Public Transportation

A Methodology to Determine the Economically Feasible Capacity for Rural Demand Response Transit Systems

Transit Itinerary Calculation on the Web: Based on a Transit User Information System

Increasing Transit Ridership: A Survey of Successful Transit Systems in the 1990s

Innovatively Saving the Future of Transportation: Small Aircraft Transportation System (SATS)

Restructuring Urban Public Transport in India
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CONTENTS

A Methodology to Determine the Economically Feasible Capacity for Rural Demand Response Transit Systems
Adam B. Sandlin and Michael D. Anderson ......................................................... 1

Transit Itinerary Calculation on the Web: Based on a Transit User Information System
Martin Trépanier, Robert Chapleau, and Bruno Allard ......................................... 13

Increasing Transit Ridership: A Survey of Successful Transit Systems in the 1990s
Daniel Baldwin Hess, Allison Yoh, Hiroyuki Iseki, and Brian Taylor ....................... 33

Innovatively Saving the Future of Transportation: Small Aircraft Transportation System (SATS)
Jocelyn Nickerson, Brent Bowen, Russell Smith, and Scott Tarry .......................... 67

Restructuring Urban Public Transport in India
Kaushik Deb ........................................................................................................ 85

Our troubled planet can no longer afford the luxury of pursuits confined to an ivory tower. Scholarship has to prove its worth, not on its own terms, but by service to the nation and the world.
—Oscar Handlin
A Methodology to Determine the Economically Feasible Capacity for Rural Demand Response Transit Systems

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Abstract
Transportation professionals generally use volume-to-capacity ratios as a standard measure of effectiveness to evaluate the operation of transportation facilities. Unfortunately, this commonly used measure has not been available for the analysis of rural demand response transit systems, as there has not been a clearly defined methodology for determining the capacity of these systems. This article presents a methodology for determining the capacity of a rural demand response transit system using an economic constraint model and spatial data for the service area stored in a Geographic Information System (GIS). The methodology develops an equation that incorporates operating costs, transit need, route distance, and revenue to define an agency's potential service area, or capacity. To demonstrate the methodology, the article presents a case study for a transit agency in Northwest Alabama. The article concludes that the methodology presented can be applied to determine the economically feasible service area for a rural demand response transit system, thus allowing for development and use of volume-to-capacity ratios as a consistent measure of effectiveness to evaluate an agency's operation.
Introduction
Generally, transportation infrastructure analysis uses standard volume-to-capacity ratios, where demand for or use of the facility is taken as volume and maximum allowable use, based on the design of the facility (Highway Capacity Manual 1994). The volume-to-capacity ratio is used as a convenient measure of effectiveness to determine the level at which the facility is operating. For roadways, the relationships for determining volume and capacity have been studied to the extent that few questions arise when attempting to determine either volume or capacity for a given highway facility.

The easily understood relationship between volume and capacity in transportation, however, has been difficult applying to rural passenger transit systems because of the lack of a clear methodology for determining the capacity of a demand response transit system. This lack of a clear methodology has been documented in the recently-released Transit Capacity and Quality of Service Manual (TCQSM) (TCQSM 1999).

In an attempt to provide a methodology, this article presents a GIS-based methodology for determining the economically feasible capacity, or maximum service extent, for a rural passenger transit system, which can be used to calculate a volume-to-capacity ratio. The methodology is designed for rural demand response transit agencies that have a centralized vehicle storage facility in an urban area and a daily operation in which the vehicles travel to pick up passengers in the rural areas and bring them to services available in the urban area. The methodology presented focuses on initially determining the total area that the rural transit agency would be able to provide service to without losing money; the later portion of the methodology identifies the percent of the total area that can be serviced with the existing fleet. The article presents a case study using a rural transit agency in Northwest Alabama to demonstrate the methodology and concludes that the GIS-based methodology represents an effective method to determine capacity of and maximum service extent for rural passenger transit systems.

Methodology
The TCQSM presents the notion that “a demand-responsive vehicle’s person capacity is inversely related to the size of its service area and also inversely related to the number of potential origins and destination it must serve” (TCQSM 1999, p. 68). The manual also identifies the use of peer agencies as the best method for determining person capacity.
In contrast to the TCQSM, this article does not define capacity in terms of the number of passengers that can be moved by the existing fleet but focuses on the service area that the agency can economically serve. The basis for the methodology presented here is the economic notion of diminishing returns. By definition, the point of diminishing returns is the point at which providing transit service to a larger area causes a decrease in the overall trip rate, resulting in an inefficient operation (Spielberg et al. 1995). This point will be referred to as the maximum service criterion. The methodology defines the variables necessary for calculating the maximum service extent and presents a series of GIS-based steps to complete the calculation.

The variables needed to define the service criterion are operational costs, transit need, charge for transportation services, and distance to each stop. The operational costs are to be obtained from the agency being studied. If, for some reason, this information is not available, operating costs can be estimated after examination of similar transit agencies serving similar areas. For this analysis, it is necessary to develop a single cost rate to serve as operating costs. The operating costs, which include all administrative and maintenance fees, should be calculated on a cost-per-mile basis.

Transit need can be determined in different ways, depending on available data and/or the particular study area (U.S. Department of Transportation 1990). The most widely accepted method to determine transit need is to use a profile of the population who represent those individuals most likely to use transit service (Mazur et al. 2001). For the case study presented in this article, the transit need was determined through a combination of number of people older than 65 and number of households without a vehicle in the study area. Although other definitions of transit need can be used or other variables can enter the equation, there must be consistency in determining transit need between agencies that are being evaluated against each other.

The charge for transportation service is easily understood. This represents the total cost paid for the transportation service, including both the fare charged to the passenger and any subsidy allotted for the service. The cost for transportation service should be obtained from agency and/or State Department of Transportation records.

The distance to each stop is defined as total distance from the vehicle storage location to each passenger pick-up location. To ease the number of calculations when
determining the distance to each stop, it is recommended that the center of each given area where transit need is determined be used. For the case study, this location is the center of the census block group upon which the transit need is determined. The distance to each stop is to be determined using either a GIS or other service area map.

Procedures

The following sections examine the five-step GIS-based procedure.

**Step 1. Collect Data Necessary for the Analysis.**

The initial step is to collect the data necessary for the analysis. GIS-based data requirements include roadway locations and census demographics for the study area. A possible source for the data is the U.S. Census Department Internet site or similar website. Typically the data will be segmented to individual county boundaries, not necessarily covering the entire study area. If the agency study area covers more than one county, the GIS-based data need to be merged into a single coverage. The charge for transportation service should also be collected from the agency of interest or State Department of Transportation.

**Step 2. Determine Maximum Service Criterion**

The second step is to determine the maximum service criterion, defined as the point when the distance necessary to travel to pick up another passenger becomes cost-ineffective. This maximum service criterion is derived from the following:

- Cost to operate service to a given location:
  Per mile operating costs for the vehicle * total distance of the route

- Revenue generated from the service:
  Number of riders * equivalent farebox fee

- To be economically feasible, the revenue must exceed the costs.

Therefore, the maximum service criterion is defined as:

\[
\left( \frac{\text{distance of route}}{\# \text{ of transit riders/route}} \right) \times \left( \frac{\text{operating cost/distance}}{\text{equivalent farebox fee}} \right) \leq 1
\]

where:

- Distance of route represents the pick up and return to the urban area.
- Distance is in miles and operating costs are in dollars.
Using this equation, it is possible to identify route pick-up locations that are of a great distance and so few riders that they are not cost effective and therefore represent locations out of the agency's economically feasible capacity.

**Step 3. Determine Transit Need**

Transit need, as defined earlier, represents the number of individuals who potentially need transit service. For this step, the census data are suggested as a baseline socioeconomic dataset for the area of interest. From the census data, at the block-group level, it is possible to determine the number of elderly individuals, number of individuals living below selected poverty levels, and number of individuals without private automobiles—all of which might be used to determine the number of potential transit riders. For this step, it is necessary for the agency to identify the method it intends to use to determine transit ridership characteristics of its particular service area.

For an example of the determination of transit need using census block-group data, determine the percent of households without vehicles and the percent of the population more than 65 years old. Making the generalized assumption that the percent of people without automobiles is constant for all age categories, multiply these two values and then multiply the total population of the block group to estimate the population over age 65 and without vehicles. This value can then be used as one estimate of the population within each block group that needs public transportation. This number, however, is an estimate of the transit need and many additional factors could be used to determine the transit need for a selected area [e.g., the National Personal Transportation Survey (NTPS) or other transportation-related data].

**Step 4. Determine Distance from Storage Location to Block-Group Centroids**

After determining the transit need based on the census data block groups, the next step is to determine the distance from the storage facility where the vehicle trip originates to the pick-up locations where passengers are assumed to be waiting. The use of GIS is almost necessary for successfully completing this step in a timely manner. Using the functionality available in most GIS software packages, it is possible to determine the coordinates of the block-group centroids (i.e., locations where passengers are to be picked up). Then, also using functionality available in most GIS software packages, it is possible to determine the shortest distance from the storage facility to the centroid along the shortest path. Although this step is possible without using GIS, the determination of the block-group cen-
troid would have to be performed using visual interpolation methods and the shortest-route distance would then need to be calculated manually—both actions are timely and have great potential for error.

**Step 5. Determine Block Groups that Are Within Maximum Service Criterion**

At this point, with the transit need and distance from storage facility to all stops described, it is possible to identify those stops within the maximum service criterion. Again, using the relationship,

\[
\left( \frac{\text{distance of route}}{\# \text{ of transit riders/route}} \right) \times \left( \frac{\text{operating cost/distance}}{\text{equivalent farebox fee}} \right) \leq 1
\]

it is possible to determine these stop locations. This information now provides the maximum service extent (or total capacity) for the transit area to provide service without losing money as a result of the service.

This determination also provides a total transit need that the agency should attempt to serve. Unfortunately, this total transit need is developed independent of vehicle fleet size and most agencies will not be able to serve the entire transit need with their existing fleet. Using the total transit need, however, provides a method for determining the total number of vehicles necessary to provide service to the entire population by dividing need by occupancy per vehicle. When taking into account the actual number of vehicles operated by an agency, it is possible to determine a modified capacity by allocating vehicles in the most cost-effective manner (i.e., starting with short routes that have high ridership). In this manner, it is possible to determine a modified capacity for the agency, which is a factor of the total capacity.

The final step of the analysis would be the determination of a volume-to-capacity ratio for the agency, in which the volume would represent an average number of people served per day divided by the capacity of transit needs based on the agency fleet. In this manner, different agencies could then be compared using a single standard measure of effectiveness.

**Case Study**

To aid in understanding the methodology presented, a case study has been performed for an agency serving the two-county region covering Lauderdale and
Colbert Counties, Alabama. The urban center for the region is the combination of four Alabama communities: Florence, Muscle Shoals, Sheffield, and Tuscumbia, known collectively as the Shoals. The area is home to 136,572 people, with 15 percent of the population more than 65 years old (www.census.gov 2001).

**Step 1. Collect Data Necessary for the Analysis**

Roadway and census data at the block-group level were downloaded from the Internet and brought into the GIS environment. For the case study, the data were downloaded from www.geographynetwork.com and the GIS program used was ArcView (ESRI Inc.). The data downloaded from the Internet were segmented by county level, and the GIS program was used to develop a single coverage for roadways and census demographics for the two-county area.

In addition to the roadways and census demographics, operational costs and charges for transportation services were obtained from the transit agency directly. Operational costs were determined to be $0.50/mile and $7.00/hour. The agency also noted that the average speed for any bus traveling throughout the network was 10 mph (NACOLG Transit Representatives 2001). Assuming that these costs include all administrative and maintenance fees, operational costs were determined to be $1.20 per mile.

Regarding the charge for transit service, an assumption was made in this case study that the transit agency would be responsible for collecting 35 percent of the total operational costs from farebox revenue, with the other 65 percent coming from local or federal funds. For the agency studied, the farebox charge was $1.25 per trip, making the total charge for transit service $3.57 per trip.

**Step 2. Determine Maximum Service Criterion**

As noted above, the definition of capacity used in this article is the service area that can be covered by the agency without losing money as a result of providing the service. This was defined previously as:

\[
\left(\frac{\text{distance of route}}{\# \text{ of transit riders/route}}\right) \times \left(\frac{\text{operating cost/distance}}{\text{equivalent farebox fee}}\right) \leq 1
\]

Solving this inequality for the case study agency using an operating cost/distance of $1.20/mile and an equivalent farebox fee of $3.57 yields:
distance of route
# of transit riders/route ≤ 2.975 = service criteria

This measure implies that service should be offered, essentially defining the area that should encompass the agency's capacity, if the ratio between the distance to the riders and the number of riders is less than 2.975. This inequality takes into account zones with high transit needs that are a considerable distance from the central bus facility, making them good candidates for transit service.

**Step 3. Determine Transit Need**

The transit need for the case study agency was determined using census block-group data for the two-county area downloaded in the first step. The transit need was determined as the number of people in the block group age 65 and older multiplied by the percentage of the block group without automobiles. This was performed, in GIS and there were 100 stops calculated to have at least one potential transit rider to service as transit need. For simplicity, all block groups without a single transit rider were deleted from the theme.

**Step 4. Determine Distance from Storage Location to Block-Group Centroids**

Distances from the central bus storage facility to passengers in the block groups were determined using GIS. A point theme for the agency's central bus facility and census block-group centroids, to serve as pick-up locations for the areas, was created in ArcView. The agency's facility was created using the geocode address feature in ArcView representing the point of origin of all bus routes. The “Get coordinate table” extension for ArcView was used to create a point theme for the centroids of each block group to simulate transit stops. The block groups attribute table and the bus stops point theme were then joined, linking the location and transit need.

The shortest path from each point, including the origin, as defined by distance, to all the other points was determined using the Network Analyst and Shortest Network paths extension (see Figure 1). The bus stops table and the new network's attribute table, created using the Shortest Network path extension, were then joined to calculate the cost associated with traveling to each pick-up location, using the $1.20 per mile operating cost developed earlier.
Economically Feasible Capacity

Figure 1. All pick-up locations and shortest routes

Step 5. Determine Block Groups that Are Within Maximum Service Criterion

Using the service criterion as cost, setting the cut-off value at 2.976 as defined previously, and specifying the agency's bus facility as the origin, GIS was used to identify pick-up locations that can be reached where passengers available divided by the distance is less than 2.975. The service area could quickly be identified as a region to better understand the capacity for the particular agency (see Figure 2).

