency or effectiveness of the system. This step is certainly the most challenging and creative part of the process, but it also may require difficult choices regarding the level of service offered or the resources used to provide the service. Common problems and possible corrective actions for paratransit systems are described and illustrated in the case study described later.

Once the corrective actions are implemented, the evaluation cycle begins again with a review of the goals, indicators, and data collection. Then, during the next review cycle, the results of the previously implemented corrective actions are evaluated using the next period's performance results, and additional corrective actions can be taken as needed.

Paratransit Performance Evaluation[4]

Collecting and tabulating the operating and financial data required to calculate performance ratios is the most time-consuming performance evaluation related task. However, this task need not be difficult if the record-keeping system is planned so that it produces the necessary information. While many shared-ride systems now use computers to maintain service records and prepare driver logs, the evaluation framework described in this guide does not require such an automated system to produce the necessary data.[5] A comprehensive, accurate manual system can also yield the necessary statistics. Nevertheless, advanced planning is required to ensure that the basic records of the shared-ride system (e.g., the driver log, the monthly finance report, the complaint log, accident files) are designed to capture the needed statistics at the level of detail required.

This section describes how the required data elements can be collected and applied to the paratransit evaluation. Table 1 lists the performance indicators to be calculated, the data elements required to calculate them, and the source used to obtain each element. Certainly the list of indicators presented in table 1 is not exhaustive, and the manager of a shared-ride paratransit system may wish to modify this list to reflect the goals and objectives of the individual system. Nevertheless, the basic data collection and tabulation procedures will illustrate the key issues associated with data collection.

As shown in the table , the two primary sources for the 13 data elements used to calculate the 10 indicators are the driver log that records the daily activity of each shared-ride vehicle, and the system's financial records--primarily the monthly income statement, which summarizes the system's revenue and expenses. The following section describes how the daily driver log can be used to collect most of the operating data required for the performance analysis. Because the expense and revenue statistics required for the performance evaluation often require special treatment, especially if expenses
and revenues are to be assigned to specific vehicles or types of service, tabulation of the financial data will be dealt with elsewhere.

Four data elements used in the performance evaluation are not derived from financial records or the driver log. These items --avoidable accidents, service-related complaints, paid driver hours, and senior citizen population-- must be tabulated from other records. The six data elements derived from the driver log are discussed in the following section along with a brief discussion of the accident, complaint, population, and paid driver information required. Cost allocation procedures for paratransit are essentially the same as for fixed route transit and are discussed elsewhere.

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[4] Portions of this section are adapted from James H. Miller, Shared-Ride Performance Guide, prepared for the USDOT, Urban Mass Transportation Administration; September, 1989.

[5] For more information on available paratransit software see Lave, Roy E. and Piras, Pat, A Handbook for Acquiring Demand-Responsive Transit Software, TCRP, TRB, NRC, July 1996.

Table 6: Data Requirements for Paratransit Evaluation - Data Requirements for Shared-Ride Paratransit Evaluation

Performance Measure	Data Element	Source of Data
	Operating Efficiency	
1. Operating expense/vehicle hour (a)/(b)[1]	a. Operating Expense	Finance report
2. Administrative expense/total expense (c)/(a)	b. Vehicle hours	Driver log
3. Live hours/paid driver hours (d)/(e)	c. Administrative expense	Finance report
	d. Live hours	Driver log
Effectiveness	e. Paid driver Hours	Payroll
4. One-way passenger trips/vehicle hour (f)/(g)	f. Total one-way passenger trips	Driver log
5. Senior citizen one-way passenger trips/ senior citizen residents of service area (h)/(g)	g. Senior citizen population	Driver log
	h. Senior citizen one-way trips	Driver log
	i. Service-related complaints	Complaint log
Service Quality	j. On-time pickups	Driver log
6. Service-related complaints/1000 one-way passenger trips (i)/(f)	k. Total passenger revenue	Finance report
7. On-time pickups/total pickups (j)/(f)	l. Avoidable accidents	Accident log
	m. Vehicle miles	Driver log
Financial		
8. Operating expense/one-way passenger trip (a)/(f)		
9. Revenue/one-way passenger trip (k)/(f)		
Safety		
10. Avoidable accidents/100,000 vehicle miles (l)/(m)		

[1] Formula and data elements required to calculate performance measure

Data Items Derived from the Driver Log

The driver log, used by the paratransit vehicle driver to record daily trip activity, provides the raw data for 6 of the 13 data elements required for the proposed evaluation framework. While the information contained on the driver log varies widely among systems due to differences in funding agency data requirements and operating procedures, the driver log shown in figure 2 is typical of those used by specialized transit providers.

