Performance Measurements

Purpose for Establishing Service Standards

Service standards reflect performance goals set by a transit agency to define where transit service is performing at inadequate, adequate, or superb service levels. Individual route performance can be compared to appropriate standards to determine how well the service is performing with respect to specific measures. PART will need to continually monitor the performance of its transit service to identify ways in which productivity can be improved on all existing routes, and to provide guidance where new routes are justified. Applying an established method of measuring performance and well-defined indicators will allow PART to make planning decisions based on solid data. Through a long-term application of service standards, PART can monitor changes in route performance, determine which operating strategies will attract greater ridership and revenue, and then apply such strategies to areas of the system that are underperforming. Also by sharing information on service performance and service standards with the public, PART will be able to demonstrate greater transparency and accountability in the managing the use of public funds for transit service. This chapter presents a potential framework for such standards and design guidelines associated with new PART transit services.

Overview of Performance Indicators and Standards

Three basic types of service indicators are typically applied by transit agencies, related to:

- Service Attractiveness
- Cost Effectiveness
- Cost Efficiency

Service Attractiveness measures how much travel is obtained per unit of service. This dimension of service evaluation is the one most focused on the ability to meet customer needs. PART routes with the greatest service effectiveness meet the needs of the greatest number of people per unit of service. Examples of service effectiveness measures include:

- Passengers Per Vehicle Revenue Mile
- Unlinked Passenger Trips Per Vehicle Revenue Hour
- Peak Load Factor

Cost Effectiveness measures how much cost is incurred per unit of travel. This dimension of service evaluation is the one most focused on the value obtained for the dollars invested in transit. Citizens and politicians will want to ensure that PART is spending funds wisely. Examples of cost effectiveness measures include:

- Cost Recovery Ratio
- Operating Cost Per Passenger Mile
- Operating Cost Per Unlinked Passenger Trip
- Subsidy Per Passenger Trip

Cost Efficiency measures how much cost is incurred per unit of service. This dimension of service evaluation is most focused on the productivity of transit operations. By having knowledge of the cost structure on different routes, costs can be kept as low as possible while meeting safety and operating rules. Such measures also provide insights on the cost of providing service in areas which are currently un-served or underserved. Examples of cost efficiency measures include:

- Operating Cost Per Vehicle Revenue Hour
- Operating Cost Per Vehicle Revenue Mile

In addition to these three basic categories of service standards, a fourth category can be applied that measures the degree to which land use patterns and policies shaping urban form encourage the use of transit. PART could operate high-quality services, but citizens may not ride due to a number of land use conditions or policies over which PART has no jurisdiction. Improvements to the environment in which transit operates could have more of an impact on ridership than investments in the transit system itself. Triangle Transit in the Raleigh-Durham-Chapel Hill area has categorized these as Environmental Support measures. Examples of environmental support measures include:

- Quality, quantity, and interconnectivity of pedestrian facilities
- Quality, quantity and interconnectivity of bicycle facilities
- Proximity of different land uses
- Amount of free parking at major activity centers
- Walking distance from major residential areas to transit system
- Number of people living within ½-mile of the system

Recommended Service Performance Standards

To assess the performance of its transit service, PART should use the following measures:

- Unlinked Passenger Trips Per Vehicle Revenue Hour
- Cost Recovery Ratio
- Operating Cost Per Unlinked Passenger Trip
- Subsidy Per Passenger Trip
- Unlinked Passenger Trips Per Vehicle Revenue Mile

These five measures are applied by the neighboring regional system, Triangle Transit. A review of service performance standards used by other transit systems also indicates widespread adoption. The rationale for applying such measures is:

- ***Unlinked Passenger Trips per Vehicle Revenue Hour*:** This measure is proposed as a primary indicator of route performance. It is a direct indicator of service effectiveness and a strong indicator of cost effectiveness (passengers are the primary determinant of fare revenue, and hours are the primary determinant of cost effectiveness). Also passengers per revenue hour can be easily measured with a high degree of accuracy.
- ***Cost Recovery Ratio*:** It is expected that the PART Board of Trustees would want to use this indicator to measure progress in achieving cost effectiveness of future transit services. It is also a primary way to measure the effectiveness of the system's fare structure.
- ***Operating Cost per Unlinked Passenger Trip*:** Another cost effectiveness measure, this measure indicates whether more costly services with a high number of deadhead miles are worth the number of passengers which use the service.
- ***Subsidy per Passenger*:** This measure is typically applied in conjunction with the Cost Recovery Ratio. A route where both measures are declining means more people are riding with less revenue, typically during promotional periods when free passes are distributed. Subsidy per rider identifies routes with poor Cost Recovery Ratios that may improve when promotional periods end. Also falling subsidy per passenger (perhaps due to more people riding but using passes) is a way to show that PART is more judiciously investing in its system.
- ***Unlinked Passenger Trips per Vehicle Revenue Mile*:** This measure helps to determine the number of Vehicle Miles Travelled (VMT) by PART passengers, providing an indication of the potential air quality benefits to the Triad region associated with resident use of transit.