Figure 2. Maximum service area for the case study

Results

The results of the case study identify that 70 of the 100 sites with transit riders are located outside the economically feasible capacity and, therefore, should not be included in the agency's capacity. The study also indicates that the agency's capacity includes 69 percent of the transit need for the two-county area, or 1,298 of 1,884 potential transit riders based on the definition of transit need used. This information implies that the agency would be able to accommodate all of the 1,298
potential transit riders without losing money as a result of offering the service. The number of potential transit riders in the economically feasible area would require 87 vehicles (assuming 15 passengers per vehicle) in the fleet to move all passengers in a given day. Taking into account the actual number of vehicles operated by the agency, the capacity for the agency should be the total potential transit riders multiplied by the ratio of the actual vehicles in the fleet versus the total vehicles required to transport all riders. This value can then be compared to the number of passengers actually using the system to determine the volume-to-capacity ratio.

**Conclusions**

This article presents a methodology to determine the capacity of a rural transit agency using a methodology based on the economical limit of service and spatial data stored in a GIS. The methodology and GIS were used to identify all the locations where the number of potential passengers and the operating costs for the transit system allowed for inclusion in the maximum service criterion, or limits of capacity for the agency. The methodology can also be used to assist transit areas in determining their target market for advertising and publicity by identifying areas where there are a high number of potential riders and the distance or operating costs are low.

In general, the methodology presents one way to determine the capacity for rural demand response transit service. This calculation of capacity would thus allow for the development of commonly used volume-to-capacity ratios for different transit agencies. These agency-specific volume-to-capacity ratios can then be used as measures of effectiveness for evaluating rural demand response transit agencies.
References


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Transit Itinerary Calculation on the Web: Based on a Transit User Information System

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Abstract
Transit path calculation is not yet widely available on transit authority websites. This is because the calculation of complete transit itineraries requires the integration of underlying components such as Geographic Information Systems (GIS) and operational database and, unlike a simple road application, involves a complex transportation network. In this article, a hybrid algorithm based on heuristics and optimization is presented for the calculation of urban transit itineraries including information on pedestrian access and egress paths, route sequences, schedules, and stops. The use of the Transit User Information System (TUIS) to support the calculations is emphasized. The TUIS uses the Totally Disaggregate Approach (TDA) and Transportation Object-Oriented Modeling (TOOM) in transportation to gather data on territory (for origin and destination specifications and for the pedestrian network) and transit operation (route geometry, schedules). Websites that have been implemented are referenced to demonstrate the applicability of the hybrid algorithm. These websites make use of some special techniques for disseminating user information over the Internet.
Introduction

In general, public transit authority websites fail to offer a complete solution for users who want to obtain transit itineraries between an origin and a destination in a metropolitan area. By January 2000 about 93 percent of public transit websites in the United States still had not integrated an itinerary planning service (Soolman and Radin 2000). Furthermore, the path calculators that do exist on the web rarely provide all the specifications needed by users: origin and destination locations are often limited to a set of locations, and calculations usually do not consider the pedestrian paths built to reach the transit network. Besides, few of these sites provide the schedules associated with the itineraries. Smith (2000) has successfully defined some of the challenges related to this issue. Smith reported that path calculation involves minimizing trip times with respect to spatial, temporal, and system constraints. He maintains that the use of GIS is imperative as a support for the system, and he identified some technologies which could provide the system with flexibility, ease of maintenance, and operability. In the Montreal area, where transit usage is high, research has shown that it is important to provide transit users with the best possible itineraries to facilitate their travel on the network.

In this article, a hybrid algorithm is presented for the calculation of transit itineraries based on a TDA, along with the web architecture and tools needed to set it up on three websites in the Montreal area. With the feature, transit users can now, via the web, have their transit itineraries calculated between any two points in the transit authority’s territory. Itineraries are composed of information on pedestrian access and egress paths, bus stops and stations, as well as the set of routes to be taken, full boarding schedule, and transfer, departure, and arrival times. Web users can interactively modify the circumstances of their travel and have the recalculation completed within seconds.

The article presents the research objectives and contributions related to transit path calculation on the web. Then, after providing a conceptual background, it describes three methodological developments associated with the TUIS: the TDA, TOOM, and Object-Oriented GIS (OO-GIS). This is followed by the development of the hybrid algorithm, which is divided into four major phases: (1) origin, destination, and circumstance specification; (2) access and egress calculation; (3) path calculation; and (4) schedule integration. Finally, three examples of tested website environments are reviewed. To facilitate the discussion, relevant elements of a literature review are presented along with the topics.
Research Objectives

In the mid-1990s, the Montreal Urban Community Transit Commission (MUCTC), a 65-station subway and 1,500-bus operator, expressed the need to computerize the activities of its 20-agent phone information center to increase the productivity of its phone agents and to broaden the range of informational tools available to its users. An initial research project led to the implementation in 1995 of the software MADPREP (*Module d'Acquisition de Données pour la Préparation de la Réponse Émise par le Préposé,* data entry module for the preparation of agent responses) (Chapleau et al. 1997). The technology has since been upgraded and installed in two other transit information centers in the Montreal area.

Given the continuing growth and popularity of the Internet, another research project was initiated to set up a website for the MUUCTC. The first objective was to provide users with static information on transit services; the second objective was more challenging: to give users web tools for calculating transit itineraries. Typically, the information associated with transit paths would include:

- multimodal (transit and pedestrian) paths from point A to point B located within the territory;
- stops, routes, transfer points, and schedules related to the itineraries; and
- estimated walking, waiting, transfer, and travel times.

Figure 1 shows a graphical representation of the transit path information.

Since no commercial software or actual model could fulfill MUUCTC needs, a new method was developed based on the TDA, TOOM, and OO-GIS.

Background

This section examines the three methodological developments of the TUIS.

**TDA**

The TDA was developed in the 1980s in Greater Montreal for the validation, processing, and modeling of large, origin-destination surveys among householders, conducted particularly with a view to gather data on transit usage. Typically, in 1998, a phone survey would involve more than 70,000 households (5% overall sampling). Planners, however, were not satisfied with the way in which such a quantity of data was being modeled with an aggregate approach, even with a 1,500-zone system (Chapleau 1986). A new method had to be developed to store and process...
Figure 1. The totally disaggregate trip
data on households, individuals, and trips. The TDA can be quickly defined by the following two essential elements:

1. The focus throughout the transportation analysis is the individual trip. All trip characteristics (time, purpose, modes, itinerary) are maintained in association with the individual and household concerned.

2. **X-Y** coordinates, monuments, and statements about places are used to form the basic, spatially referenced system for the origin, destination, and residential and intermodal junction locations of each trip and other space-related objects in the system.

In terms of data completeness, the TDA does not use an origin-destination matrix, as this would aggregate and dissolve information. It maintains origin-destination files instead, which contain survey information on trips, individuals, and households (see Figure 1). The use of the best-defined information improves the level of resolution of the system without preventing any possible aggregation.

Over the years, many applications have been developed to enrich the data in these databases by adding new attributes (e.g., status derivation from a daily activity or from car ownership) (Chapleau et al. 1998). One of these applications is the trip calculator, which was first used to validate the transit trips described in surveys. Once calibrated with survey data, the calculator is used to simulate trips on the transit network. It has been used in several models and studies on trip generators, financing (Chapleau 1995), modal split (Chapleau and Trépanier 1997), etc. The itinerary calculation process presented in the section on OO-GIS is based on this methodology.

**TOOM**

TOOM is derived from object-oriented schemes used in traditional approaches like those of Booch, Coad, Colbert, Yourdon, and others (Trépanier and Chapleau 2001a). Viewed in this way, the object is a unique entity with its own properties and methods. Its properties (attributes) describe the object's state. Its methods constitute the behavior of the object: its actions and its services to other objects.

The transportation object is a special component intended for modeling, observing, planning, and analyzing the transportation system. For this purpose, its state is variable in time and space and possesses special properties and methods. For example, a RoadLink object has the commonly used road properties (length, name, number) but can also have time-varying properties (e.g., pavement condition).
Figure 2. Simplified object model of the transit user itinerary.
There are four metaclasses of transportation objects involved in dynamic and space-related relations, depending on their specific role:

- **Immobile (static) objects** have a fixed location in time and space. Their role is to describe the territory and serve as transportation movement beacons. Some examples are: TripGenerator, PostalCode, CensusTract, and Zone objects.

- **Dynamic objects** are the transportation actors. They decide on, and contribute to, their movements. They include a group of individuals (Household objects, Person objects), moving objects (Bus, Car), or even objects moved (Goods).

- **Kinetic objects** are objects that describe movement. Some examples are: Trip, TransitLink (simple kinetics), Path, and TransitRoute (compound kinetics).

- **System objects** are groups of embedded objects with their set of relations. They can be operational (TransitNetwork, RoadNetwork), informational (Survey, Census), or globally comprehensive (UrbanSystem).

A transportation method is an “intelligent” sequence of procedures used to manipulate and transform one or more transportation objects. It blends models with information, creating “infomodels” to be reapplied to similar objects. TOOM is not primarily aimed at software design or database structure, and it is not a database issue. First and foremost, it is a “way of thinking” about the role and specific use of every piece of information in the system. With adequate diagrams, objects can be rapidly identified, along with their properties and methods involved in the analysis. The software implementation could easily integrate these underlying concepts, but not all software languages are adapted to this methodology.

**OO-GIS**

The use of TOOM is particularly important for the implementation of GIS within a transit authority’s territory (Trépanier and Chapleau 2001b). This kind of GIS is unfamiliar, since it integrates a transit network, a road network, and territorial data simultaneously (Peng, Groff, and Dueker 1998). In Figure 2, the object model for a typical path calculation is represented schematically. The transit supernetwork describes the geometry and the chronometry (time-related aspects) of transit operation. For a given authority, it includes all modes; in the Montreal case, the bus, subway, and commuter train networks are integrated. The territorial network describes land use, the street network, and the sidewalk network (pedestrian). This
Figure 3. Transit User Information System architecture.
third object is mandatory to provide adequate information to the transit user, since access to transit services is a pedestrian path and must be considered. The system also integrates some "classic" GIS information [e.g., addresses, intersections, postal codes, trip generators (monuments)]. These objects are used for origin and destination specifications. At the bottom of the object model, the transit user is provided with two elements of information: the user path on the pedestrian network, and the itinerary for arriving at the transit network.

**TUIS**

Some effort has been made to describe the elements that could be used to supply information to a transit website. Ventura County was among the first to provide transit service information on the web (Gherardi et al. 1997). Lee, Baumgartner, and Tschango (1999) presented a web-based bus information system (WBI) implementation with data stored in a Microsoft Access database. Peng and Huang (2000) also used Access to store route and transit networks, bus stops, and time-point data, and their database is linked to GIS and network servers (Peng and Beimborn 1998).

**Architecture**

In terms of implementations of our websites, the following architecture has proven to be an adequate means of providing transit trip itinerary calculation on demand via an Internet interface (about 80,000 calculations in the year 2000). The whole system is called the TUIS for the web and is represented in Figure 3.

As shown previously in Figure 2, OO-GIS integrates two groups of data: operational and territorial. Transit agencies usually already have systems in place to manage data related to vehicle operations (e.g., driver schedules, vehicle dispatch times, runs, schedules). At the MUCTC, many software programs are used for these tasks. Interface software has been developed through this project to gather, integrate, and validate data from these systems. In contrast, territorial data are commonly used in the planning department and stored in GIS architecture. Another program processes these data to adapt them to the OO-GIS model.

Data are transmitted through the phone information center service. Typically, a copy of the data is installed there shortly before its implementation. This copy is installed in the phone information center so that the agents, who probably have the best knowledge of the operational and territorial networks in the organization, can then test the calculator to detect problems and initiate last-minute changes, such as new streets (new streets may not immediately be included on official city
Figure 4. Elements of a TUIS for the web.
maps) or modified schedules (these small changes may not be reported to the corporate information systems department).

The architecture of the web server, which is quite simple, is shown in Figure 3. The PC based server physically integrates all the components: database (operational and territorial data in a Visual FoxPro application), web server (Internet Information Server), and calculation engine (Windows DLL dynamic library). The major part of the data are asynchronously transferred to the web server when needed. Events and other real-time data are transferred through TCP/IP communications between application servers.

**Spatial and Temporal Level of Resolution**

A common question related to user information concerns the level of spatial and temporal resolution needed to satisfy the user. Should it be a simple on-demand route schedule or a stop schedule? Should the transit operator provide a full transit path between two points in its territory? In the Montreal area, authorities had accustomed the user to receiving precise and detailed information, including, for example, the full pedestrian network for reaching bus stops. This information had historically been provided by phone by experienced agents, with no computerized tools, only paper-based documents like maps and schedules.

Spatial and temporal levels of resolution are two dimensions to consider when designing a TUIS for the web (see Figure 4). As the spatial level of resolution increases, the spatial definition of transit information becomes more precise, and the number of web elements (e.g., bus stop location pages) increases. The same logic is applied to the temporal level of resolution. These two dimensions have an impact on the technical structure of the website, so that several web technologies must be used to render the information with efficiency and without overloading the web server. Individualized schedules and calculated itineraries constitute on-demand, real-time information that must be provided by the web server via scripted pages (e.g., Active Server Pages, Common Gateway Interface). The path calculation process described in this article is illustrated in the upper-right-hand part of the chart. In contrast, general information on the transit authority is usually provided via static HTML pages to improve the server’s performance (Kothari and Claypool 2001). The central zone includes generated pages, containing a large number of data, like route geometry, bus stop lists, planned schedules, and point-of-sale lists. To avoid overloading the web server, this information is not scripted, but rather generated by a database software program used to make the several thousand HTML pages.
Figure 5. The itinerary calculation process.
Itinerary Calculation Process

Although many transit agencies have implemented websites in recent years, few provide adequate transit itinerary service via this medium. Peng and Huang (2000) have indicated that a network analysis model is "the key component" to providing trip itinerary planning and reported that most algorithms and programs are designed for highway calculation use. In fact, transit path calculation is much more complex than road network itinerary calculation because it involves different transportation modes, time-dependent levels of service, and the presence of transfer points, terminals, stops, and stations.

The transit path calculation methodology presented in this article consists of four steps (Figure 5): (1) origin, destination, and circumstance specification; (2) access and egress calculation; (3) path calculation; and (4) schedule integration.

Origin, Destination, and Circumstance Specification

The calculation process begins with a choice of origin and destination. The user then has to define the circumstances of the itinerary. To determine location, an HTML form is used to enter an address (civic number + street name), intersection (two street names), monument (interactive search or browsing of a list), or station or bus stop number. The web server, with the help of the underlying territorial OO-GIS, decodes the form and stores the locations as user preferences. An interactive, clickable map is also provided as an alternative way to define origin and destination, supported by a bitmap-based web GIS. Any reachable location in the agency's territory (not simply a restricted list) can be specified as an origin or a destination. Under "Circumstances," the user enters the travel day and time and selects options related to subway, train, and pedestrian usage. The user can choose not to use the subway, for example, and ask for the shortest access distance, thereby increasing the number of transfers but minimizing walking distance.