Typically, a driver is given a daily log that already lists the trips scheduled for the day, including the scheduled pick-up time, the person's name and the address of the trip origin, and the trip destination. Once the transportation is provided, the driver completes the log by entering times and odometer readings for the pick up and delivery of each passenger. In addition, the driver completes the information at the top of the log that describes the vehicle and driver's activity for the entire day. One common variation to the procedure described above occurs when taxis are used to provide shared-ride service and trip requests are radio-dispatched to drivers rather than provided in advance for the entire day. In this situation, all information is recorded by the driver as the trips are provided. In either case, however, information such as that contained on the sample driver log shown in figure 2 is required for the performance evaluation; therefore, a shared-ride system that does not presently record this information must modify its data collection procedures to obtain these data. To help determine if a driver log in its current form provides the required information, each of the data elements listed on the log are defined in table 2-4.

The next section defines each of the driver log-derived data elements and describes how each can be tabulated using information from the driver logs.

Figure 2: Sample Shared-Ride Driver Log. Sample Shared-Ride Driver Log.

CARRIER NAME _____ PARATRANSIT DRIVER'S LOG DATE _____

LOG NUMBER _____ ENDING ODOMETER READING _____ STARTING TIME _____

VEHICLE ID _____ BEGINNING ODOMETER READING _____ ENDING TIME _____

DRIVER NAME _____ TOTAL VEHICLE MILES _____ TOTAL TIME _____

TRIP ID	PASSENGER	NAME OF PASSENGER	TRIP CLASS			ORIGIN	DESTINATION	ODOMETER		PSGR. MILES	TIME		TOTAL FARE	PSGR. FARE	ZONES
			65+	NAMB	PURP			ON	OFF		ON	OFF			

Table 7: Explanation of Driver Log Entries.

	Item	Explanation
1	Carrier Name	Name of service provider.
2	Date	The date that the trips listed on the log were made
3	Log Number	Any unique number that can be used to identify log sheet during the tabulation of data.
4	Vehicle ID	A letter, number, or other unique identification.
5	Driver Name	Enter the driver's name. If log stays with the vehicle rather than with the driver, and a vehicle has more than one driver in a given day, list all drivers.
6	Ending Odometer Reading	The odometer reading of the vehicle once it is parked for the day.
7	Beginning Odometer Reading	The odometer reading of the vehicle at the start of the day.
8	Total Vehicle Miles	Difference of the ending odometer reading (6) and the beginning odometer reading (7).
9	Starting Time	The time, to the nearest five minutes, when the vehicle is first available to provide service.
10	Ending Time	The time when the vehicle is removed from service.
11	Total Time	The total driver hours for the vehicle by determined by calculating the difference between the starting time (9) and ending times (10).
12	Trip ID	An identifier for each trip.
13	Sched. Pick Up Time	The time that the trip was scheduled to be made
14	Name of Passenger	The last name and at least the first initial of the rider
TRIP CLASS		Items 15, 16, 17 allow the provider to categorize trips by purpose or characteristic of the rider. The categories listed are typical of the types of designations used but may be modified to a particular system's needs.

15	65+	Check to identify trips made by persons 65 years or older.
16	NAMB	Check to identify trips made by nonambulatory persons.
17	PURP	Enter code for type of trip, e.g. M for medical, S for shopping, etc.

Table 2. Explanation of Driver Log Entries (continued).