Potential Service Evaluation Framework

Although there are numerous examples of regional express transit service standards applied by transit agencies across the country, the best example to a system similar to PART is provided by Triangle Transit. This transit agency has applied a framework for addressing service evaluation that would be applicable to PART, recognizing that the systems provide regional express services from multiple outlying areas to similarly sized central city/employment areas – Raleigh, Durham, Chapel Hill and the Research Triangle Park for Triangle Transit compared to Greensboro, Winston-Salem and High Point for PART.

Triangle Transit's service evaluation framework focuses on a tiered approach addressing:

- System Characteristics Standards

- Existing Route Performance Standards
- New Service Standards
- Special Events/Demonstration Services

System Characteristics Standards

Local Financial Participation

Because the PART board approves the total number of service hours to be provided in a fiscal year, a set of regional equity measures should be applied in allocating service in as equitable a manner as possible. Regional bus service provision in individual counties should reasonably reflect county financial participation in covering PART operating costs. Recommended measures to identify regional equity include total service hours, peak period service hours, and service span. The cost and productivity of services provided in each county should also be identified.

Title VI

PART should regularly evaluate its services to assess compliance with Title VI regulations to ensure that minority and low income populations are treated equally in the provision of PART service. This includes relating existing PART service to designated demographic and socioeconomic maps identifying the location of such populations. In addition, specific indicators that compare predominantly minority/low income census tracts with predominantly non-minority census tracts should be monitored to identify any disparities in PART service. Such measures could include:

- Load factor
- Vehicle assignment (age of vehicle, level of repair, types of vehicles assigned)
- Vehicle headway
- Distribution of passenger amenities (shelters, benches, etc.)

Non-Traditional Services

While PART provides traditional fixed-route services, other non-traditional services may be appropriate in certain portions of the PART service area. These services should be considered where fixed-route service is projected to yield low cost recovery ratios. Some non-traditional service concepts which could be considered include:

- Deviated Fixed-Route Services
- Flex Routes within Specified Corridors
- Feeder Services
- Employer Subscription Bus Service
- Volunteer Driver Trip Reimbursement
- On-Call Shared Taxi
- School Bus-Based Public Transit

Existing Route Performance Standards

Useful comparisons to other bus systems, other than Triangle Transit, are currently limited based on 1) the small number of peer services in the United States, 2) the multi-centered Piedmont Triad region and 3) the extensive service area of eight outlying counties. Because a similar situation existed when Triangle Transit adopted its regional service standards in 2004, PART should initially adopt "relative" (centered on system wide averages) as opposed to "absolute" standards. As benchmarking improves from the application of relative service standards, the long-term goal will be to develop appropriate absolute standards.

Based on the five indicators previously discussed, each current PART route should be evaluated with respect to existing performance, with the primary indicator being Unlinked Passenger Trips per Vehicle Revenue Hour. After these indicators have been measured, averages should be determined for each indicator. The system wide averages will serve as a benchmark (or standard) to which individual routes will be evaluated. System wide averages should be developed for the following periods:

- Weekday peak period
- Weekday daytime
- Weekday evening
- Weekend

Once averages have been identified, each route would be classified as Low, Average, or High-Performing for each measure. Each classification is proposed to be defined as follows (similar to Triangle Transit's definition):

- *Low-performing:* Indicator value is less than 75 percent of system average.
- *Average:* Indicator value is equal to or greater than 75 percent but less than or equal to 125 percent of system average.
- *High-performing:* Indicator value is greater than 125 percent of system average.

A total performance score could be calculated if each rating is assigned a number, such as 1 for High-Performing, 2 for Average-Performing and 3 for Low-Performing. The selected indicators would be measured for existing PART route for different route segments and for the overall route. Route segment-level analysis would be used to evaluate minor route pattern or timing changes. Based on this stratification of existing route performance, specific actions could be undertaken to improve service performance. A strategy applied by Triangle Transit that may be applicable to PART is:

1. Routes those are Low-Performing against one or two indicators:
    - Small adjustments in routing or service frequency/span, preserving the format and major route destinations.

