# Guidelines for Planning Public Transportation Terminals

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**The considerations necessary in the planning of transit stations from the viewpoint of the transit user and the operator are described. The basic function of a transit station is to process the flow of passengers between modes. A station also serves to attract the user to the system and it provides space for service functions, access, and joint development. Transit stations should be designed for the convenience, comfort, and safety of the passenger. A clearly defined pathway is essential and will reduce the need for information, improve safety and security, and facilitate consumer services. Station operations are enhanced by the provision of sufficient exit and entrance facilities, dependable fare-collection equipment, and adequate platform dimensions. Maintenance should be considered in the planning process, and operating personnel are essential members of the design team. The station design experience of the three major new U.S. systems—San Francisco, Atlanta, and Washington, D.C.—is reviewed, and a brief outline is presented of the elements of a transit-station design methodology that, if used, can assist to incorporate both policy and design considerations into the station design planning process.**

The planning and design of intermodal transit facilities are of significant concern in the development of a regional metropolitan rapid transit system. The basic function of a passenger terminal is to process the flow of passengers between modes--that is, to assist in the transfer of passengers from one mode or vehicle to another, in an efficient, convenient, comfortable, and safe manner. The fundamental purpose of a transit station is to transfer passengers between modes within a transportation network (1).

The manner in which a station design is successful in accomplishing its primary purpose, smoothly, continuously, and in a pleasant environment, will strongly influence the degree to which the system is accepted by the riding public. A poorly designed station can affect the advantages of the line-haul rapid transit portion of the trip if the perceived impedances within the station are sufficiently great that they outweigh the gains of the between-station portions of the trip.

Terminal planning and design are especially critical for metropolitan rapid transit since station-to-station times cannot be easily decreased due to the relatively short distances between stations. Thus, the relative effect of access to and transfer through a station is significant and can influence the share of the market attracted to the new system. The simplest transfer is one in which there is no waiting time and the walk between modes is short and direct--for example, from one train to another across a platform or from one bus stop to another. The problem increases in complexity for large, multilevel stations at which several modes interface, including automobile parking and fare-collection barriers.

The fundamental purpose of a transit station--to transfer passengers between modes--should be foremost in the station planning and design process. It is usual to assume that the transit passenger perceives the transfer as taking from 2.5 to 3.0 times the actual time spent waiting. Thus, compromises in the station design that serve to inconvenience the transfer process or create congestion in order to save cost should be avoided. A life-cycle cost approach that considers the use of the station over its useful life will serve to justify additional initial costs for station elements. Among these are wider platforms, shallow stations, and more escalators.

## STATION FUNCTIONS AND DEFINITIONS

In the process of carrying out its basic function, which is to assist passengers between modes, the station serves a variety of purposes, each of which can be supportive of the total system objectives. These functions range from attracting users to the system, processing passengers through the station, service functions, and joint development.

To begin with, the station serves as the first image that the traveler has of the system (2). The station exterior acts as the "store front" of the system, creating for the potential user an impression of what might be available inside. Upon the entry of the user into the station, the station serves as a reception center, a place where the customer can inspect and get an impression of the likely quality of the system. The station environment, lighting, decor, cleanliness, sense of security, and general ambiance serve to create an impression of the type and quality of service that the traveler can expect. For example, consider the difference in the effect created by an intercity bus terminal and an intercity airport terminal. In contrast, the new Port Authority of New York and New Jersey bus terminal was designed to operate like an airport terminal. The quality of the station environment immediately creates an impression of the quality of the transportation service provided.

As one proceeds into the station toward the rapid transit line, the station serves the function of a business office or travel agent. It is here where payment is made, tickets are purchased, travel information is supplied, and records are kept. It is important that the passenger make this transaction easily and with little time delay. Long waiting lines at ticket counters, poor and discourteous service, and lack of information will detract from the level of service. Rapid transit systems process many passengers in a short period of time, and this requires an efficient and reliable method of fare collection. The station must also act as a business office and provide the space for necessary functions to take place. These include storage areas for stock, offices for ticket agents, space for recordkeeping, and secure areas for revenue.