Access and Egress Calculation

In the next step, a pedestrian path calculation is used to gather a set of bus stops (or train and subway stations) around the origin and the destination. To identify this set, a shortest-path tree is calculated on the pedestrian network from the origin location. The same task is performed for the destination. At least four stops are gathered at each end, since the nearest stop would not necessarily provide the best transit path. (This number is parametrized according to the sensitivity of the model.) The use of the pedestrian network (sidewalks, pedestrian paths, underground paths, and pedestrian overpass bridges) is very important to avoid confusing users. The
pedestrian network must consider geographical obstacles such as train tracks, rivers, and freeways.

**Path Calculation**

The set of stops located at the origin and destination is then used to calculate several transit paths. Peng and Huang (2000) suggest that some elements of the paths should be precalculated to speed up the calculation. In our applications, it would be unrealistic to prestore the information because the number of stops (more than 16,000), number of routes (more than 500), and the temporal dynamic aspects of the transit network would generate millions of possible paths. Another reason not to prestore the information is that the calculation is performed within a fraction of a second on a regular PC. The calculator uses a shortest-path algorithm (adapted from Dijkstra) and heuristics (to rearrange the network) to determine a set of feasible itineraries between the stops and relies on the transit network definition of the MADITUC software in the TDA (Chapleau 1986). The shortest paths are calculated such that the total generalized travel time \( t_{\text{total}} \) obtained from this impedance function is minimized:

\[
t_{\text{total}} = w^m t_o^m + \sum_{n=1}^{n} (w^a t_n^a + t_n^p) + w^m t_d^m
\]

where:

- \( t_o^m \) is the access time (walk at origin).
- \( t_d^m \) represents the egress time (walk at destination).
- \( t_n^p \) is the travel time on-board route \( n \) vehicle.

These times are estimated from an average walking speed (about 4 km/h) and highway speeds derived from schedules. Weighting factors \( w^m \) (walk) and \( w^a \) (waiting) are applied to balance the impedance. The waiting time for route \( n \), \( t_n^a \), takes into account several components:

\[
t_n^a = \min(\max(t_n^a, w_n^x h_n^1), t_{\text{max}}^a) + t' w_n^f + w_n^{n-1}
\]
where:

\[ t_{\text{min}} \] is the minimum waiting time (boarding time at a minimum).

\[ t_{\text{max}} \] represents the maximum waiting time (over that time, the user will adjust this time in accordance with the schedule, especially for large headways).

\[ w^x_n \] is the weighting factor for the waiting time related to headway \( h^x_n \). This waiting factor depends on the location on the route (0.5 near the beginning). The second term is the transfer time (0 for the first route) and implies \( t' \) the base transfer time and \( w^f_n \) the weighting factor related to the route mode (could be higher for a commuter train, for example).

\[ w^{n-1}_n \] is an additional penalty for mode transfer between route \( n-1 \) and route \( n \). This term of the impedance function can be used to consider rates dues to mode change.

This impedance function is calibrated with the help of household survey data. More than 35,000 origin-destination pairs were extracted from the 1998 survey and simulated with the algorithm to reproduce the transit statements in the survey (sequences of routes taken). Weighting factors also serve the user on-line on the web. For example, if the walk is to be minimal, its weighting factor (\( w^w \)) in the impedance function will be increased so that the calculator will try to minimize the walk-time terms.

### Schedule Integration ("Trimming")

Once the calculator has produced feasible itineraries, the operational OO-GIS is used, via a database management software program (DBMS), to add detailed schedule information. In some cases, the calculator provides more than 50 itineraries (4 stops at origin X, 4 stops at destination Y, 3 or more feasible paths), and so a choice must be made to retain the two or three "best" paths. This is done by recalculating the total travel time for each itinerary using a schedule, with the following formula:

where:

\[ h^u_0 \] is the starting time specified by user.

\[ h^o_n \] is the scheduled departure time for route \( n \).

\[ h^d_n \] represents the scheduled arrival time.

\[ t^m_o, t^m_d \] is the walking time.
The total travel time is then provided in minutes and is the difference between the itinerary's overall arrival and starting times. This part of the process is called schedule "trimming."

**Implementations**

Experiments on the path calculation methodology were first conducted on a large transit agency website and were extended to a medium-sized transit agency website and a suburban transit agency. In 2001, about 462,000 path calculations were performed on the MUCTC website (80,000 in 2000).

Transit users and web surfers go onto the MUCTC website (http://www.stm.info) to calculate transit paths with the "Tous Azimuts" (all azimuths) function (Figure 6). The calculation results (one to three paths) are provided in a table format, containing: starting time from the origin location and walking time to the access stop, schedule at each stop (access, egress, and transfer), stop and route identification, pictograms for transit mode (bus, train, subway), phone numbers (for phone scheduling system), arrival time at destination location, and total travel time.

At the City of Laval Transportation Agency, a suburban transit network north of Montreal, the results are displayed in text form. The site is located at: http://www.stl.laval.qc.ca. (Text is provided in French only). The phrasing used by the web server software contains the same information as the MUCTC results table. In this case, the pedestrian and transit networks are larger, since they integrate both the
Montreal and Laval territories. Users can also store up to 10 origin and destination locations via cookie files. Precise schedules are provided for the Laval network only, and the user is invited to browse the Montreal schedule through hyperlinks to the MUCTC website.

The third implementation of the calculator provides transit access information (set of bus stops) around a location within the Greater Montreal area (5,000 km²). It is available on the Metropolitan Transportation Agency website (http://www.amtqc.ca, also in French only). The agency is responsible for the commuter bus and train services provided by about 20 small operators. A regional transit path calculator is currently under development and is awaiting the completion of a regional TUIS to gather and structure available data.

Conclusions

It is possible for transit users to use the web to calculate transit paths for their daily trips. In Montreal, where there is a large and multimodal network in place and where schedules are revised every two months, such a function has been very helpful.

This article has explored a transit itinerary calculation methodology based on a hybrid heuristic algorithm that relies on a TUIS. The TDA, TOOM, and OO-GIS are the three elements developed to support the algorithm and its embedding in websites. The article also shows that a powerful means of integrating information at each stage of the process is key to obtaining a viable algorithm for providing suitable itineraries for users.

Some challenges remain to be addressed, and these will be explored in the coming years. First, there is a possibility that path calculation will be used in some planning processes such as route synchronization or delay studies. Second, the most powerful integration of real-time events and on-board GPS data will be examined. Finally, a more sophisticated version of the algorithm for calculating hybrid road-transit paths for the use of park-and-ride facilities for commuters is under consideration.
Acknowledgments
The authors wish to express their gratitude to this project’s partners: the Montreal Urban Community Transit Commission (*Société de transport de la Communauté Urbaine de Montréal*), City of Laval Transportation Commission (*Société de transport de la Ville de Laval*), and Metropolitan Transportation Agency (*Agence métropolitaine de transport*). They also thank the Natural Sciences and Engineering Research Council of Canada.
References


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Increasing Transit Ridership:
A Survey of Successful Transit Systems in the 1990s

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Abstract
This study examines trends in public transit ridership in the United States during the 1990s. Specifically, it focuses on agencies that increased ridership during the latter half of the decade. While transit ridership increased steadily by 13 percent nationwide between 1995 and 1999, not all systems experienced ridership growth equally. Some agencies increased ridership dramatically, some did so only minimally, and still others lost riders. What sets these agencies apart from one another? What explains the uneven growth in ridership?

To examine these questions, we conducted a nationwide survey of transit agencies that added riders during the late 1990s. Specifically, transit general managers or their designees were asked about the factors they deemed important for ridership growth in their systems. We gathered information about specific transit planning efforts and programs that are not available from aggregate data sources, like the National Transit Database (NTD).
This article reports the results of this survey and documents recent planning efforts of successful transit systems. We found that:

1. Service improvements and advertising/information programs are perceived by transit managers to have increased patronage, though opinions varied widely on how significantly such changes affected ridership.

2. While the literature generally suggests that fare changes affect ridership less than service improvements, universal fare coverage programs are widely perceived to have positively influenced ridership by the systems that implemented such programs.

3. Three factors outside of the control of transit managers and planners (population growth, economic/employment growth, and worsening traffic congestion) are frequently cited as significantly causing patronage to climb.

Introduction

The 1990s were a volatile decade for the U.S. public transit industry. Many systems lost patrons during the recession years of the early 1990s, though a few actually added riders. During the economic boom of the late 1990s, transit ridership nationwide increased steadily. But not all systems increased ridership equally; some posted dramatic ridership gains, while others actually lost riders. Although many industry insiders have theories about which transit systems have been the most successful and why, there actually has been little systematic examination of ridership growth. This study explores recent trends in public transit ridership to increase understanding of why some public transit systems have been successful at attracting new riders and others have not. As part of this research, managers of the transit systems nationwide that increased patronage during the late 1990s were surveyed to explore their views of the keys to increasing patronage.

Some respondents reported that variation in transit use is largely external to transit systems and thus is outside of the control of transit managers; others reported that ridership increases on their systems resulted, at least in part, from factors internal to the agencies. In the survey reported here, we focused on internal factors that transit operators believe have been most effective in attracting and maintaining customers. In an environment of increased automobile use, some transit agen-
cies have successfully attracted new riders by becoming more flexible, creative, and innovative in their service provision and marketing.

Explaining Transit Use

Figure 1 shows the recent trend in nationwide transit patronage over the past two decades. Several important points emerge. Overall transit use declined during the recession years of the late 1980s and early 1990s, only to rebound with the economic boom of the mid-1990s. The 9.1 billion unlinked passenger trips\(^1\) in 1999 represented a 17 percent increase nationwide in just four years (APTA 1999). Per-

Figure 1. Number of unlinked transit trips on U.S. transit systems (1980-1999)

![Graph showing the number of unlinked transit trips on U.S. transit systems from 1980 to 1999. The graph shows a decline during the recession years of the late 1980s and early 1990s, followed by a rebound with the economic boom of the mid-1990s. The data indicates a 17 percent increase in unlinked passenger trips in 1999.]

Figure 2. Annual unlinked trips per capita on U.S. transit systems (1985-1999)

![Graph showing the annual unlinked trips per capita on U.S. transit systems from 1985 to 1999. The graph shows a decline during the recession years of the late 1980s and early 1990s, followed by a rebound with the economic boom of the mid-1990s. The data indicates a 17 percent increase in unlinked passenger trips in 1999.]

---

\(^1\)APTA 1999
haps the most auspicious aspect of the recent upswing in transit ridership is that transit trips per capita are on the rise as well, based on projections of the 1990 U.S. Census (Figure 2). Americans took an average of 31.3 trips per capita in 1999, compared with only 28.6 trips per capita in 1995 (a 9% increase).\(^2\)

While these increases in transit patronage are encouraging, transit's overall share of metropolitan travel fell throughout the 1980s and the early 1990s and does not appear to have increased, even with the recent transit ridership increase. This is because cities continue to grow, and urban travel is growing even faster. Just 1.8 percent of all person-trips in the United States were made by transit in 1995, down from a 2.2 percent share in 1983, and 2.4 percent in 1977. Nationwide, 4.5 percent of all commut trips were made by transit in 1983; by 1995, this share had fallen to 3.5 percent (Federal Highway Administration 1995; Pisarski 1996).

**Previous Research**

Public transit ridership is influenced by a variety of factors, both internal and external to the transit system. Internal factors are those under the purview of transit managers and policy boards, such as the quantity of service, fare structures and rates, scheduling, route design, and other aspects of service provision. Transit operators can adjust the quantity of service provided and the fare charged in an effort to attract paying customers in the most cost-effective manner possible. External factors, in contrast, are those beyond a transit agency's control, such as population and employment growth, residential and workplace locations, and factors that influence the relative attractiveness of transit (e.g., traffic congestion, gasoline prices, and parking costs). Changes in these external conditions can powerfully influence ridership. Because public transit tends to capture a relatively large share of commut trips to jobs in central business districts, downtown employment growth is strongly correlated with both the quantity of transit service and transit patronage. Further, sharply increasing unemployment rates and overall reductions in consumer spending can significantly decrease both transit ridership and revenue (Fleishman et al. 1996; Taylor and McCullough 1998).

Previous studies of transit ridership have identified several common factors that influence transit use. Among internal factors, increasing the quantity of service (in terms of service coverage and service frequency) and reducing fares are both found to have significant effects on ridership (Sale 1976; Cervero 1990). Systems with low unit costs, low fares, and low subsidies with spatially concentrated service have proven the most cost effective in increasing ridership (Hartgen and Kinnamon 1999). Kain and Liu (1996) estimate fare elasticity of ridership with respect to fare change
to be between $-0.34$ and $-0.44$, while the elasticity of ridership with respect to changes in revenue miles of service ranges between 0.70 and 0.89. A few studies found that pricing schemes, such as deep discounting,\textsuperscript{1} induce significant ridership increases, because such schemes account for different sensitivity to price among various market segments. Some transit agencies provide discounted transit fares to students through partnerships with universities—university transit pass programs—and have been very successful in increasing ridership without increasing service (Brown, et al. 2001). In addition to fare policies, some studies found that the quality of service—customer and on-street service, and station and on-board safety—is more important in attracting riders than changes in fares or the quantity of service (Cervero 1990).

Among external factors studied, many researchers argue that residential and employment density are critical determinants of transit use, while the effects of land-use mix and urban design are relatively small (Crane 2000; Pushkarev and Zupan 1977). Demographic factors, such as personal income, auto ownership, and suburbanization of residential and job locations, also have been found to display significant effects on ridership (Kain and Liu 1995; Gomez-Ibanez 1996). Gomez-Ibanez (1996) found that transit ridership is strongly affected by forces beyond the transit system's control. For example, each percentage decrease in Boston's jobs reduces Massachusetts Bay Transportation Authority (MBTA) ridership by between 1.24 percent and 1.75 percent, and each percentage increase in real per capita income reduces MBTA ridership by 0.7 percent. The effects of fare and service policies are, by contrast, relatively small. A 1 percent increase in service increases ridership by only between 0.30 and 0.36 percent, and a 1 percent reduction in fares increases ridership by between 0.22 and 0.23 percent. Finally, strategies to increase parking costs or the probability of a driver incurring parking charges are found to be more effective in increasing transit mode share than increasing either the frequency or service coverage of transit (Transit Cooperative Research Program 1998).

The studies cited here adopted a wide array of methodological approaches:

1. correlation studies,
2. simple regression models,
3. multiple regression models,
4. surveys/interviews,
5. case studies, and
6. literature reviews.
The more objective statistical analyses have typically focused on testing the relative causal influence of internal and external factors on transit ridership. Collectively, these studies have found that external factors—such as population and employment growth—have had more influence on ridership than internal factors—such as fares and service quantities. However, these aggregate statistical analyses have been hampered by limited and incomplete data, particularly concerning the external influences on patronage. In contrast, the more subjective studies based on literature reviews, surveys/interviews, and case studies have typically sought to identify the factors thought to affect ridership. Many of these studies, however, are relatively old, and most of them do not specifically ask about perceptions of causality or the relative influence of internal or external factors. In the survey described below, these two shortcomings were specifically addressed in the research on factors influencing transit patronage.