- Targeted for specific marketing actions.

2. Routes those are Low-Performing against three to five indicators:
   - Potential major adjustments, rerouting, or schedule changes.
   - If a route is low-performing against three or more indicators for nine months, PART should consider elimination of the route.

3. Routes those are High-Performing according to one or more indicators:
   - Priority to passenger amenity improvements such as shelters, benches, passenger information systems, etc.
   - Marketing programs should concentrate on leveraging existing riders to attract new riders.

Improvement measures could also be segregated by ranges of total performance scores across all performance indicators. If over 25 percent of an existing route is proposed for change, at least one public meeting should be held to obtain citizen comment on how the change would impact existing riders and the overall community. Changes to less than 25 percent of a route would not require a public meeting.

New Service Standards

PART should have standards to identify when a new transit service should be established. Elements of new service evaluation are discussed in the following sections.

Density Analysis

New transit service should reflect minimum population or employment density in areas where stops would be located. The following density calculation and assumptions were used as a measure for transit supportive areas in the Triad:

Transit Supportive Areas = Population + (2 x Employment)/square mile

Where:

- < 3500: No or minimum service
- 3501 - 5000: Demand Response Service
- 5001 - 7500: Hourly Frequency
- 7501 - 10000: 30 Minute Frequency
- 10010 - 12500: 15 Minute Frequency
- 12510 - 15000: 10 Minute Frequency
- 15000+: Rapid Transit

Demand Analysis

In addition to traversing areas of minimum density, potential new routes should reflect demand expressed through the PART customer service center or website, or through attendance and comments at public meetings held about a potential route.

Service to Key Destinations

New service may be justified to serve key trip destinations not currently served, including new employment centers, medical facilities, public facilities or other attractions.

Application of Standards

A new route would be judged by the same standards as existing routes in order to determine whether a route is Low-Performing, Average, or High-Performing. The initial evaluation would occur six months after establishment of the new route, with standards set during this initial period at 75 percent of the regular performance standards. After an initial one-year period, the new route would be evaluated with other routes at 100 percent of the standard.

Special Events/Demonstration Services

PART should consider adopting guidelines for providing special events and demonstration services. A new transit service could be initiated for less than one month as a demonstration service and would not be subject to the regular standards for new service. Demonstration services allow PART to implement service concepts without a long-term commitment to funding to evaluate a concept where patronage may be difficult to estimate. Such services would likely focus on special events, such as sporting events, annual fairs and special exhibitions, and other seasonal services.

To be considered for special bus services, events should meet some basic criteria:

- Must be open to the general public
- Must be located within the PART service area
- Must have a feasible operations plan, including adequate bus and driver availability, passenger loading and bus layover space near the venue, and assigned road supervisors
- Must achieve productivity equal to or better than the system average

New Service Design Guidelines

The following guidelines should be considered in the design of new PART services and routes:

- Route directness
- Transit to auto travel time
- Short-turns
- Branching

- Loops
- Service pattern
- Scheduling design

Route Directness

Route directness can be measured for a route in terms of distance or time. A coefficient of directness measures the ratio of the route length to the actual distance between route termini, either as the crow flies or via major corridors. Some systems propose a maximum time limit for all deviations from the main route, such as eight minutes total per trip, or require at least ten boardings along the deviation segments.

Several transit systems have used an out-of-direction (OOD) measure to address route directness. This involves evaluating each deviation in a route with respect to travel time and passenger activity along the deviation and the number of through passengers. The model calculates person minutes of delay per passenger served along the deviated segment using the following formula:

$$\textit{OOD Impact Index (minutes)} = \frac{\textit{Through Ridership} * \textit{Additional OOD Travel Time}}{\textit{OOD Ridership}}$$

Where: the OOD Impact Index is a weighted measure of time, expressed in minutes.

Through ridership is the difference between the number of passengers on board the bus prior to the OOD segment and the number of passengers alighting along the OOD segment. OOD Travel Time is the net increase in travel time that is required to operate the OOD segment rather than the direct alignment, and OOD ridership includes all boardings and alightings that occur on the OOD segment.

A threshold of three to five minutes is often used to determine whether to continue the deviation (if less than the threshold) or to straighten the route. For express routes, it is also typical to set a maximum limit for the time spent on the local collector portion of the route. For PART services, a deviation threshold of five minutes should be appropriate. For local collector portions of PART express routes, no more than 15 minutes or 50 percent of the line-haul travel time should be an appropriate guideline.