	Item	Explanation
18	Origin	Origin of the trip.
19	Destination	Destination of the trip.
20	Odometer Reading ON	Odometer reading when the passenger boards the vehicle.
21	Odometer Reading OFF	Odometer reading when the passenger gets off the vehicle.
23	Time ON	The time when the passenger gets on the vehicle to the nearest 5 minutes.
24	Time OFF	The time when the passenger gets off the vehicle to the nearest 5 minutes.
25	Total Fare	The total fare due for the trip.
26	Psgr. Fare	The fare collected from the passenger.
27	Zones	The number of grids or zones charged (if applicable).

Definitions and Tabulation methods for Driver-Log Based Data

Vehicle Hours

Definition: **Total time during which a paratransit vehicle is available to provide service**. Lunch breaks, pre-trip inspection time, and scheduled or unscheduled maintenance periods are not included as part of the vehicle-hour statistic since the vehicle is not available for service.

Method of Tabulation: Total vehicle hours can be calculated for the overall system by summing the number of vehicle hours of service provided by each vehicle each day. Data element (12) on the driver log provides this information for each vehicle each day.

Vehicle hours for specific vehicles or groups of vehicles can be tabulated by totalling individual vehicle hours for the desired vehicles. However, if a specific vehicle provides two or more types of service during the day, a more detailed tabulation method is needed to determine the total vehicle hours required to provide a particular service. For example, in Pennsylvania, taxi operators commonly provide shared-ride as well as exclusive-ride taxi service using the same vehicle and driver. Therefore, to determine the number of vehicle hours devoted to paratransit service, the time spent on the two types of service must be separated.

If a vehicle is used a portion of the day for one type of service, and then at other times for other services, vehicle hours can be determined by totaling the hours spent in each type of service. However, if paratransit and other types of trips are intermixed throughout the day, this method will be cumbersome.

One approach used by some operators faced with this problem has been to prorate the vehicle hours devoted to each type of service based on the number of live hours associated with each service. For example, if 30 percent of the live hours (time when passengers are being transported) are associated with paratransit service, then paratransit vehicle hours for that vehicle are assumed to be 30 percent of the total. So, if a vehicle is available for 10 hours of service on a particular day, and if 30 percent of the live hours derive from paratransit service, then 3 vehicle hours of service (10 hours x 30 percent) are assumed to be provided. This calculation is based on the reasonable assumption that the amount of dead time (time when no passengers are on board) is proportionately the same for both the paratransit and non-paratransit service.

Live Hours

Definition: **The amount of time vehicles are in use providing shared-ride service when passengers are on the vehicle**. Dead time--the difference between total vehicle hours and live time--includes both the time that the vehicle spends enroute between trips, and unproductive time when no trips are requested. This measure is an indicator of dispatcher effectiveness and also gauges how well a system matches its services (vehicle hours) to the demand for the service. The goal of a shared-ride system is to maximize the amount of live time that vehicles and drivers are in service.

Method of Tabulation: Total live hours of service for a paratransit system are tabulated from a detailed analysis of the driver log. The simplest way to calculate this measure is to

examine the driver log to determine the amount of time the driver is not transporting persons (dead time) and subtract it from the total vehicle hours that the vehicle was in service that day. The dead time is determined by scanning the starting and ending times on the driver log to determine when the vehicle did not have passengers on board and noting the number of minutes without passengers in the margin along the edge of the log. The total live time can then be derived by totaling the number of dead minutes, dividing this number by 60 to determine dead hours, and then subtracting this result from the total vehicle hours listed at the top of the log.

One common error that should be avoided when calculating this measure is double counting of live time when more than one person is on the vehicle. This error results from calculating live time by summing the total riding time of all passengers rather than just the total amount of the day that the vehicle was transporting passengers. For example, if four persons were on a vehicle from 9:00 am until 9:20 am, the total amount of live time would be 20 minutes. The incorrect calculation would result in 80 minutes (4 passengers x 20 minutes) being tabulated as live time. The 80 minutes, which represents the number of passenger minutes of service provided, may be a desired performance indicator, but it is not the one used in this analysis.