Beyond the fare-collection area, the passenger proceeds to the platform area where he or she will board a vehicle. At this point, the station serves as an area where passengers wait until the next vehicle arrives. If service is frequent, the passenger will wait on a platform. If service is irregular, a waiting area with seating is provided.

The services provided throughout the waiting area will also influence the user's perception of the trip. Is the area sheltered from the elements? Are other services provided, such as concessions, telephones, and restrooms? Is the station safe and well-lighted? The availability of these attributes will influence how the traveler perceives the wait.

The station also serves to communicate information to the passenger about the trip, such as his or her current location, where and when the next train will arrive, and how to get from one place to another. The station is also a communications network for management, furnishing information on such items as daily operations, schedule changes, breakdowns, emergencies, and special functions. These are handled between the control centers, the vehicles, and the station manager.

The station contains the various operations and maintenance facilities and is the location of substations, tool rooms, material storage for maintenance and facility functions, offices and workrooms, staff lunchrooms and washrooms, and offices for supervisory personnel.

In locations where the station is not at the point of origin or destination (primarily outlying stations), it must also function as the link between access modes (3). Sufficient space in the vicinity of the station must be furnished for feeder buses or trains to discharge passengers and, in suburban areas, parking near the station should be provided. The station serves as a focal point for the feeder system, and adequate provision for each arriving service must be included if the total system is to be successful. Access modes and the proportion of each will vary for each station situation, but they will include walking, bicycle, moped-motorcycle, feeder bus, automobile passengers or automobile driver (park-and-ride), and light rail feeder. The design for station access should minimize walking times and furnish a safe and convenient means of transferring from the arrival mode to the transit station.

Finally, a transit station can become an attractive location for other commercial and retail enterprises as well as high-density housing. In this role, it can serve both as a transportation center and a commercial center. Joint development of transit and commercial facilities is a logical spinoff of a successful metropolitan rapid transit system. The station can provide the spark that generates significant energy and vitality within a community.

## STATION DESIGN

### Passenger's Perspective

Transit user needs can be defined in terms of three factors: convenience, comfort, and safety. Each of these is discussed as it pertains to transit station design (4).

Convenience refers to the time and energy required to perform the transfer function. A convenient station is one that minimizes delay and exertion, reduces or avoids crowding, furnishes directional information, ensures service reliability, and provides customer services.

Station elements related to comfort include the provision of climate control, restroom facilities, adequate waiting areas, cleanliness, and aesthetic design. Standards have been established for environmental factors such as temperature, humidity, sound, and light. Other criteria exist for passenger flow through terminal components such as corridors, stairways, escalators, and fare gates.

Safety refers to the adequacy of police protection, emergency response to accidents, availability of emergency exits, adequate lighting, and nonskid walking surfaces. Of particular concern is passenger security against crimes. Safe conditions throughout the station should be considered in relation to walking surfaces when wet, stair details, warning signals near escalators, and adequate lighting.

A good station design is one in which each element of the station functions well with the others. When this occurs, there is a synergistic effect that produces a result with multiple benefits. For example, if the design is barrier free, it will not only help the handicapped but will ease the trip for others as well.

The single most important element in station design from the user's viewpoint is the pathway through the terminal. A simple, direct pathway reduces the need for information, improves safety and security, and provides a corridor around which consumer services can be provided. Directional information is the means by which the traveler is told where to walk in order to board the vehicle. It can be furnished by a configuration of pathways and signing. The pathway should be direct and easily recognized and should link logically with modes such as stairways and escalators.

Pathways and nodes should not be obscured, obstructed, or blocked from view by walls. Lines of sight should be clear and unobstructed. In addition to providing a clear and unmistakable path, unobstructed lines of sight will reduce the opportunity for crimes to occur. They also furnish a better opportunity for commerical development.