Comparison of Transit and Auto Travel Times

Passengers may consider a longer trip by transit than by driving as being less convenient although this may be mitigated somewhat if the on-board travel time can be used productively. *The Transit Capacity and Quality of Service Manual, 3rd Edition* associates different levels of service with ranges of differences in transit versus auto travel time. An appropriate guideline for new PART express service would be to have the transit travel time no more than one-third higher than auto travel time along the same route.

Bus Stop Spacing

General guidelines call for bus stops in urban areas (applicable to new express route circulator routes) to about every 700 feet, or between seven and eight stops per mile. Stops can obviously be spaced more closely in high-activity areas or areas which serve special needs such as medical facilities or elderly housing. A review of transit systems in the United States found that most operators used a standard of six to eight bus stops per mile outside of the central business district. In less densely developed suburban areas, bus stops located every 1,500 feet are suitable.

With regard to placing passenger amenities at bus stops, a shelter or bench should be provided at bus stops with at least 25 existing or planned daily boardings, and benches provided at stops with at least 15 daily boardings. Shelters and benches should also be considered within a quarter mile of medical facilities and social service agencies.

Route Branching

Branching refers to the splitting of a route along two different paths. The branches can re-join into a single route after the split, or continue separately to different destinations. Branching increases route coverage at the expense of route frequency and simplicity. Branches that re-join can be treated as deviations under the out-of-direction model described under "Route Directness." End-of-line branches are more difficult to analyze. Some systems have established minimum productivity requirements for end-route branches in their service standards.

Route Loops

Unless a route has an off-street terminal, it loops around the block to change direction at the end of the route. When routes have large one-way loops at their ends, passengers may have to ride a considerable distance out of their way in one direction. Some systems have a policy to avoid one-way loops, branches, and route deviations when possible.

Service Patterns

From the customer perspectives of simplicity and ease of understanding, a bus route should operate in the same fashion on each trip. Deviations and branches introduce additional complexity. Standards regarding deviations and branches will affect the number of service patterns, but it may be worthwhile to include a policy statement to minimize the number of service patterns on a given route.

There is one service pattern that may be applicable in certain situations. Short turns truncate or begin service on a route at an intermediate point, and are very useful in balancing service levels with demand and reducing overcrowding on close-in route segments during peak periods.

Schedule Design

Standards regarding schedule design address issues such as loading standards on individual trips, headways, span of service, and scheduling techniques such as the use of "clock face"

headways (when the bus arrives at a given stop at the same time each hour during a given portion of the day).

Typical loading guidelines specify loads of no more than 125 percent of seated capacity on local routes during peak periods, and no more than 100 percent on express routes and on local routes during the off peak. These guidelines would be appropriate for PART express and local/circulator services. Express loading standards are lower because of the distances involved in express service. Some larger systems include a time factor, e.g., the loading standard may not be exceeded for over 10 or 20 minutes. Others require corrective action only if a certain percentage of trips (20 or 25 percent) exceed the loading standard. In the case of PART regional express routes, a loading standard of not more than 20 minutes would be appropriate.

Headways are generally driven by passenger demand, but many systems adopt policy headways that specify a minimum frequency of service. Guidelines recommending policy headways of 30 minutes during peak periods and 60 minutes during off-peak periods are typical for larger urban systems. Adoption of policy headways allows routes to operate more frequently, depending on demand, but not less frequently. Policy headways appear appropriate for PART local service and express service.

Span-of-service is not addressed in service standards from peer systems. For large transit systems, it is not uncommon for service spans on weekdays to extend to 20 hours a day, with weekend service on both Saturdays and Sundays over fewer hours per day. For circulator or local routes in the Triad, a more limited service span would be appropriate, to cover at least 12 hours with possibly Saturday service. For PART express routes, operating up to 14 hours per day (6:00 AM to 8:00 PM) would be appropriate.

"Clock face" headways (e.g., 10, 12, 15, 20, 30, or 60 minutes) result in the bus serving a given stop at the same time each hour over a given time period. This operating approach makes it easier for riders to remember schedules. Strict adherence to clock face headways can create scheduling inefficiencies, depending on route length and cycle time. A few medium-sized transit systems address "clock face" headways in their service standards; however, several larger systems do adopt this approach. A service standard for "clock face" headways is not necessary for PART operations.