Total One-Way Passenger Trips

Definition: **The total number of individual rides provided to individuals where each separately scheduled segment of a ride constitutes a one-way passenger trip**. For example, if a passenger rides from home to a doctor's appointment, from the doctor's appointment to a shopping center, and then home, a total of three one-way passenger trips have been provided. Similarly, if 15 senior citizens are transported to and from a senior nutrition program, 30 one-way passenger trips of service have been provided.

Method of Tabulation: Total one-way passenger trips is a very simple statistic to tabulate once the basic definition of the measure is established. Assuming that each entry on the driver log represents an individual one way trip, total one-way trips can be tabulated by summing the number of entries on each log.

Though total ridership as measured by one-way passenger trips is the performance measure used in this evaluation, most shared-ride systems will want to maintain more detailed ridership records that indicate the number of one-way trips provided to different categories of riders or for different trip purposes. These more detailed statistics may be required by funding agencies or may be used by the system to describe the benefits derived from the transportation program. For example, systems commonly tabulate the number of seniors, people with disabilities, low-income, or other target population riders that they serve. The trip classification fields on the driver log allow for this recording of subcategories of ridership.

Senior Citizen One-Way Trips

Definition: **The number of one-way passenger trips provided to persons 65 years or older**. Because a goal of many paratransit systems is to provide mobility to the elderly population, this particular subcategory of ridership is specifically identified and reported. However, a system's effectiveness in serving other target populations may also be measured by adding or substituting other measures such as the number of low-income one-

way passenger trips provided, or the number of non-ambulatory one-way trips provided.

Method of Tabulation: The number of one-way passenger trips provided to senior citizens or other specified subgroups can easily be calculated if riders are identified as belonging to the category being studied. The trip classification fields on the driver log allow for this categorization. Total senior citizen one-way passenger trips can be tabulated by totalling from the driver log the number of trips by this category of rider.

On-Time Pickups

Definition: **The number of one-way passenger trips where the actual pick-up time is within the tolerance desired from the requested pick-up time**. For example, if the system established that on-time was within plus or minus 15 minutes, then a trip would be considered on time if the driver arrived for the pick up within the time period 15 minutes before or after the requested time.

Method of Tabulation: The total number of on-time trips is determined by comparing the scheduled and actual pick-up times on the driver log. Because of the time required for this examination and tabulation, one might elect to sample this measure by randomly selecting a day's or a week's set of driver logs (depending on the size of the system) for analysis of this measure. The performance measure that uses this data element, the percentage of on-time trips, requires two statistics, the number of on-time trips and the number of total trips. Therefore, in sampling this statistic, be sure to also determine the total number of one-way trips provided during the sample period so that the percentage statistic can be calculated correctly.

Vehicle Miles

Definition: **The miles operated by vehicles are measured by the vehicle odometer**. The statistic includes miles operated with and without passengers.

Method of Calculation: Total vehicle miles can be determined in one of two ways. First, vehicle odometer readings at the end of each reporting period can be used to calculate vehicle miles. Second, the number of vehicle miles listed on each driver log can be summed. The second way is preferred since it may be a more accurate measure of vehicle miles of service, especially if the vehicles are also used for other purposes and if these miles would be included if the periodic odometer readings were used to tabulate this measure.

If during a given day a vehicle is used to provide services other than paratransit, and the exclusion of mileage resulting from these other services is desired for analysis, then a procedure similar to the one described above for vehicle hours must be followed to prorate the total daily miles among the various services provided by the vehicle. In the case of vehicle miles, this method requires that total vehicle miles be apportioned in a ratio equal to the proportion of live miles (miles with passengers on board) provided for each type of service. As with the vehicle hour estimate, this method of using live miles to apportion total miles assumes that dead miles (miles driven without passengers on board) are in proportion to live miles for all categories of vehicle use

Miscellaneous Paratransit Data Items

In addition to the six driver log-based data elements described above and the three financial data elements considered in the next chapter, the proposed performance evaluation framework requires four data elements derived from other system records. Definitions and tabulations for these measures (paid driver hours, avoidable accidents, service-related complaints, and senior citizen service area population) are presented below.