**Survey Design and Response**

Data for this analysis are drawn from a national survey of managers of transit systems that increased ridership. The goal of this survey was to ask transit managers about the factors they believe were responsible for recent ridership growth on their systems and to learn about the specific policies, programs, and planning efforts conducted on these increasingly well-patronized transit systems. To identify which transit systems were most successful at increasing ridership during the late 1990s, the NTD maintained by the Federal Transit Administration (FTA) was used to measure national trends in ridership during the 1990s. From the entire sample of 587 reporting transit agencies, 227 agencies (or 62% of the sample) submitted complete data for some form of fixed-route transit service and increased ridership (measured as unlinked trips) during a four-year period between 1994–1995 and 1998–1999, a period in which transit ridership nationwide increased by 14 percent. These 227 agencies carried more than 86 percent of the total unlinked trips reported to the FTA in 1999.

Next, a questionnaire was developed and mailed a questionnaire to the chief executive of each of the 227 agencies. The questions were structured to allow respondents to address key factors contributing to their effectiveness in increasing ridership. The survey consisted of a combination of closed-ended, open-ended, and ranking questions; the questions sought information about the costs and benefits of programs and policies that contributed to ridership gains, the transit system's goals in increasing ridership, and how the ridership increase has benefited the community and the transit system. Findings from the literature review were used to
Increasing Transit Ridership

develop the list of programs and policies. In addition, the survey asked respondents to discuss their respective agencies' future plans for maintaining and increasing ridership.

Five surveys were returned undeliverable, and a second attempt was made to contact these agencies to obtain valid contact information. Follow-up calls were placed to a random sample of 60 agencies that did not respond to the initial survey. Five agencies that responded to the mailed survey indicated their ridership levels actually decreased during the period of this study (in other words, the NTD data were incorrect). These agencies were subsequently removed from the sample. In total, 103 surveys were returned, for a response rate of 45 percent.

There are some limitations to the data and findings. We would expect that transit officials are more likely to attribute their ridership growths to internally controllable programs than to external factors outside of their immediate control. In this sense, it is important to view the questionnaire results more as the perceptions of experts and less as causal explanations of noteworthy ridership increases. In addition, because the survey was sent to only one person in each agency, responses may be biased to the individual's perception of the effectiveness of particular programs and factors, rather than representative of the agency-wide perspective of ridership increases. Finally, since surveys were conducted only of transit agencies that added riders in the late 1990s, the results do not reflect the views of transit managers whose systems lost riders during this period.

Survey Findings and Analysis

The internal and external factors thought by transit officials to influence ridership are summarized in Table 1. These internal and external factors, however, can be highly interdependent. For example, although many agencies attribute increased ridership to service expansions and the introduction of new and specialized programs, these services are often dependent on demand. In fact, many agencies report that an obstacle to increasing ridership even further is the lack of funds for more rolling stock and operating costs to meet demand. Nevertheless, throughout this study, external and internal factors are considered separately for purposes of analysis and presentation.

Internal Factors

Survey respondents indicated that in recent years, policy-makers have sharpened their focus on increasing public transit ridership, due in part to legislation such as the Clean Air Act Amendments of 1990 and the Transportation Equity Act for the
<table>
<thead>
<tr>
<th>Internal and External Factors Contributing to Ridership Growth</th>
</tr>
</thead>
</table>
| Fare Changes and Innovations | Fare decrease or freeze  
|                               | Universal fare coverage programs  
|                               | Introduction of new payment options  |
| Marketing and Information Programs | Advertising  
|                                   | Niche marketing/marketing segmentation  
|                                   | Survey research  
|                                   | Customer satisfaction feedback mechanisms  |
| Service Improvements | Expansion of routes (geographic/temporal)  
|                       | Introduction of new/specialized service  
|                       | Route restructuring  |
| Amenities/Service Quality | Development of transit centers  
|                           | Development of park-and-ride facilities  
|                           | Increasing reliability of service  
|                           | Cleanliness of vehicles  
|                           | New equipment/rolling stock  
|                           | Bus stop improvements (signage, shelters, benches)  |
| Partnerships | Community outreach/education  
|              | Planning and strategies  
|              | Intra-agency collaboration  |
| Population Growth | More immigration  
|                   | Rising transit dependency (aging populations, etc.)  |
| Economy and Employment Growth | Increased tourism  
|                              | More demand for travel  |
| Changing Metropolitan Form | Suburbanization  
|                           | Residential and employment relocation  |
| Changes to Transportation System | Increased congestion  
|                             | Parking shortage and increasing costs  
|                             | Rising gas prices  
|                             | Construction projects and time delays  |

21st Century. Questionnaire results concerning the operating changes that transit officials believe have helped increase ridership can be grouped into five general types shown in Table 2.9 These groups are:

1. transit service improvements through route expansion, restructuring, and new or specialized services,
2. fare innovations and changes,
3. marketing and informational efforts,
4. partnerships and community collaborations, and
5. improvements to service quality and passenger amenities.

Many transit systems report carrying out initiatives in several categories simultaneously.
For each item, Table 2 notes the number of transit systems per size category—(1) very small, less than 1 million unlinked trips, (2) small, between 1 and 2 million trips, (3) medium, between 2 and 5 million trips, (4) large, between 5 and 20 million trips, and (5) very large, more than 20 million trips—responding that the item helped increase ridership. Each of the types of programs is discussed in turn below.

**Service Improvements.** Transit systems have undertaken a wide array of service improvements that have resulted in ridership gains. Service changes are defined here as any changes that alter the type or quantity of transit service as perceived by the riding public. These can include service expansions, introduction of new or specialized services, and route restructuring.

**Table 2. Frequency of Reported Internal Factors Contributing to Ridership Growth**

<table>
<thead>
<tr>
<th>Internal Programs</th>
<th>Very Small</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
<th>Very Large</th>
<th>Total</th>
<th>Average</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 29)</td>
<td>(n = 13)</td>
<td>(n = 22)</td>
<td>(n = 17)</td>
<td>(n = 22)</td>
<td>(n = 103)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Service Improvements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service Expansion</td>
<td>23</td>
<td>13</td>
<td>17</td>
<td>14</td>
<td>16</td>
<td>83</td>
<td>81%</td>
<td>1</td>
</tr>
<tr>
<td>Route Restructuring</td>
<td>19</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>8</td>
<td>62</td>
<td>60%</td>
<td>2</td>
</tr>
<tr>
<td>Introduction of New/Specialized Services</td>
<td>14</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>11</td>
<td>51</td>
<td>50%</td>
<td>4</td>
</tr>
<tr>
<td><strong>Fare Innovations and Changes</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>New Payment Options</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>29</td>
<td>28%</td>
<td>6</td>
</tr>
<tr>
<td>Universal Fare Coverage Programs (UFC)</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>9</td>
<td>28</td>
<td>27%</td>
<td>7</td>
</tr>
<tr>
<td>Fare Increases and Decreases</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>20</td>
<td>19%</td>
<td>9</td>
</tr>
<tr>
<td><strong>Marketing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Advertising/Information Programs</td>
<td>20</td>
<td>9</td>
<td>12</td>
<td>7</td>
<td>11</td>
<td>59</td>
<td>57%</td>
<td>3</td>
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<tr>
<td>Market Segmentation/Niche Marketing</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>10</td>
<td>10%</td>
<td>10</td>
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<tr>
<td><strong>Partnerships and Community Collaborations</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employer-based Partnerships (incl. UFC)</td>
<td>3</td>
<td>7</td>
<td>6</td>
<td>9</td>
<td>8</td>
<td>33</td>
<td>32%</td>
<td>5</td>
</tr>
<tr>
<td>University-based Partnerships (incl. UFC)</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>25</td>
<td>24%</td>
<td>8</td>
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<tr>
<td>Community Outreach and Local Government</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>7%</td>
<td>11</td>
</tr>
<tr>
<td>Social Services Collaborations</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>5%</td>
<td>14</td>
</tr>
<tr>
<td><strong>Service Quality and Amenities</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Improved Schedule/Service Reliability</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>7%</td>
<td>11</td>
</tr>
<tr>
<td>Park-and-Ride Lots</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td>6%</td>
<td>13</td>
</tr>
<tr>
<td>Rail Development</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>5%</td>
<td>14</td>
</tr>
<tr>
<td>Transit Center Improvements</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>3%</td>
<td>16</td>
</tr>
<tr>
<td>Safety, Cleanliness</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>3%</td>
<td>16</td>
</tr>
<tr>
<td>New Buses</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2%</td>
<td>18</td>
</tr>
</tbody>
</table>

**Note:** Multiple-responses, do not sum to 100%.

a. Questionnaire results reflect perceptions of exports and not necessarily causal explanations of ridership increases.

b. Results do not reflect transit managers' views on the relative effectiveness of each measure because these data do not include responses from transit managers who implemented these measures but did not perceive them to have an effect on ridership.

c. Internal programs are ranked in descending order based on the average reported in column [7].
### Table 3. Reported Transit Service Improvements Contributing to Ridership Growth

<table>
<thead>
<tr>
<th>Agency Name</th>
<th>Effectiveness</th>
<th>Type of Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Small</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alameda Ferry Services</td>
<td>Very effective</td>
<td>Frequency—linking activity center</td>
</tr>
<tr>
<td>Alameda Ferry Services</td>
<td>Very effective</td>
<td>New Service—new park-and-ride shuttle</td>
</tr>
<tr>
<td>Cape Cod Regional Transit Authority</td>
<td>Did not specify</td>
<td>New Service—summer trolley</td>
</tr>
<tr>
<td>Dutchess County Division of Mass Transportation (LOOF)</td>
<td>Did not specify</td>
<td>New Service—medical transportation</td>
</tr>
<tr>
<td>Eau Claire Transit System</td>
<td>Did not specify</td>
<td></td>
</tr>
<tr>
<td>Massachusett Regional Transportation Authority</td>
<td>Some effective</td>
<td>Temporal—extended evening and/or weekend</td>
</tr>
<tr>
<td>Redding Area Bus Authority</td>
<td>Some effective</td>
<td>Temporal—extended evening and/or weekend</td>
</tr>
<tr>
<td>Tri-State Transit Authority</td>
<td>Did not specify</td>
<td></td>
</tr>
<tr>
<td>Tri-State Transit Authority</td>
<td>Very effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Tuscaloosa County Parking and Transit Authority</td>
<td>Very effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td><strong>Small</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lakeland Area Transit District</td>
<td>Somewhat effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Sonoma County Transit</td>
<td>Some effective</td>
<td>Restructure Routes—better transfers</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ann Arbor Transportation Authority</td>
<td>Very effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Central Arkansas Transit Authority</td>
<td>Some effective</td>
<td>Restructure Routes—to serve university connections</td>
</tr>
<tr>
<td>Grand Rapids Transit Authority</td>
<td>Some effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Kalamazoo Metro Transit System</td>
<td>Very effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Lexington-Fayette County Transportation Authority</td>
<td>Did not specify</td>
<td>New Service—senior routes and expanded paratransit</td>
</tr>
<tr>
<td>Lexington-Fayette County Transit Authority</td>
<td>Some effective</td>
<td></td>
</tr>
<tr>
<td>Monorail Transit of Seattle</td>
<td>Some effective</td>
<td></td>
</tr>
<tr>
<td>Rock Island County Metrolink</td>
<td>Some effective</td>
<td></td>
</tr>
<tr>
<td>Salem Area Mass Transit District</td>
<td>Some effective</td>
<td></td>
</tr>
<tr>
<td>Sunline Transit Agency</td>
<td>Some effective</td>
<td></td>
</tr>
<tr>
<td>Sunline Transit Agency</td>
<td>Some effective</td>
<td></td>
</tr>
<tr>
<td>VOTRAN - County of Volusia</td>
<td>Very effective</td>
<td>Restructure Routes—to serve university connections</td>
</tr>
<tr>
<td>Whatcom Transportation Authority</td>
<td>Some effective</td>
<td>Restructure Routes—connect university and shopping</td>
</tr>
<tr>
<td>Wichita Transit</td>
<td>Some effective</td>
<td>New Service—neighborhood routes</td>
</tr>
<tr>
<td><strong>Large</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital District Transportation Authority</td>
<td>Did not specify</td>
<td>New Service—wellness-to-work</td>
</tr>
<tr>
<td>Central Ohio Transit Authority</td>
<td>Some effective</td>
<td>Restructure Routes—use of circulators</td>
</tr>
<tr>
<td>Charlotte DOT</td>
<td>Some effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Corpus Christi Regional Transportation Authority</td>
<td>Very effective</td>
<td>Frequency</td>
</tr>
<tr>
<td>Flint Mass Transportation Authority</td>
<td>A Little</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Pinellas Suncoast Transit</td>
<td>Did not specify</td>
<td>New Service—job access</td>
</tr>
<tr>
<td>Pinellas Suncoast Transit</td>
<td>Very effective</td>
<td>New Service—bus beach trolley</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Very effective</td>
<td>Restructure Routes—improve direct connections</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Very effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Suburban Mobility Authority</td>
<td>Very effective</td>
<td>New Service—medical transportation</td>
</tr>
<tr>
<td>Suburban Mobility Authority</td>
<td>Very effective</td>
<td>New Service—paratransit</td>
</tr>
<tr>
<td>Suburban Mobility Authority</td>
<td>Very effective</td>
<td>Restructure Routes—suburban job growth areas</td>
</tr>
<tr>
<td><strong>Very Large</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alameda/Contra Costa Transit District</td>
<td>Very effective</td>
<td>Temporal—extended evening and/or weekend</td>
</tr>
<tr>
<td>Chicago Transit Authority</td>
<td>Did not specify</td>
<td>New Service—limited stop service</td>
</tr>
<tr>
<td>Los Angeles County Metropolitan Transportation Authority</td>
<td>Very effective</td>
<td>New Service—rapid bus</td>
</tr>
<tr>
<td>Miami-Dade Transit</td>
<td>Some effective</td>
<td>New Service—rapid bus</td>
</tr>
<tr>
<td>Port Authority of Allegheny</td>
<td>Some effective</td>
<td>Restructure Routes—express and shuttle</td>
</tr>
<tr>
<td>Santa Clara Valley Transportation Authority</td>
<td>Some effective</td>
<td>Frequency</td>
</tr>
<tr>
<td>Santa Monica Municipal Bus</td>
<td>Very effective</td>
<td>Geographic—area expansion</td>
</tr>
<tr>
<td>Santa Monica Municipal Bus</td>
<td>Very effective</td>
<td>Temporal—extended evening and/or weekend</td>
</tr>
</tbody>
</table>

Note: Only agencies that specified the type of expansion are included above.
Service Expansion. Service expansions mentioned by respondents include programs that increase service hours, provide additional or extended evening and/or weekend service, and expand the geographic coverage area through new routes. At least 73 percent of transit systems in all size categories, and 81 percent of all agencies, reported that service expansions and changes contributed to ridership increases (Table 2).