Directional signing should be simple to understand. Short, familiar, and consistent words should be used, and the need for translation should be avoided. Messages should be repeated when appropriate. Explicit information about the surface location of exits, transit routes, and nearby buildings should be provided, especially for underground stations. Station names should be explicit.

Service reliability within a transit station should be assured. This relates to the number of turnstiles, ticketing machines, escalators, etc. The user expects a certain amount of inconvenience, but it must be reasonable. For example, a 60-s wait for a 1-h train ride would be acceptable, whereas the same wait for a 20-s escalator ride would not be. The maintainability of equipment, the installation of heavy-duty devices, and the availability of standby equipment are essential if the station, and the system, are to operate reliably and without breakdowns. Consideration of maintenance concerns in the planning phase will enhance reliability in the long run. Consideration should be given to closing portions of stations, or possibly even the entire system, during off-peak hours in order to permit complete and thorough maintenance of the system on a regular basis.

Provision of commercial services can be a convenience to the traveler and a source of revenue for the transit authority. The type of services provided will depend on the length of time that the patron is in the terminal, the location of concessions along the pathway (they should not be placed so as to be an obstruction), and the socioeconomic characteristics of the traveler. In a rapid transit system, a large passenger volume does not guarantee commercial success, nor is the passenger a captive buyer. Careful thought should be given to the benefits and problems associated with allowing concessions in a terminal. The decision is a policy one for determination by the transit management.

The provision of climate control is well established and, once specifications are set for lighting, sound, and temperature levels, they can easily be met through design. However, the extent to which these are provided can affect passenger comfort. For example, extending covered and climate-controlled walkways to parking areas and traffic generators enhances passenger comfort. Underground pedestrian walkways that connect terminals with stores and offices have been successfully developed in many cities. Covered elevated facilities are also appropriate. These pedestrian connections enhance connectivity to destinations and create further incentives for transit use.

Cleanliness and station aesthetics are important to the functioning of the transit system. Selecting finishes that are easily maintained will help to preserve the newness of the system. Regular maintenance schedules for cleaning, disposal of trash, and removal of graffiti are one way to enhance the image of the station.

Station security is an essential requirement if other than captive riders are to be attracted to the transit system. Security can be designed into the station by providing open station and platform areas in direct view of the station attendants, direct telephone access to transit or local police, television surveillance of selected station areas, good lighting, and direct communication for passengers via telephones or alarms. Controlled spaces can be created by well-defined patterns of movement, and the station size can be reduced by using movable gates during late-evening hours when patronage is low. Vandalism can also be a serious problem, but it can be reduced in the station design process by the choice of vandalproof materials, barriers between the platform and the wall, alarms, and surveillance. The use of easy-to-clean materials and prompt removal of the signs of vandalism are deterrents to further damage of property.

Principles for designing effective passenger information systems include the following:

1. Use a single style of lettering, standard signs, and simple words.
2. Avoid advertising near information signs.
3. Locate information at critical node points where a change of direction or elevation will occur.
4. Make maps of the system and its surrounding areas available near fare-collection points and on platforms.
5. Minimize the number of independent messages.
6. Maintain continuity, consistency, and sight distances.
7. Furnish direct information that is immediately understood.

Standardization of graphics throughout the system is essential, but no standard has yet been set for graphics and signing for use in stations in different cities.

Stair design should be based on comfort and the characteristics of passenger locomotion. The trend is toward lower riser heights and wider treads; 6-in heights and 12-in treads represent a reasonable standard. Escalators are provided in most new stations and are safer and more attractive than stairs. There is the potential, however, for accidents, and care must be taken to warn pedestrians that caution must be observed when escalators are in use.

### Operator's Perspective

Station operations depend on the ease with which passenger flow is accommodated at various points throughout the station. Surge volumes and heavy crowds can be handled safely and expeditiously if the station has been carefully planned (5). Among the items essential for good station operation are sufficient pedestrian exit and entrance facilities, dependable fare-collection equipment, and adequate platform dimensions. Exit and entrance facilities include wide doors, stairways, ramps, escalators, and passageways of sufficient dimension to handle large crowds. Provision should also be made to disperse patrons away from station areas to avoid crowding at street curbs and on sidewalks.