Paid Driver Hours

Definition: The time for which compensation is paid to drivers to operate vehicles in paratransit service. For operations using commissioned drivers (e.g., taxi operators), paid driver hours may equal live hours. Paid driver hours will usually exceed vehicle hours due to pretrip inspection time, paid meal breaks, vacations, and so forth, which result in drivers being paid for time when service is not available.

Method of Tabulation: Paid driver hour data may be obtained from one of two sources. If drivers only provide paratransit service, or if it is easy to segregate driver hours paid for paratransit service, payroll records will provide an accurate source for this data element. However, if drivers provide paratransit service along with other services, and it is not possible to easily document the number of hours spent providing each type of service, then a method of estimating paid driver hours based on live time will be required. Again, as recommended in the section describing the tabulation of vehicle hours, when several services are provided by the same driver, the best way to allocate paid driver hours is to assign them to each service based on the proportion of live hours devoted to that service.

As defined for this evaluation, paid driver hours are those for which the vehicle operator is compensated. If all operators are paid drivers, then this measure will truly reflect the productivity of the paratransit service. However, if volunteer drivers are used, as is the case for many specialized providers, special care must be taken in calculating the performance measures that use the paid driver statistic. Perhaps the simplest way to accommodate volunteer drivers is to modify the definition of "paid driver hours" to include the volunteer time. Doing so will allow valid calculations of one-way trips per hour and live time to paid driver hours. Alternatively, the trips provided by the volunteers and the live time involved in providing these trips should be excluded from the totals for these measures. If the live time and passenger trips provided by volunteers are not excluded, and total trips and live time ar divided by only the paid driver hours, the actual amount of time required to provide the transportation will be understated, thus distorting the values of the performance indicators

Avoidable Accidents

Definition: All passenger or collision-type accidents involving revenue vehicles, whether in service or on system property, that, as determined by the system manager, police, and other investigators, resulted from infractions of either motor vehicle law or system policy by the transportation system's operator.

Method of Tabulation: The number of avoidable accidents can be tabulated by simply

keeping a count of all such occurrences. The most difficult aspect of this performance measure is not its tabulation. Often the determination of whether an accident was avoidable will be difficult. Such a determination is often important not because the number will be used in a performance indicator, but rather, because employee discipline or other action may be involved. If the police report does not assign fault, or if other circumstances do not present easy identification of the cause of the accident, it may be necessary to seek third-party interpretation of the results.

Because paratransit systems may define "avoidable" in different ways, care must be taken when making cross-system comparisons of this indicator. Once peer systems are selected for this measure, the system manager should be contacted regarding this definition to ensure that comparable data are evaluated.

Service-Related Complaints

Definition: The number of concerns expressed by riders and nonriders above adverse operating practices and/or equipment. Service-related complaints are distinguished from policy-related complaints in that policy complaints (such as inadequate service hours or service area, or too high a fare) are related to actions taken by funding agencies or policy boards and are not directly within the control of the system manager. Ideally, a paratransit system should track both types of complaints; however, the quality of service can best be monitored by the more narrowly defined service-related complaint measure.

Method of Tabulation: Again, as for the case of the accident data, the key to obtaining service-related complaint data is to clearly define the meaning of the measure and then set up a system to log and count the number of complaints. A paratransit system should maintain a written record of all telephone, driver-relayed, and written complaints that not only records the complaint, but also indicates the follow-up action taken by the system management.

Senior Citizen Service Area Population

Definition: The number of persons age 65 or older living within the system service area. Senior citizen population is just one of several target population statistics that might be used. If a primary goal of the shared-ride system is to serve low-income residents, a measure such as number of one-way trips by low-income persons per low-income population in the service area could also be calculated.

Method of Tabulation: Senior citizen population data can be derived from U.S. Census data since paratransit systems are demand-responsive and usually define their service areas in terms of discrete political subdivisions. Even if the service area boundaries do not follow municipal or county boundaries, census track data can be used to estimate the target population within a service area.

In addition to the 10 data elements described in this section that are derived from the driver logs, other system records, and census data, three very important financial data elements must also be obtained to conduct the proposed performance evaluation. These measures, total operating expense, administrative expense, and total revenue, are discussed elsewhere.