Introduction of New/Specialized Services. Agencies also reported that the introduction of new services targeted to populations with specialized needs (e.g., welfare-to-work recipients, tourists, the disabled, and senior citizens) helped increase ridership. Fifty percent of all responding transit systems, ranging from 35 percent of large systems to 77 percent of small systems, report that new and specialized services contributed to their ridership increase (Table 2). Some service changes were implemented in response to changing urban form and travel patterns; for example, the Sunline Transit Agency (CA) introduced intercity commuter services to meet growing suburbanization and increasing travel distances.

Route Restructuring. Most of the route restructuring reported by transit systems involved service modifications (e.g., redesigning routes for efficiency, simplifying routes for user-friendliness, eliminating unproductive service, redirecting obsolete service, eliminating deviations, coordinating radial/grid routes, creating tiered systems of transit, and focusing service on major corridors and activity centers). Above all, transit officials report that they attempt to structure services to better match an increasing variety of travel needs within diverse markets. These special needs include commuter travel from suburb-to-suburb, seasonal tourism, welfare-to-work transportation, and medical transportation programs. For example, the Redding (CA) Area Bus Authority reports that improved service and broader coverage has diversified mode choice options for many trips.

Table 3 identifies agencies that specifically cited particular types of service improvements—either through expanded geographic coverage area, temporal expansion of service (i.e., new evening and/or weekend service), route restructuring, or the introduction of specialized services—with the reported degree to which respondents attribute ridership increases to service improvements.

Fare Innovations and Changes. Fare and pricing adaptations that change the fare level, fare media, or payment options alter the price of transit service rela-
tive to its quality and convenience. Types of fare adjustments mentioned by respondents include changes in base fares, passes and discounting strategies, changes to transfer policies that effectively lowered fares, and partnerships with businesses or other organizations or institutions to provide discounts or universal fare coverage.

**Fare Decreases and Freezes.** Nineteen percent of all responding transit systems, ranging from less than 5 percent of medium systems to 41 percent of very small systems, report that a fare decrease helped increase their ridership (Table 2). Some transit agencies use deep discount pricing strategies by offering a per ride discount with the purchase of multiple rides, which increases ridership without losing much fare revenue (Oram 1990). In addition, some transit systems have kept cash fares the same for many consecutive years in the face of inflation, which is a *de facto* fare decrease. For example, the Cape Ann (MA) Transportation Authority kept its shuttle fares at $0.25 and $0.50, and reports that the low fares have helped increase ridership over time. Similarly, the Orange County (CA) Transportation Authority, which has not instituted a fare hike in nine years, reports that its ridership growth may be due in part to steady fares.

Special fare promotions and "free fare" events, however, have been used to a lesser extent to increase ridership. Ben Franklin Transit (WA) experimented with fare-free local routes on Wednesdays and Saturdays. The agency found that the free days introduced new riders to the system, thus increasing ridership on regular fare days. Although the agency reports reduced revenue from the free service, the loss was minimal since fares were only $0.40 to $0.50.

**New Payment Options.** Technological advances in recent years have brought stored value card technology to transit, and in some cases transit cards can be used on more than one transit system. Twenty-eight percent of all responding transit systems, ranging from 9 percent of medium systems to 47 percent of large systems, report that new payment options helped increase their ridership (Table 2). Omnitrans (CA) reports that it has equipped buses in Riverside with new add-on farebox units for handling the new technology, offering passengers a choice among a variety of fare media at minimum operations costs. Rhode Island Public Transit Authority (RIPTA) also has created one-day and family passes that are targeted to tourists. Other agencies, such as Bay Area Rapid Transit (BART) and Sonoma County Transit (both in California) have
also provided pass sales over the Internet and credit card and debit card payment options at stations. Many of the respondents believe that the new flexibility in fare payment has helped increase ridership, although its degree of effectiveness is relatively small when compared with fare media changes. Most agencies that reported fare media changes—generally discounted passes or ride cards that also lowered fares for frequent riders—reported a greater degree of effectiveness in increasing ridership.

Table 4. Reported Fare Restructuring Contributing to Ridership Growth

<table>
<thead>
<tr>
<th>Agency Name</th>
<th>Effectiveness</th>
<th>Type of Program or Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Small</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eau Claire Transit System</td>
<td>Very effective</td>
<td>Fare decrease</td>
</tr>
<tr>
<td>Eau Claire Transit System</td>
<td>Very effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Laguna Beach Municipal Transit</td>
<td>Somewhat effective</td>
<td>Employee-based program—fare subsidy</td>
</tr>
<tr>
<td>Pasco County Public Transportation</td>
<td>Did not specify</td>
<td>Fare decrease</td>
</tr>
<tr>
<td>Tri-State Transit Authority</td>
<td>Very effective</td>
<td>Fare decrease (33%)</td>
</tr>
<tr>
<td>Small</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City of Rochester</td>
<td>Very effective</td>
<td>Employer-based program—universal fare coverage</td>
</tr>
<tr>
<td>Greater Portland Transit</td>
<td>Very effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Logan Transit District</td>
<td>Did not specify</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Madison County Transit District</td>
<td>Did not specify</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Sonoma County Transportation Authority</td>
<td>Did not specify</td>
<td>Free local fares on Wednesdays and Sundays</td>
</tr>
<tr>
<td>Sonoma County Transit</td>
<td>Somewhat effective</td>
<td>Employer-based program—universal fare coverage for county employees</td>
</tr>
<tr>
<td>Sonoma County Transit</td>
<td>Not effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ann Arbor Transportation Authority</td>
<td>Very effective</td>
<td>Employer-based program—Go Passes in downtown</td>
</tr>
<tr>
<td>Ben Franklin Transit</td>
<td>Did not specify</td>
<td>Free local fares on Wednesdays and Sundays</td>
</tr>
<tr>
<td>Kalamazoo Metro Transit System</td>
<td>Very effective</td>
<td>Employer-based program—universal fare coverage</td>
</tr>
<tr>
<td>Salem Area Mass Transit</td>
<td>Did not specify</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Salem Area Mass Transit</td>
<td>Somewhat effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Weymouth Transit</td>
<td>Somewhat effective</td>
<td>Employer-based program—passes sold in bulk at discount</td>
</tr>
<tr>
<td>Weymouth Transit</td>
<td>Not effective</td>
<td>University-based program—limited rides for students</td>
</tr>
<tr>
<td>Large</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital District Transportation Authority</td>
<td>Very effective</td>
<td>Employer-based program—passes sold in bulk at discount</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Very effective</td>
<td>Conversion from zone-based to flat fare structure</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Somewhat effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Snobucks Community Transit</td>
<td>Did not specify</td>
<td>Employer-based program—universal fare coverage</td>
</tr>
<tr>
<td>Snobucks Community Transit</td>
<td>Did not specify</td>
<td>Employer-based program—passes sold in bulk at discount</td>
</tr>
<tr>
<td>Suburban Mobility Authority</td>
<td>Very effective</td>
<td>University-based program—universal fare coverage for new employees</td>
</tr>
<tr>
<td>Very Large</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alameda/Contra Costa Transit District</td>
<td>Very effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Chicago Transit Authority</td>
<td>Somewhat effective</td>
<td>Pass prices reduced</td>
</tr>
<tr>
<td>Chicago Transit Authority</td>
<td>Somewhat effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Denver Regional Transportation Authority</td>
<td>Somewhat effective</td>
<td>Employer-based program—universal fare coverage</td>
</tr>
<tr>
<td>Denver Regional Transportation Authority</td>
<td>Somewhat effective</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Long Island Bus</td>
<td>Very effective</td>
<td>Free transfers, purchase discounts</td>
</tr>
<tr>
<td>New Jersey Transit</td>
<td>Somewhat effective</td>
<td>Fare freeze</td>
</tr>
<tr>
<td>Port Authority of Allegheny</td>
<td>Somewhat effective</td>
<td>Employer-based program—discount passes and tax incentive</td>
</tr>
<tr>
<td>Port Authority of Allegheny</td>
<td>Very effective</td>
<td>University-based program—discounted school zone</td>
</tr>
<tr>
<td>Portland Tri-Met Sacramento RTD</td>
<td>Did not specify</td>
<td>Employer-based program—universal fare coverage</td>
</tr>
<tr>
<td>Queens Surface Corporation</td>
<td>Very effective</td>
<td>Free transfers, first transfer</td>
</tr>
<tr>
<td>Sacramento Regional Transit District</td>
<td>Did not specify</td>
<td>University-based program—universal fare coverage</td>
</tr>
<tr>
<td>Santa Clara Valley Transportation Authority</td>
<td>Somewhat effective</td>
<td>Employer-based program—universal fare coverage</td>
</tr>
</tbody>
</table>

Note: Only agencies that specified the type of fare program are included above.
<table>
<thead>
<tr>
<th>Agency Name</th>
<th>Effectiveness</th>
<th>Type of Program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Small</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alameda County Transit</td>
<td>Did not specify</td>
<td>Improve public information, new marketing staff position</td>
</tr>
<tr>
<td>Arlington Department of Parking and Transportation</td>
<td>Did not specify</td>
<td>Market segmentation—well-to-work, disabled riders</td>
</tr>
<tr>
<td>City of Kansas City KATS</td>
<td>Did not specify</td>
<td></td>
</tr>
<tr>
<td>Columbia Area Transit System</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Laguna Beach Municipal Transit</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Missoula Urban Transport</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Porta County Transit</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Sioux Falls Transit</td>
<td>Very effective</td>
<td>Advertising/General, market segmentation—new residents</td>
</tr>
<tr>
<td><strong>Small</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escambia County Area Transit</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Five Seasons Transportation</td>
<td>Did not specify</td>
<td>New marketing staff position</td>
</tr>
<tr>
<td>Greater Portland Transit</td>
<td>Somewhat effective</td>
<td>In-house marketing</td>
</tr>
<tr>
<td>Lake Area Transit District</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Livinmore/Amador Valley</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Logan Transit District</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Sonoma County Transit</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Space Coast Area Transit</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Tri-State Transit Authority</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Walasha Transit Commission</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Yuba-Sutter Transit Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ann Arbor Transportation Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Connecticut Transit-Stamford Division</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Grand Rapids Transit Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Lexington-Fayette County Transportation Authority</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Salem Area Mass Transit Authority</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Sunline Transit Agency</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Agency Name</td>
<td>Effectiveness</td>
<td>Type of Program</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>---------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Alameda/Contra Costa Transit District</td>
<td>Somewhat effective</td>
<td>Market segmentation—San Francisco</td>
</tr>
<tr>
<td>Charlotte DOT</td>
<td>Very effective</td>
<td>Market segmentation—etail</td>
</tr>
<tr>
<td>Clark County Public Transportation Benefit Area Auth.</td>
<td>Did not specify</td>
<td>Market segmentation—periodic, targeted</td>
</tr>
<tr>
<td>Corpus Christi Regional Transportation Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Golden Gate Bridge Highway and Transp. District</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Miami Valley Regional Transportation Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Pinellas Suncoast Transit</td>
<td>Very effective</td>
<td>Improve local image</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Very effective</td>
<td>Improve local image, market segmentation—new residents</td>
</tr>
<tr>
<td>St. Louis Community Transit</td>
<td>Did not specify</td>
<td>Market segmentation—employees</td>
</tr>
<tr>
<td>Suburban Mobility Authority</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Very Large</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BART-San Francisco</td>
<td>Somewhat effective</td>
<td>New website</td>
</tr>
<tr>
<td>Denver Regional Transportation District</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Long Island Bus</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Los Angeles County Metropolitan Transportation Auth.</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Port Authority of Allegheny</td>
<td>Somewhat effective</td>
<td>Improve local image, advertising, logo charge</td>
</tr>
<tr>
<td>Santa Clara Valley Transportation Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Santa Monica Municipal Bus</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Southwest Ohio Regional Transit Authority</td>
<td>Very effective</td>
<td>Advertising/General</td>
</tr>
<tr>
<td>Tecoma-Fierce Transit</td>
<td>Very effective</td>
<td>Market segmentation—directed mailings</td>
</tr>
<tr>
<td>Washington Metropolitan Area Transit Authority</td>
<td>Somewhat effective</td>
<td>Advertising/General</td>
</tr>
</tbody>
</table>

Note: Only agencies that specified the type of marketing program are included above.
Universal Fare Coverage Programs. In combining fare discounts and the innovation of new fare media and payment options, some agencies have implemented universal fare coverage programs in partnerships with local agencies, businesses, or institutions. In a universal fare coverage program, local public transit systems provide fare-free transit service for all members of a particular community, such as employees of a business or students of a local university or school. The partnering agency or institution typically pays the transit agency an annual lump sum based on expected ridership, and riders show their business or school identification to receive either free or heavily discounted transit rides. Table 4 summarizes the types of fare programs or changes that agencies reported and the degree to which the respondents believe they have affected increased ridership.

Fifteen agencies attributed ridership increases to university-based fare programs, of which 13 agencies reported that the programs significantly helped increase ridership. Thirteen agencies surveyed reported that partnerships with businesses—either employer subsidized passes or universal fare coverage—helped increase ridership levels. The City of Rochester (MN), Ann Arbor Transportation Authority (MI), Salem Area Mass Transit (OR), Capital District Transportation Authority (NY), and Suburban Mobility Authority (MI) all reported that such programs were highly effective in increasing ridership.

Marketing. New marketing strategies include general information programs and programs targeted at specific riders or specific services. Marketing strategies increase the level of information about transit services without actual changes to the services themselves. Table 5 summarizes the types of marketing programs or efforts that agencies reported and the degree to which the respondents believe they have increased ridership.

Advertising and Information Programs. In all size categories, more than half of the respondents made reference to marketing initiatives as major factors. Fifty-seven percent of all responding transit systems, ranging from 41 percent of large systems to 69 percent of very small and small systems, report that general marketing and advertising campaigns helped increase their ridership (Table 2).

Market Segmentation and Niche Marketing. Transit agencies have pursued innovative marketing techniques aimed at certain submarkets. Market segmentation, widely used throughout the transit industry, is the practice of identifying groups of people who have similar characteristics or needs and who are
likely to exhibit similar purchase behavior and/or responses to changes in the marketing mix (Elmore-Yalch 1998). Ten percent of all responding transit systems report that market segmentation defined by geographic area, trip purpose, or socioeconomic characteristics helped increase ridership (Table 2). For example, Kingsport (TN) Area Transit Service targets markets that are most likely to rely on transit service: welfare recipients, low-income workers, and disabled citizens. Chicago (IL) Metra emphasizes niche marketing to off-peak and discretionary, reverse commute, and suburb-to-suburb riders, to broaden their market beyond traditional downtown riders.