Fare-collection systems must be adequate to handle peak volumes. Long lines and crowding in mezzanine areas should be avoided. Backups should not be permitted to develop to such an extent that they interfere with passengers debarking from vehicles. Train platforms should be sufficiently adequate in size to accommodate peak flows. Objects such as stairwells, elevator shafts, utility rooms, advertising signs, and concession stands should be located so as not to impede passenger flow. Ample space should be provided to allow passengers to spread out along the platform and to uniformly fill up each train.

Station announcements should be clear and easily heard by the passengers. Directional signs should serve a useful purpose. These should be reviewed periodically to reestablish need.

Stations should be designed for each cleanup. A clean station is necessary to maintain its aesthetic value, to eliminate potential fire hazards, to avoid insurance claims, and to create goodwill. Typical of the debris found in a station are papers, sticky items on the floors and benches, and pools of liquid. Cleaning will also identify other maintenance problems. Stations should be designed to be maintained at low cost. Barriers and irregular spaces, as well as other objects that are difficult to clean, should be avoided. Good placement of trash containers is helpful.

Periodic maintenance of a station will be required over time. Damage due to occurrences such as floods, derailments, and fires may require major repair. Painting and repair of walkways, floor coverings, and roofing will be necessary from time to time. Warranties or bonds should be kept in a safe place, since replacements may be covered by a warranty. The original station design should minimize maintenance problems.

Maintenance should also be considered in the design of the station in terms of accessibility to items that will be cleaned or replaced. In the location of lighting fixtures, signs, and other similar items, consideration should be given to the fact that they must be periodically cleaned and replaced. Drainage, seepage, and water problems can be avoided by careful construction and inspection practices.

It cannot be overstressed that maintenance and operating personnel should be consulted during the planning phases of the project. These professionals will be able to review the station design in terms of how it will operate and what its potential maintenance problems will be.

## EXAMPLES OF STATION DESIGN AND LESSONS LEARNED

### Bay Area Rapid Transit System

The Bay Area Rapid Transit (BART) system was opened in 1972 with 26 miles of service and 12 stations. By 1974, the entire 71-mile system was opened, including 34 stations--15 subway and 19 at grade or elevated (6).

BART uses center platforms in subway stations and side platforms in suburban stations. Center platforms offer greater flexibility for loading and unloading and for differential traffic loadings and usually have higher initial costs than side platforms, although additional costs for escalators or other factors narrow this difference. A life-cycle cost analysis might show that center platforms are not as costly as side platforms. There are several station locations where center platforms might have been a better choice.

The decision to permit a variety of station designs does not appear to have posed problems or added cost. In practice, many designs are similar. Certain design criteria, such as station length, map areas, and graphics, were uniform.

Estimation of station parking did not recognize that more parking is required in outlying stations than in those close in. Although total space needs were accurate, parking areas at outlying stations are oversubscribed whereas lots closer in are not.

Provision for intermodal transfer facilities between bus and rapid transit was neglected in the planning stage. This is an important aspect of station design and should be considered early in the planning process. Bus loading areas are now being added. In addition, storage for bicycles and mopeds is being provided.

Basic circulation and orientation within the BART system are good, although a newcomer may be disoriented in locating a correct platform due to the absence of clear sight lines. A particularly vexing barrier is the stored-fare system, which is difficult to understand, time-consuming, and subject to breakdowns.

The method of fare collection is perhaps the most unique feature of the BART system and the one that creates the most difficulties within the station. Although it has many theoretical advantages in handling various fare structures, in practice it has had serious drawbacks. Aside from being complicated to operate, it is difficult to maintain. This type of equipment has not proved to be effective in situations that involve high-volume ridership on a daily basis.

Successful passenger services provided by BART include advertising, public telephones, and mailboxes. Concession stands in downtown stations have not been successful. In addition, wood benches should be removed and platform edge warnings and locker facilities for bicycles provided.