**Partnerships and Community Collaborations.** When transit systems coordinate services with businesses, organizations, or institutions, they attempt to address the needs of a specific market on a unique basis. In particular, transit

<table>
<thead>
<tr>
<th>Agency Name</th>
<th>Nature of Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Small</strong></td>
<td></td>
</tr>
<tr>
<td>Columbia Area Transit System</td>
<td>Three area universities—coordinate service</td>
</tr>
<tr>
<td>Dutchess County Division of Mass Transp.</td>
<td>Citizen, businesses, and county officials—meet needs</td>
</tr>
<tr>
<td>Missoula Urban Transport</td>
<td>Employers and community—neighborhood passes</td>
</tr>
<tr>
<td>Sioux Falls Transit</td>
<td>Government—build support for funding transit</td>
</tr>
<tr>
<td>Springfield City Area Transit</td>
<td>Social service agencies—most targeted needs</td>
</tr>
<tr>
<td><strong>Small</strong> City of Vesta - Vesta City Coach</td>
<td>Social service agencies—most targeted needs (welfare-to-work)</td>
</tr>
<tr>
<td>Five Seasons Transportation</td>
<td>Local government—build support</td>
</tr>
<tr>
<td>Greater Portland Transit</td>
<td>Businesses and university—coordinate service</td>
</tr>
<tr>
<td>Lakeland Area Transit District</td>
<td>Businesses—provide fare promotion programs</td>
</tr>
<tr>
<td><strong>Medium</strong> Ann Arbor Transportation Authority</td>
<td>Collaboration with university to coordinate airport service</td>
</tr>
<tr>
<td>Central Arkansas Transit Authority</td>
<td>Citizen—develop priorities for transit investment</td>
</tr>
<tr>
<td>Kalamazoo Metro Transit System</td>
<td>Students, transit operators, university—route development</td>
</tr>
<tr>
<td>Rock Island County Metrolink</td>
<td>Local government, communities—joint development of transit center</td>
</tr>
<tr>
<td>Salem Area Mass Transit District</td>
<td>Businesses, community leaders, government, media—public support for transit</td>
</tr>
<tr>
<td>Whatcom Transportation Authority</td>
<td>Shopping mall and university—improve connections</td>
</tr>
<tr>
<td><strong>Large</strong> First Mass Transportation Authority</td>
<td>Employers, communities—improve service</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Social service agencies—most targeted needs, education of stakeholders</td>
</tr>
<tr>
<td>Suburban Mobility Authority</td>
<td>Local governments, employers, social service agencies—creation of &quot;ombudsman&quot;</td>
</tr>
<tr>
<td>Tacoma Pierce Transit</td>
<td>Businesses—rideshare and commuter services</td>
</tr>
<tr>
<td><strong>Very Large</strong> Denver Regional Transportation District</td>
<td>Businesses—meet employer needs</td>
</tr>
</tbody>
</table>

Note: Only agencies that specified the type of collaboration are included above.
systems in recent years have begun to enter into partnership with colleges and universities, employers, housing developers, and social service agencies and clients. In addition to universal fare coverage mentioned previously, transit systems report that they have increased ridership because they reach a wider range of citizens by adding new service or tailoring existing service to the riding patterns of specifically targeted groups. Table 6 presents collaborative programs reported by respondents.11

Employer-based Partnerships. Several agencies reported that they work in cooperation with local businesses to provide service to employees, reduce parking pressures on businesses, and encourage a higher transit mode split. Thirty-two percent of all agencies, ranging from 10 percent of very small systems to 54 percent of small systems, reported some interaction or collaboration with the local business community such as universal fare coverage programs, information programs, or service planning. For example, RIPTA, Chicago (IL) Transit Authority, and Tacoma-Pierce (WA) Transit have partnered with local businesses to provide commuter benefit and rideshare programs.

University-based Partnerships. Rosenbloom (1998) and Brown et al. (2001) find that university-based transit programs are among transit's key success stories in the United States. Twenty-five transit systems (or 24% of transit systems responding to the questionnaire) report that coordination with colleges and universities in their service area helped increase ridership by gearing transit service toward the university community. Ten percent of the very small, 31 percent of small, 32 percent of medium, 29 percent of large, and 27 percent of very large agencies reported working with universities to better serve travel needs and thus increase ridership.

Community Outreach and Local Government. Seven percent of the agencies reported that support from citizens and local governments has been critical in implementing service to attract riders. Through community meetings and local government support, agencies are better able to address public needs, build support and consensus, and develop community objectives and priorities. Most important, these outcomes led to an increased likelihood for funding. For instance, Sioux Falls (SD) Transit reported that its city government strongly supported transit, and this has ensured funding and facilitated marketing.
Increasing Transit Ridership

Social Services Collaborations. Five percent of all responding transit systems also report that partnerships established with human and social service agencies have helped boost ridership (Table 2). Transit systems are assessing how public transit can address the needs of the potential market. Three transit systems report that their coordination with welfare-to-work programs has helped increase ridership: Kingsport (TN) Area Transit Service (KATS), Visalia City (CA) Coach, and Five Seasons Transportation (Cedar Rapids, IA). Usually the county

Table 7. Reported Service Quality and Amenities Contributing to Ridership Growth

<table>
<thead>
<tr>
<th>Agency Name</th>
<th>Type of Amenity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very Small</strong></td>
<td></td>
</tr>
<tr>
<td>Cape Ann Transportation Authority</td>
<td>Park-and-Ride lots/shuttles</td>
</tr>
<tr>
<td>Sioux Falls Transit</td>
<td>New buses</td>
</tr>
<tr>
<td>Space Coast Area Transit</td>
<td>Bus stop amenities</td>
</tr>
<tr>
<td><strong>Small</strong></td>
<td></td>
</tr>
<tr>
<td>City of Rochester</td>
<td>Park-and-ride lots/shuttles</td>
</tr>
<tr>
<td>Greater Roanoke Transit</td>
<td>Park-and-ride lots/shuttles</td>
</tr>
<tr>
<td>Livermore/Armador Valley</td>
<td>Rail development</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td></td>
</tr>
<tr>
<td>Ann Arbor Transportation Authority</td>
<td>Park-and-ride lots/shuttles</td>
</tr>
<tr>
<td>Lexington-Fayette County Transportation Authority</td>
<td>Bus stop amenities</td>
</tr>
<tr>
<td>Rock Island MetroLink</td>
<td>Transit center</td>
</tr>
<tr>
<td>Salem Area Mass Transit</td>
<td>Park-and-ride lots/shuttles</td>
</tr>
<tr>
<td><strong>Large</strong></td>
<td></td>
</tr>
<tr>
<td>Fresno Area Express</td>
<td>Safety, cleanliness</td>
</tr>
<tr>
<td>Fresno Area Express</td>
<td>Reliability</td>
</tr>
<tr>
<td>Montebello Bus Lines</td>
<td>Safety, cleanliness</td>
</tr>
<tr>
<td>Montebello Bus Lines</td>
<td>Reliability</td>
</tr>
<tr>
<td>Pinellas Suncoast Transit</td>
<td>Bus stop amenities</td>
</tr>
<tr>
<td>Pinellas Suncoast Transit</td>
<td>New buses</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Safety, cleanliness</td>
</tr>
<tr>
<td>Rhode Island Public Transit Authority</td>
<td>Reliability</td>
</tr>
<tr>
<td><strong>Very Large</strong></td>
<td></td>
</tr>
<tr>
<td>Chicago-RTA-Metro</td>
<td>Park-and-ride lots/shuttles</td>
</tr>
<tr>
<td>Denver Regional Transportation Authority</td>
<td>Rail development</td>
</tr>
<tr>
<td>Los Angeles County MTA</td>
<td>Rail development</td>
</tr>
<tr>
<td>Massachusetts Bay Transportation Authority</td>
<td>Rail development</td>
</tr>
<tr>
<td>Queens Surface Corporation</td>
<td>New buses</td>
</tr>
<tr>
<td>San Juan MTA</td>
<td>Reliability</td>
</tr>
<tr>
<td>Southwest Ohio Regional Transit Authority</td>
<td>Park-and-ride lots/shuttles</td>
</tr>
<tr>
<td>Washington Metro Area Transit Authority</td>
<td>Rail development</td>
</tr>
</tbody>
</table>

Note: Only agencies that specified the type of quality/amenity program are included above.
department of welfare purchases transit passes from the transit system for eligible clients to facilitate travel to social service agencies, job training centers, and potential employment locations that are dispersed across a wide geographic area.

Some transit systems have been successful in converting a large number of taxi and medical transportation passengers to public transit. In Poughkeepsie (NY), the Dutchess County Mass Transit acquired responsibilities for the County Medicaid Transportation program. In addition, some systems report modifying and expanding bus routes to meet the needs of the traveling public. KATS also reports that it serves a large number of disabled passengers; when the City eliminated its taxi subsidy program, many passengers shifted to transit.

Service Quality and Amenities. Many of the survey respondents mentioned the importance of improvements or enhancements to the quality and reliability of current or new transit services. Apart from service modifications, some transit systems have made service quality improvements that have helped increase ridership. Twenty-five percent of all responding transit systems report that passenger amenities and other quality improvements that enhance the experience of riding transit helped increase ridership (Table 2). These service quality and amenity improvements include reducing headways; increasing service frequencies; improving service reliability; adding bus shelters, benches, signage at bus stops, and park-and-ride lots at rail stations; and improving safety and cleanliness. Table 7 summarizes the amenity improvements reported.12

Park-and-Ride Lots. Several transit systems report that they have coordinated transit services with parking. Five Seasons Transportation has assumed management of downtown parking in Cedar Rapids (IA) and subsidizes citywide transit with downtown parking revenue. Other systems operate suburban park-and-ride facilities. Chicago's Metra, Salem (OR) Area Mass Transit District, Southwest Ohio Regional Transit Authority, Ann Arbor Transportation Authority, Greater Roanoke (VA) Transit, Cape Ann (MA) Transportation Authority, and City of Rochester (MN) maintain park-and-ride lots and attribute ridership growth, in part, to commuters.

Rail Development. Five agencies report that rail projects have been helpful in increasing ridership during the late 1990s. Livermore/Amador Valley (CA) attributes 20 percent of its ridership growth to BART's extension into its service
Increasing Transit Ridership

area. The Los Angeles County (CA) MTA and Washington (DC) Metropolitan Area Transit Authority both report that expanded rail routes and services were a major factor contributing to the ridership increases. Denver (CO) Regional Transportation District also attributes ridership growth to a new light rail line serving suburban commuters. The agency reports that future plans include further light rail development and the linking of buses into the rail configuration. Boston’s MBTA reports that commuter rail expansion has heavily contributed to ridership growth by increasing capacity and improving the reliability of the transit system.

While rail development may increase system capacity and attract new riders, it may also increase the number of transfers needed to complete a journey and thus increase the number of unlinked passenger trips, but not the total number of linked trips.

Transit Center Improvements. A few respondents reported that their agencies had created or were in the process of developing new intermodal transit centers to help coordinate and improve transfers among transportation modes. These centers provide rider-friendly environments and amenities for waiting passengers. Rock Island (IL) Metrolink completed a new $8 million transfer center in 1998 as a joint development project between a municipality and a private development company. The transfer center was an integral part of a large downtown redevelopment program, and the transit system was a significant partner in economic development. According to the agency, the transit center allows more convenient and secure transfer between routes and provides greater mobility for residents.

Space Coast (FL) Area Transit and Pinellas (FL) Suncoast Transit and Lexington-Fayette County (KY) Transportation Authority reported improving and providing bus stop signage and information, shelters, or seating.

As with rail development, some of the increase in unlinked passenger trips associated with restructuring bus routes around transfer centers may be due to an increase in the number of transfers, but not necessarily to an increase in the number of linked passenger trips.

Safety, Cleanliness, Reliability, and Shortened Headways. Several agencies such as Fresno Area Express and Montebello Bus Lines (both in California) and Regional Public Transportation Authority (AZ) reported that safety and cleanliness were important factors in attracting riders by changing perceptions about
transit and increasing the comfort of the rides. Efforts to increase service reliability were also important in attracting riders and included shortening headways, increasing schedule adherence, and reducing wait times. San Juan (PR) Metropolitan Bus Authority aggressively works to comply with schedules and attributes ridership growth to their increasingly dependable service.

**New Buses.** While agencies often mentioned bus procurement as a factor in providing increased service, a few agencies specifically named acquiring new buses as a way to improve passenger comfort and convenience. Some respondents claim that the acquisition of new handicap-accessible, low-floor buses has been instrumental in attracting specific populations as well as increasing the reliability of the fleet for more dependable service.

Among the many internal factors identified by survey respondents, service improvements, such as service expansion, route restructuring, and introduction of new/specialized services, are the most frequently reported (Table 2). And service improvements were also most frequently cited by respondents as having positive effects on ridership (Table 3). Following service improvements, advertising/information programs were mentioned by more than half of the respondents. Views on the effectiveness of these programs were mixed, however; the managers of smaller transit systems were more likely than their counterparts in large transit systems to believe that advertising and information programs helped to increase patronage (Table 5). As noted in the literature review, few agencies implement fare freezes or reductions in an effort to increase ridership (Table 2), and respondents to the survey reported here were generally skeptical of their effectiveness, even managers of systems that implemented fare freezes or reductions (Table 5). In contrast to across-the-board fare reductions, two fare innovations—new payment options and universal fare coverage programs—were frequently cited as having significant effects on patronage (Table 5). Lastly, two forms of institutional partnering—employer-based and university-based—are cited by one-third and one-fourth of respondents, respectively (Table 2), as having significant effects on ridership growth (Table 6). Because many of the statistical analyses of transit ridership have found that external factors—those outside of the control of transit managers—have significant effects on changes in transit ridership, transit managers' perceptions of the importance of these factors are explicity analyzed in the following section.
Table 8. Frequency of Reported External Factors Contributing to Ridership Growth

<table>
<thead>
<tr>
<th>Factor</th>
<th>Very Small (n=29)</th>
<th>Small (n=13)</th>
<th>Medium (n=22)</th>
<th>Large (n=17)</th>
<th>Very Large (n=22)</th>
<th>Total (n=103)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population Growth</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>28</td>
<td>27%</td>
</tr>
<tr>
<td>Strong Economy/Employment</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>13</td>
<td>15</td>
<td>15%</td>
</tr>
<tr>
<td>More Congestion</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>11</td>
<td>11%</td>
</tr>
<tr>
<td>Increased Immigration/Transit Dependency</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Suburbanization/New Residential and Employment Areas</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Parking Shortage/Costs and Gas</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>4%</td>
</tr>
</tbody>
</table>

Note: Multiple-responses, do not sum to 100%.
a. Questionnaire results reflect perceptions of experts and not necessarily causal explanations of ridership increases.