Security provisions in BART stations include good lighting, surveillance capability, courtesy telephones, and spacious areas. The need for closed-circuit television (CCTV) is evident. If this was not installed initially, the conduit work should be provided. Provisions for partial station shutdowns are needed as are barriers to fare evasion.

### Washington Metropolitan Area Transit Authority

The Washington, D.C., Metro system was opened in 1976 with a 5-station line. As of 1980, the system consisted of 33.5 miles and 38 stations. When the system is complete, it will be 101 miles long and have 86 stations about equally divided between (a) subway and (b) elevated and/or at-grade. Ridership is 300 000 passengers/day (7).

Metro uses a unique station monitoring system that consists of planning staff people who review the operations of a set of stations every two weeks. They note problems and take whatever action is necessary, including follow-up on the results. This information is used in planning for future stations as well as correcting existing ones.

The planning estimates of parking spaces required fell far short of demand. Original plans called for 30 000 spaces. Revised estimates show a need for 100 000 spaces. An additional 25 000 spaces have been authorized.

Platform widths were reduced as a cost-saving measure. This has caused serious safety problems in the vicinity of escalators at the Metro Center and Farragut West stations. Again, ease of circulation for passengers was sacrificed at the expense of first cost.

Temporary terminals occur where a transit system is being built under a staged construction program. In Washington, several on-line stations are serving as temporary terminals, and this has created problems in terms of train storage, maintenance, turnback facilities, train control, accommodations for operating personnel, passenger handling and circulation, and station access. A temporary terminal may be required to serve in this capacity longer than expected, and provisions should be made in the planning stages to avoid these problems.

Attention to the problem of general maintenance should be given during the planning and design phase. Access to stationary equipment for repair and maintenance should be provided. In the Washington case, several problems of this type currently exist.

Provisions for the handicapped, including elevators, should be considered in the early phases of the project to avoid inaccessible elevator locations or elevators that must bypass fare-collection areas. The fare-collection system, which is a stored magnetic fare system similar to BART's, has been a problem. It is complicated for the public to use, it changes without notice, and it is unreliable.

Design of passenger drop-off facilities, including drop-off by taxis, is essential. At the National Airport station this was not done, and the drop-off takes place in a dangerous and illegal location.

When stations are overloaded, excess demand can create dangerous backups, queuing, and congestion. The Farragut West station is in this condition, and when the fare-collection system is not working or headways are not maintained, a dangerous and unsafe situation can occur.

In the design stage, it is necessary to ensure that adequate escalator capacity is provided in the proper location. The Metro Center station is deficient in this regard.

Bus services should be terminated at the transit station. This avoids competition between modes and provides an integrated system. Passenger drop-off facilities should be flow-through designs in order to ensure safe, efficient movement.

The Washington Metro system has selected uniform station design. Stations are well-lighted and relatively crime free. They are air-conditioned and have controlled acoustics and only minor litter or graffiti problems. They permit modest advertising and public announcements, and there are no concessions or toilets.

### Metropolitan Atlanta Regional Transit Authority

The Metropolitan Atlanta Regional Transit Authority (MARTA) system was opened in 1979 with 13 stations on a 12-mile line. A north-south spine is under construction. Ridership is 85 000 passengers/day. MARTA established several design policies that affect station design (8). These policies were based on previous U.S. experience and practice in Canada and Europe:

1. The transit system is linked with the surface bus system.
2. Stations are unmanned.
3. The fare-collection system is based on a flat fare and is barrier free.
4. All stations are individually designed.

Bus loading is directly connected with station platforms. Priority is given to bus interface with separate protected roadways, minimal walking distances, good signing and graphics, and full weather protection. Bus loading is incorporated into the paid areas of stations.

Stations do not have attendants at the change booth. Security is handled at a central zone that has surveillance over 6-7 stations and is located within one of the stations. It contains CCTV monitors, security telephones, controls for fare-gates and restroom doors, and telephones for passenger assistance. It has its own security force and operates in a manner similar to the Port Authority Transit Corporation (PATCO) line (from New Jersey to Philadelphia), which controls all 13 stations from one central location.