Results do not reflect views of transit managers who implemented programs but found no significant ridership increase.
**External Factors**

External factors, outside the direct control of transit agencies, are less relevant to transit managers than internal factors, but nevertheless they are clearly important determinants of transit patronage. These external factors are subdivided into five categories: population growth, employment/economic growth, changing metropolitan form, and changes to the transportation system (Table 8).

*Population Growth and Increased Immigration/Transit Dependency.* Location in a rapidly growing metropolitan area contributes to the success of some transit systems. Regional population growth expands the pool of potential riders and usually results in more activity and more travel. High population growth was mentioned by survey respondents in all five agency-size categories and in all regions of the country. Some respondents identified particular growing population subgroups as important transit markets that have contributed to the growth in ridership. These subgroups include the Latino population for Santa Maria (CA) Area Transit and Annapolis (MD) Transit and senior citizens, many of whom are no longer able to drive automobiles, for the Pasco County (FL) Public Transportation Authority. Some agencies also target new residents moving into the service area to encourage transit use. Snohomish (WA) Community Transit and Sioux Falls (SD) Transit, for example, market to new residents in the area through targeted mailings or Welcome Wagon promotions.

*Employment Growth.* Since growth in employment generally accompanies growth in population, one can reasonably assume that accompanying employment growth also played a role in ridership increases. Previous research has found a relationship between system size and employment level. According to Kain and Liu (1996), "service miles supplied is a policy variable highly correlated with both employment and population in the service area." There are certain employment/worker subgroups that respondents have identified as contributing to their overall ridership increase. For example, the Jackson (TN) Transit Authority reports that large employment growth among part-time fast-food workers, who typically depend on transit for their commute to work, helped to increase ridership. In addition, local governments in some rapidly growing areas have partnered with transit agencies to increase and integrate transit service to attract businesses and light industrial companies to locate in the area.
Economic Growth. During the early 1990s, aggregate transit ridership nationwide was declining slightly, coinciding with lagging economic performance nationally. After the economic recession of 1989–1993 abated, the late 1990s were marked by a sustained period of economic growth nationwide. Some transit officials report that, with a healthy economy, more people are working, have more money to spend, and tend to travel more. For example, the Orange County (CA) Transportation Authority reports that an improved local economy in recent years has helped increase its ridership. Meanwhile, other transit officials report that transit ridership fell during the period of economic growth, concluding that the robust economy improved incomes and increased levels of automobile ownership, which led to increased auto travel and decreased transit use.

Some respondents report that their transit systems have begun to pay more attention to visitor and tourism demands. The Cape Cod (MA) Regional Transit Authority notes that an expanding tourist industry has helped increase its ridership. Transit systems also can make transit travel attractive to tourists through route design and payment options. As mentioned earlier, some agencies have created pass programs and specialized services to serve tourist and visitor needs. These include Escambia County (FL) Area Transit's beach trolleys and Rock Island County (IL) Metrolink's seasonal ferries. Seasonal peaking, however, may be difficult to manage in the long term because it does not efficiently use capital and labor throughout the year.

Changing Metropolitan Form. Many academics and researchers have attributed transit's decline in the United States to the suburbanization of jobs and households (Fielding 1995). Low-density suburban neighborhoods separate homes both from each other and from commercial establishments. Decentralized job sites and residences are difficult to serve by traditional public transit because transit works best when a large number of people are all headed to activity nodes that contain various destinations. Dense and compact sites are more conducive to efficient transit operations than dispersed and sprawling patterns of urban development. For suburban transit systems, however, growing suburbs mean more riders. While sprawling homes and worksites are blamed by many for decreasing transit use, the respondent from the Sacramento (CA) Regional Transit District reports that a state policy of locating office buildings along transit lines (both bus and rail) has helped boost ridership.
Changes to the Transportation System (Congestion, Parking Shortage/Costs, and Gas). Significant travel time and dollar savings can induce riders to switch from other modes to transit. Snohomish (WA) Community Transit reports that the addition of high-occupancy vehicle/bus lanes on the Interstate 5 corridor has helped boost its ridership by reducing the time costs of transit travel relative to single-occupancy driving. The transit system reports that its “commuter express” serves a well-defined commuter need and is an important market where transit can be competitive against the single-occupancy vehicle.

Changes to the price of traveling by automobile, which is transit’s chief competitor, can affect people’s mode choices. The Orange County (CA) Transportation Authority reports that the rising cost of owning an automobile (especially the cost of insurance and fuel) as well as stiff penalties for DWIs (driving while intoxicated) and driving without a license have helped increase ridership. In addition, 15 percent of all agencies pointed to increasing congestion and time costs of driving and believe that this disincentive to car use has given people an incentive to use transit. Other agencies, such as Whatcom (WA) Transportation Authority and Southwest Ohio Regional Transit Authority, reported that increasing parking costs, high demand for parking, and parking shortages have been influential factors in the agencies’ abilities to attract riders.

Several agencies also reported that regional construction projects, though localized and temporary, have also helped to increase the viability and attractiveness of transit use. Washington (DC) Metropolitan Area Transit Authority’s rail construction, Boston’s MBTA’s “Big Dig” highway/tunnel project, and highway and riverfront construction in the Southwest Ohio Regional Transit Authority’s area are all examples cited of local and temporary disruptions to transportation systems that have shifted some drivers to transit.

It was expected that respondents to the survey would be more likely to cite internal factors and less likely to cite external factors in explaining transit ridership growth on their systems. And this was, indeed, the case, though external factors were cited more often than we might have guessed. Among the six factors reported, population growth, economic/employment growth, and worsening traffic congestion are considered by the respondents to have significantly affected ridership. Interestingly, respondents from medium-sized, large, and very large agencies were far more likely to cite external factors than their counterparts at smaller systems.
Conclusions
This study conducted a national survey of transit agencies in the United States that added riders during the late 1990s to identify what factors are considered by transit managers to have most significantly influenced recent ridership growth. Transit managers were asked about recent changes in their systems and what factors—both internal and external—they believed to be most responsible for increasing ridership. Overall, service improvements were the most frequently cited factors. This is perhaps not surprising because (1) more frequent service and broader network coverage increases capacity to serve more riders, and (2) such service improvements often (though not always) occur in response to increasing demand.

While survey respondents were collectively skeptical of the effects of across-the-board fare reductions on ridership, they were generally enthusiastic about the influence of universal fare coverage programs (combinations of fare discounts and new fare media and payment options). These universal fare coverage and partnership programs represent the efforts of transit systems to improve their flexibility and responsiveness in meeting mobility needs of particular market segments and changing demographics and development patterns. Although several previous studies of transit ridership have found that service quality improvements (such as more reliable service, cleaner vehicles, safer, more attractive stops) trump fare reductions in attracting riders, relatively few respondents attributed patronage growth to improvements in the quality of service.

As expected, the transit managers surveyed were more likely to cite internal factors to their systems as responsible for increasing ridership, rather than external factors. Among those who cited external factors, population growth, economic/employment growth, and worsening traffic congestion were the most frequently mentioned. Only a few respondents cited policies or programs to increase the cost of driving (these concerned increases in parking costs); that such measures were rarely cited probably reflects the fact that such policies are, in most cases, beyond the control of transit managers, and not that they are ineffective in motivating transit use.

While one must keep in mind that the findings of this survey are limited to the perceptions of transit managers responding to the survey, this study does offer an illuminating snapshot of the strategies pursued by transit systems that added riders during the 1990s. In particular, transit systems have employed a wide array of fare and service innovations coincident with increasing patronage. While the causality between system changes and ridership growth is only hypothesized by
respondents to this survey, the respondents are, as a group, professionals for whom the relationship between transit service provision and transit service consumption is a daily (pre)occupation. As such, the findings here, at the very least, reflect the views of informed observers. As the next step in this research, we plan to complement this study with a statistical analysis of national ridership, service provision, and economic data in an effort to measure the relative effects of both internal and external factors on transit ridership in the 1990s.

Acknowledgments
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Endnotes

1. The NTD reports the number of unlinked trips. According to the American Public Transportation Association (APTA 2001), an unlinked transit trip is a trip on one transit vehicle. A person riding one vehicle from origin to destination takes one unlinked trip; a person who transfers to a second vehicle takes two unlinked trips; a person who transfers to a third vehicle takes three unlinked trips. APTA estimates that the number of people riding transit on an average weekday is 45 percent of the number of unlinked transit passenger trips.

2. These numbers are based on the Federal Transit Administration’s NTD and differ somewhat from the longer-term ridership statistics provided by APTA cited earlier. This is because the NTD includes only those agencies that receive federal funds and thus report to the FTA, while APTA estimates ridership for 6,000 transit systems, whether or not they report to the NTD. Most data cited in this study are drawn from the NTD, supplemented by the U.S. Census and the Nationwide Personal Transportation Survey.

3. Deep discount fare policies stratify transit markets into segments based on two primary factors: (1) frequency of use and (2) sensitivity to cost (Fleishman 1993). Such policies generally offer a per ride discount for the purchase of a multiple-rides pass or transit card, aiming to induce potential riders with low usage and high price sensitivity to increase overall transit patronage.

4. The NTD, formerly known as Section 15 database, is a system of accounts and records reported annually by the more than 500 transit systems that receive federal transit subsidies. These transit systems are required to report a wide range of data to the FTA concerning the finance and operation of their system. Although the NTD is clearly the best, comprehensive, cross-sectional transit data source, it is not without limitations. For example, not all systems report data to the NTD because systems that do not receive federal subsidies are not required to report. However, the transit systems operating the vast majority of service and carrying the vast majority of passengers in the United States do report to the NTD. The authors estimate that, nationwide, 93 percent of all transit ridership is counted in the NTD. The APTA estimates a grand total of 9.17 billion unlinked passenger trips taken in 1999, while the FTA’s NTD reports that 8.52 billion unlinked passenger trips were taken (8.52 ÷ 9.17 = 0.93). APTA’s ridership estimates are available online at http://www.apta.com/stats/ridershp.
5. Such as bus, trolleybus, light rail, heavy rail, commuter rail, ferryboat, cable car, inclined plane, monorail, jitney, or automated guideway.

6. For the many agencies that provide both fixed-route and demand-response or taxi services, the authors included data only on the fixed-route modes (so the data analyzed here may differ slightly from NTD published "totals" for each agency).

7. Most transit researchers would agree that linked trips (i.e., trips that include transfers) and passenger miles data (i.e., total trips * average trip length) are more telling and less biased measures of transit use. But reliable, comparable cross-sectional data for either of these measures of transit service consumption are simply not available. Lacking data on these measures, the authors (and nearly all previous research on transit ridership) use unlinked trip data.

8. In some cases, open-ended questions were grouped together based on similar responses.

9. Some observers may be surprised to learn that increasing ridership is typically not an explicit goal of transit systems, since it often conflicts with service utilization and budgetary goals. Nevertheless, some transit systems surveyed reported that increasing ridership is among their objectives. For example, the Cleveland (OH) LAKETRAN reported a goal of serving 1 million riders in 2001; the Antelope Valley (CA) Transit Authority intends to increase transit ridership by 5 percent per year; Chicago (IL) Metra hopes to increase growth 2 to 3 percent per year; Vallejo (CA) Transit intends to increase midday and weekend ridership on its ferry system; and the Orange County (CA) Transportation Authority has estimated that the system must grow by 50 percent in the next 5 or 6 years to accommodate forecast ridership.

10. A detailed review of universal fare payment programs in universities—also known as unlimited access—is given in Brown et al. (2001). The authors found that at the universities studied, student transit ridership increases ranged between 71 percent and 200 percent during the first year of unlimited access, and growth in subsequent years ranged between 2 percent and 10 percent per year.

11. Because partnerships were reported mostly in discussions of other programs and service changes, respondents often did not specify the degrees of effectiveness of partnership efforts. Table 6, therefore, does not include relative importance.
12. Because most amenities were reported as “other” service changes, respondents did not provide their views of each amenity’s degree of effectiveness in increasing ridership. Table 7, therefore, does not indicate the relative importance of the programs.

13. This relationship between fast food and transit ridership has, to the authors’ knowledge, been completely ignored in previous research.
References


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Innovatively Saving the Future of Transportation: Small Aircraft Transportation System (SATS)

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Abstract
The aviation industry is a rapidly changing entity of the world’s economy. Millions of travelers consistently choose aviation as their mode of transportation because it is reliable, time-efficient, and safe. However, high demand has led to delays, cancellations, and gridlock. As the need for efficient travel options increases, passengers will look for other avenues of travel. Fortuitously, the National Aeronautics and Space Administration (NASA) and its partners are developing a unique and innovative alternative to this problem. The solution, known as the Small Aircraft Transportation System (SATS), will likely change the face of general aviation (GA) as it is known today. It is a clear concept, made credible by extensive research. The members of the Public Administration Department and the Aviation Institute of the University of Nebraska at Omaha have committed many of their resources to the successful realization of the SATS concept. These individuals have formed a unique Nebraska SATS research team, devoting their valuable time and effort to seeing the dream of SATS come true.
Introduction
The aviation industry, a rapidly changing entity of the world's economy, has allowed a variety of individuals to expand their businesses as well as their horizons through the use of commercial air carriers. However, the high demand for air travel has led to delays, cancellations, and gridlock. Yet the need for efficient options for business and personal travel is anticipated to increase steadily. Most travelers will soon experience the symptoms of an aviation industry seemingly overwhelmed by the traffic it so desperately needs to survive.

Contributing to the attitude that air travel is unsafe and inefficient is the fact that areas of transportation other than aviation are also plagued by traffic accidents and delays. Highways throughout the nation and the world are becoming increasingly ineffective in delivering travelers to their destinations in a timely manner. According to William Fay, president and CEO of the American Highway Users Alliance, "traffic congestion is growing, (which is) threatening safety, stifling production, slowing deliveries, and taking time from . . . families" (2001).

Travelers have consistently chosen aviation as their mode of transportation because it is reliable, time-efficient, and safe. However, commercial airlines are required to follow routes that have been designated by the current hub-and-spoke system. This system emphasizes large airports and large aircraft and requires travelers to fly long distances through metropolitan areas to be advantageous. As these hubs become more and more crowded, passengers will look for other avenues of travel.

Perhaps consumers will look to the 5,000 small airports throughout the United States to alleviate their transportation problems. Unfortunately, these travelers will find that business strategies have not been created to address the air transport needs of rural and isolated communities. Even the Federal Aviation Administration (FAA) lacks the budget to deliver the efficiencies that the aviation industry demands. Without additional business to help maintain the facilities of these small airports, they will remain underutilized. The future of multifaceted air carriers looks bleak. An increase in safety and congestion problems has been predicted for both highways and runways. The decrease in client and customer satisfaction, coupled with a decrease in overall efficiency, will lead to loss of revenue, opportunities, and time.
Proposed Solutions
Perhaps constructing new runways and introducing new airports is the answer to the aviation industry’s crowding problems. Maybe larger aircraft to haul the increased traveling masses will provide the remedy. Increasing the cost of airline tickets could also dissuade passengers from using aviation. Twenty-four-hour airport operation and free flight could allow for additional flights on nondesignated paths. However, these solutions create new concerns.