A flat fare is used. Entry is by exact fare, and no fares are sold at the station. Entry may also be by bus-to-rail transfer or monthly fare card. There is space for token vendors. Open entry, which is used in Europe, was considered but discarded. The Atlanta experience illustrates that fare policies can have a significant effect on station design.

Uniqueness in station design, with overall control on design specifications, was adopted. This decision allowed many local architects to participate in the process. The cost apparently did not exceed that of a uniform station approach. The system does not operate between 1:00 and 5:00 a.m. Since all stations are closed during this period, station designs must include limited entrances and exists that are easily secured. Concession space was not designed into the system.

A conceptual plan was developed by staff, and the consulting firms were required to strictly adhere to it. Without this control, costs would probably have increased and exceeded budget amounts.

Temporary terminal stations are overloaded and underdesigned for interim use. These terminals will be troublesome until the next phases are complete. Stations are larger than needed, exhibiting a tendency toward monumentality in design that should be controlled. The designs for parking lots did not anticipate as many small cars as occurred. The downsizing of the American automobile is affecting parking-lot design.

MARTA claims to have adopted most of its policy from the experience of PATCO and not BART or Metro. The PATCO system, with its spartan, compact stations, illustrates that the bottom line is system reliability, access, and convenience. Since stations exist basically to transfer passengers between modes, it should do so in a safe, rapid, and smooth manner. In the downtown area, connections to major generators should be direct and use pedestrian ways. In the suburbs, emphasis must be placed on intermodal connections, adequate parking, and direct paths between access modes and the station.

## TRANSIT-STATION DESIGN METHODOLOGY

A transit-station design methodology is a systematic procedure for ensuring that a station configuration fulfills its policy guidelines and objectives from the viewpoint of the transit user and the operator.

The design process begins with an inventory of data, including local site studies, travel demand, access-mode requirements, and construction costs. Policy must also be established concerning station design, operation, and maintenance. Among the items to be considered are concessions, advertising, personal-care facilities, public telephones, construction materials, fare-collection methods, intermodal integration, and provision for the elderly and the handicapped. Other aspects of station performance should be considered at this stage, including the physical environment, security, and passenger orientation.

Trial station designs can be prepared by the design team, which will consist of architects, engineers, planners, and operators. Among the considerations at this stage are adherence to policy guidelines and other considerations such as potential for joint development, station platform configuration, number of levels, location of paid and unpaid areas, and access modes.

An evaluation of the transit-station schematics is completed to compare the system costs, identify possible design problems, and determine the extent to which policy guidelines can be met. After the selection of a design concept, a series of detailed design studies can be prepared.

The design of the station will be concerned with selecting the location and amounts of various station components necessary to achieve smooth and efficient passenger processing through the station. The station designs will be evaluated in terms of travel times, queues, crossing flows, and connectivity. Transit-station simulation models, such as the Urban Mass Transportation Administration (UMTA) transit station computer simulation package, would be appropriate at this stage. Other criteria would also be considered, such as noise levels, lighting, air quality, and thermal comfort.

The candidate station designs are then evaluated in terms of cost and effectiveness. The viewpoints of the user and the operator should be considered. In some cases, there may be conflicting results to be resolved. With the selection of a station design layout and flow pattern, detailed construction drawings and specifications can be completed.

In summary, the transit-station design methodology is a planning tool for developing station configurations that take account of the specific requirements for system integration. It involves specific statements of policy concerning the role of the station, data acquisition for site selection, travel demand analysis and access mode choice, initial sketch planning, detailed design of station areas and components (e.g., parking areas, platforms, escalators, and fare collection), and the generation of alternative plans and their evaluation in terms of user and operator objectives and cost.

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# Guidelines for Allocating Public Transportation Costs Among Towns in Nonurbanized Areas

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**A crucial question affecting the long-term viability of public transportation programs in nonurbanized areas concerns the allocation of deficit costs among towns receiving service. An evaluation is presented of alternative cost-allocation procedures that include one or more of the following variables: population, property valuation, passenger trips, passenger miles, vehicles miles, and vehicle hours. The procedures are evaluated based on several criteria, including simplicity, data requirements, cost of use, and equity (or perceived fairness) of the allocations. The evaluation brings into perspective the need to make trade-offs among these criteria. Sensitivity analysis is therefore conducted to determine the relative differences in allocations depending on (a) the procedure, (b) the data sampling method, and (c) the cost assignment policy. Population, ridership, and cost data on two public transportation programs in nonurbanized areas of Massachusetts are used to conduct the evaluation. One service, operated in Barnstable County, is offered on a prearranged demand-responsive basis. The other provides fixed-route, fixed-schedule service to nine towns in Franklin County.**

Recent government actions have responded to the need for public transportation programs in nonurbanized areas (1-4). Starting with the Federal-Aid Highway Act of 1973 (Section 147) and continuing with the Urban Mass Transportation Act of 1964 as amended (Section 18), increasing amounts of federal aid have been committed to support these programs. Many states have supplemented this federal aid with financial assistance of their own. In many cases, local governments are financially responsible for as much as 25 percent of the deficit costs of such programs.

A crucial question affecting the long-term viability of these programs concerns the allocation of deficit costs among towns receiving service. Many communities desire precise information on the manner in which deficit costs will be allocated before deciding to participate in such programs. At the same time, these towns lack the resources to carry out adequate cost-allocation analyses themselves.

The purpose of this paper is to present a critical evaluation of cost-allocation procedures available for use in nonurbanized areas. The procedures discussed are applicable to fixed-route and demand-responsive systems and may be pertinent to urban transportation programs as well. Twelve selected procedures are applied by using population, ridership, and cost data on two public transportation programs in nonurbanized areas of Massachusetts (Franklin and Barnstable Counties). Both programs were initiated several years ago under the Federal Highway Administration (FHWA) Section 147 Demonstration Program and are currently being supported with federal Section 18 funds and state and local resources.

Based on the results of this evaluation, conclusions about the overall usefulness of the various procedures are presented. The paper is intended to serve as a guide for regional and local transportation officials who are considering the implementation of public transportation programs in their nonurbanized areas.

## DEFINITION OF TERMS

Before we proceed, some clarification is in order regarding the definition of certain terms. For the purposes of this paper, a cost-allocation procedure is a means of determining what portion of the local share of the deficit each town should pay. A procedure consists of an equation or formula that determines town allocations based on one or more variables. Depending on the procedure favored by regional and local officials, variables can represent the level of service available to each town, the amount of service actually used by each town, or a town's ability to pay.

The total costs of public transportation services may be broken down into capital costs (e.g., purchase of vehicles and other equipment) and operating costs (e.g., driver's wages, fuel, and oil). These total costs can be annualized (i.e., expressed on an annual basis). The difference between the total annual costs and total annual revenue is the annual deficit costs (assuming that costs exceed revenues).

## BASIC ISSUES IN COST ALLOCATION AMONG TOWNS

Many different cost-allocation procedures are available for use by regional transportation agencies in nonurbanized areas (5). The various procedures differ in their variables. The most common procedures use one or more of the following variables: population, property valuation, passenger trips, passenger miles, vehicle miles, or vehicle hours. In cases where a multivariable procedure is used, weights can be assigned so that one factor is counted more heavily than another. The choice of variables or weighting schemes depends on a number of criteria, such as simplicity, data requirements, cost to use, and equity of results. Each criterion must be balanced against another to produce a procedure that is acceptable to a particular region. A discussion of these criteria can provide the context within which the comparative evaluation of procedures can be carried out. For discussion purposes, the criteria have been grouped into two categories: (a) ease and cost of implementation and (b) equity. The implementation criteria relate to the ease and cost with which procedures can be used. Equity criteria relate to the ability of the procedures to produce results that are considered fair by the member towns.