Politics play a major role in the decision-making process. Thus, questions of environmental issues, noise problems, and funding associated with an increase in the number of runways and airports must be taken into account. The infrastructure, business plans, and organizational culture of individual airlines will determine whether changing aircraft size, ticket prices, and the number of flights is even feasible. Furthermore, travelers’ preferences will likely influence what solutions, if any, are chosen.

General Aviation as a Solution
Perhaps increasing the current hub-and-spoke system is not the most appropriate solution. GA seems to be a viable environment to cultivate a new system of travel. In fact, for distances of 500 miles or less, GA flights are faster. This segment of the industry could fill the gap between customer satisfaction and what the airlines can provide. The needs of rural and isolated communities could finally be met by utilizing GA. The opportunity for expansion is available and necessary. Eighty-seven percent of small airports still lack systems that allow precision instrument approaches (ILS). With the use of such facilities, short-distance travel would become increasingly efficient.

Pioneering GA revitalization programs have been introduced and are already being developed and enhanced. The Advanced General Aviation Transport Experiment (AGATE) is a cost-sharing, industry-university-government alliance initiated by NASA. It was established to create the advanced technological basis that future GA flights will require. In addition, the General Aviation Propulsion (GAP) program was created to develop revolutionary propulsion systems (engines) for light aircraft.

Aviation manufacturers, such as Cirrus and Lancair, have already begun development of aircraft that will be technologically advanced enough to function effectively within the future GA environment. On-demand, point-to-point service will be available through jet aircraft with airlinerlike capabilities and coachlike fares.
Japanese carmaker Toyota has also begun to establish its presence in the small airplane industry by producing an aircraft with the affordability and reliability of its high-end automobiles. Overall, those associated with aviation are becoming increasingly curious as to how GA can be utilized to save time and money.

However, there are a variety of questions surrounding the new developments that are being completed.

- Who will fly these technologically advanced aircraft?
- If congestion continues, how will travelers get to their destinations without delay?
- If highways become too inefficient, what method of travel will be used?

**Introducing a SATS**

NASA is developing a unique and innovative alternative to the current delay-driven transportation industry. This substitute for air carrier travel, SATS, will likely change the face of GA as it is known today. This system is considered to be a revolutionary concept in the provision of air transportation services.

SATS is defined as “an intermodal, personal, rapid transit, air travel system (with) the target consumer base (being) comprised of ... those consumers for whom the value of SATS transportation services can be economically or personally warranted” (Holmes 1999). This system will solve a variety of transportation problems while adding flexibility in air travel the likes of which the world has never seen.

Those who created this concept recognized the importance of time and remained sensitive to how long the execution of this system would take. Therefore, it was determined that SATS’s goal would be to reduce public travel time by half in 10 years and two-thirds in 25 years. In addition, this would be completed at costs equivalent to those for the highway system, increasing mobility for all of the nation’s communities through advanced on-demand air transportation. Those working on the development of this project have remained faithful to this time line and fully expect this goal to be accomplished.

**Instilling Public Confidence**

The aggression that our nation experienced on September 11, 2001, has changed the way many view the aviation industry. Few can travel without remembering the terrorist attacks. What has been so vividly displayed throughout the media has
now become a distrust of transportation in general. Heightened concern for passenger safety must be addressed. The SATS system could provide the solution to the fear that many travelers are feeling.

Now more than ever, the original SATS technology strategy possesses the envisioned potential of providing a distributed safe travel alternative, freeing people and products from transportation system delays by creating access to more communities in less time. Now more than ever, the need for on-demand alternatives for travelers to move quickly and safely where they need to go, in the interest of national economic productivity, is paramount. SATS as originally envisioned, holds these promises. The challenge now to the government, industry and university partners is to focus sharply on the purpose and execution of the NASA program, that is, to prove SATS works (Holmes 2001).

SATS technologies were created to provide consumers with a safe alternative to crowded highways and airline hubs. The system employs small aircraft and underutilized airports to provide near all-weather access to more than 5,000 urban and suburban communities throughout the nation. This allows isolated communities to receive safe, affordable, and timely transportation.

What cannot be mistaken is the fact that SATS is no longer a futuristic concept. "NASA has completed the first year of developing the SATS requirements with the FAA, and has released the SATS Partnering Announcement. [This solicited] the formation . . . of a nonprofit corporation as the public-private interface for the development of the FY 2005 SATS Demonstration" (Holmes 2001).

The United States will now demand "a transportation system that is robust, reliable, and resilient, in the face of any kind of disruption. Accessibility to air travel is fundamental to our nation's cherished freedom of movement" (Holmes 2001). SATS offers this kind of mobility while providing equal access to thousands of suburban, rural, and remote communities. "The SATS vision presents an alternative for preserving freedom of movement that can be developed with enhanced safety and security-based technologies" (Holmes 2001).

SATS utilizes larger numbers of smaller aircraft and airports. Reducing the concentration of travelers at large hubs would lead to fewer disruptions in travel and, therefore, greater robustness and resilience for the aviation industry. "Widely distributed systems in power grids, communication, computing, navigation systems,
or in transportation are more robust... than centralized systems. This theory of networks applies to the consequences of disruptions of any kind, such as caused by weather, labor disputes, system overload, or other causes" (Holmes 2001). In addition, a more effective domestic air support system would allow for more efficient "movements of people away from danger, movement for disaster relief, movement of law enforcement and other public service functions" (Holmes 2001).

Individuals as well as businesses will benefit from this system, which makes use of technologically advanced aircraft and systems. With more efficient and more effective equipment, SATS will provide air assistance to rural and isolated areas through point-to-point service between communities of all sizes. On-demand service will be based on travelers' specific needs in an effort to cater to the individual. This will provide an alternative for those communities that have been struggling with Essential Air Service. In addition to expanding service in communities already utilizing aviation, new air transport service will be offered to other remote communities. SATS will supply affordable, safe, reliable air travel while aiding in the revitalization of GA.

Collective Efforts
SATS is clearly a collaborative effort among a variety of distinguished individuals and institutions. Without each component of the SATS team, unarguably this concept would not come to fruition. Partnerships among the government, private firms, and universities have allowed the development of new technologies to begin. Private organizations have been charged with the creation of aircraft capable of using these technologies. Other private corporations must be committed to offering air transport services through the use of SATS aircraft and newly revitalized GA airports. In addition, the work of university-sponsored individuals will be required for a smooth transition in travel through SATS implementation.

Nebraska SATS Research Team
The Public Administration Department and the Aviation Institute of the University of Nebraska at Omaha (UNO) have committed many of their resources to the successful realization of the SATS concept. A number of individuals formed a unique Nebraska SATS research team and have devoted their valuable time and effort to seeing the dream of SATS come true. The initial activities of this team were divided into three subclusters and their corresponding support personnel. The subclusters were charged with investigating the areas of:
1. systemic change and innovation in public infrastructure in Nebraska,
2. public finance and economics for SATS planning in the states, and
3. state and local airport planning for SATS implementation.

Dr. Russell Smith, Dr. Massoum Moussavi, and Mr. Fred Hansen were involved in subcluster 1. Their research led them to investigate how the proposed small aircraft mode of transportation would be made more available throughout the nation’s suburban, rural, and remote communities. They determined that the answers to this question would require research “in multiple policy, technological, market, and economic areas” (Bartle et al. 2000).

The systemic change and innovation subcluster focused on two areas. The first entails development of a formal systems engineering model for SATS implementation in the states, using Nebraska as an example. This systems engineering process could be used to develop a formal model for SATS. The formation of mathematical relationships would then be used to create a formal computer-based systems engineering model.

The second critical set of this cluster’s activities focused on examining SATS as an innovation. The researchers were concerned with the important dimensions of the SATS technology, and how these dimensions might affect adoption of SATS by small airports in the United States (Bartle et al. 2000).

Nebraska will be used as an example to identify the unique qualities of SATS, such as capabilities, knowledge requirements, and cost. The projected rate of system adoption will be compared to the original roadmap goal. The difference between the two “would guide follow-on research activities in other project clusters” (Bartle et al. 2000).

Dr. John Bartle, Dr. David Hinton, and Richard Swayze, of UNO Public Administration, contributed to the second subcluster. They determined that federal development of SATS would require a series of national “templates.” “These templates would serve as national guidance for state aviation system planning, regional intermodal transportation system planning, and airport master planning for [incorporation of] SATS technologies and capabilities” (Bartle et al. 2000).

In addition, the researchers found that the ultimate funding goal is to “match costs and benefits to the various affected parties” (Bartle et al. 2000). This ensures equity, plans for facility requirements, creates appropriate incentives, and stimulates
technology. However, current federal financing tools are not capable of achieving these objectives. “The current grant and fee structure . . . oversubsidizes certain airports and activities and undersubsidizes others” (Bartle et al. 2000). Such a customized approach requires the administrative capacity to weigh costs and benefits for each local project.

Therefore, the individuals working within this group were concerned with the financial and economic aspects relating to SATS. They “investigated the various financial options available to the federal government to build the SATS infrastructure in a manner that is both financially and administratively sustainable in the long term and is palatable to the states/local beneficiaries” (Bartle et al. 2000).

In addition, a general conceptual framework was developed for airport personnel to quantify both the direct and indirect benefits and costs to their various stakeholders. “This [framework] will develop the capacity on the part of federal and local officials to judge the propriety of projects, and to develop the necessary customized financial and administrative tools to implement them” (Bartle et al. 2000).

Researchers involved in the third subcluster included Dr. Hank Lehrer, Ms. Tracey Cullan, Mr. Fred Hansen, and Mr. Richard Swayze. This cluster’s approach encompassed both short- and long-term goals for SATS. In the short term, it was determined that a statewide conceptual framework is crucial in developing the possible impact of the SATS airport program. “A need exists to justify the integration of SATS [technology] . . . within the state airport master planning scheme” (Bartle et al. 2000). This comprehensive change will require significant coordination and evaluation.

Existing GA airports will play an integral part in the airport compliance strategy of SATS. However, before upgrades in systems and operations can take place, minimum airport standards for SATS facilities must be established. “These standards must be developed in partnership with the state and airport owners to define SATS capabilities tailored to current national and local requirements” (Bartle et al. 2000). Strategies must be developed to assist airports that are preparing for the introduction and use of SATS.

When considering the long-term aspects of this system, there is a need to develop airports that are capable of serving the rural populations of the United States. An example of this need is expressed in the distribution of population in the state of Nebraska. “Approximately 70 percent of Nebraska’s population is concentrated within 50 miles of the Omaha/Lincoln area. This concentration of population . . .
has diminished the air service available to [other] residents of the state” (Bartle et al. 2000). While there are numerous airports in all portions of Nebraska, most of these airports have no air transportation other than widely scattered GA service. Utilizing a rural demonstration site in Nebraska with this demographic profile would validate the SATS concept and provide a template for future developments.

Public Outreach and Education
The importance of local and regional public outreach and education activities must not be underestimated. The implementation of SATS relies heavily on the participation of its stakeholders in such activities. Lack of public endorsement of the SATS concept will likely impede the realization of this program.

While it will be necessary for stakeholder groups to offer assistance, a specialized team of UNO representatives has been created to provide support through extensions of research activities. This SATS team “will provide an Internet-based forum for information dissemination and dialogue” (Bartle et al. 2000). An Internet platform has already been designed to accomplish this goal and can be viewed at www.unomaha.edu/~unoai/sats/. Additional tasks will include coordination with NASA Langley Research Center education personnel and links to stakeholders.

A SATS discussion board will also be available for posting related reports, papers, and other items. The team will coordinate with NASA’s national public outreach and educational activities to provide support to the developing National Transportation Library. “Additionally, research outcomes will be brought into the collegiate classroom through courses such as airport master planning, operations, and independent research. Students will participate in course projects relating to SATS objectives” (Bartle et al. 2000).

Nebraska Native American Outreach Program
A large portion of Nebraska’s Native American population has no access to public transportation of any kind. The development of an advanced airport system would bring air transportation access to a greatly underserved portion of the State as well as the region. A SATS facility “could form a vital link for isolated populations, providing enhanced access to health care, government, and employment opportunities” (Lehrer and Zendejas 2000).

However, this emergence will occur only through outreach and training within the associated school systems. The Nebraska Native American Outreach Program began five years ago as a partnership between the NASA Nebraska Space Grant Consortium (NSGC) and the Native American community, in response to the need for
outreach activities. Through this program, “numerous . . . projects have been undertaken, . . including educational, motivational, and infrastructure-building activities” (Lehrer and Zendejas 2000). In addition, this partnership has aided “the state’s Native American educational community, particularly in the areas of improving mathematics, science, and technology” (Lehrer and Zendejas 2000).

“However, one clearly identifiable barrier in completing future projects . . . is [the fact that] the Nebraska Native American population on [Nebraska’s] reservations has been plagued by unemployment and extremely dismal family situations. As a result, school-age children often have difficulty in meeting minimum academic standards or even staying in school until graduation” (Lehrer and Zendejas 2001). The NSGC and Native American partnership was established to aid in the reversal of this trend.

**Annual NASA Aeronautics Day**

Another successful public outreach endeavor has been the annual NASA Aeronautics Day at the Sioux City (Iowa) Airport. This program, begun in 1997, provides students attending Nebraska’s reservation schools with experiences involving aeronautics and scientific aviation activities (Lehrer and Zendejas 2000). Seven hundred students have already become familiar with both military and general aviation operations. These projects have been extremely successful in highlighting aviation and aerospace as possible career options. It is anticipated that many of these youngsters will become fascinated with the thought of pursuing aviation careers and thus help to promote SATS in the future.

**Family Science Project**

The Family Science Project is designed to encourage families to work together to complete several hands-on activities. Such activities are taught during evening meetings at the students’ schools. Occasionally, special demonstrations and guest speakers are included in the programs, which provide parents with ideas to encourage the completion of experiments and projects at home with their children.

“The purpose of this program is not to make parents into scientists or the primary teacher of their child, but to provide an opportunity for families to work together in an interesting and enjoyable manner” (Lehrer and Zendejas 2001). By doing such activities families can appreciate that science is not only for school but also for their real, everyday lives. “Doing such activities provides additional time for the learning of science and enhances student learning skills” (Lehrer and Zendejas 2001).
Systems Engineering

The successful implementation of SATS will require the establishment of advanced technology at various airports. The SATS Systems Engineering Precursor Studies/Nebraska Implementation was initiated to support the implementation of SATS in Nebraska. This research defines SATS and its requirements and provides a body of reference material for SATS implementation in Nebraska. The study supports the ongoing national SATS effort by developing a computer-based decision-support system/model for SATS implementation. The system's engineering requirements and SATS metrics for implementation in Nebraska are identified and their interrelationships (cause-and-effect relationships) are being investigated. These requirements and metrics include air travel demand, mobility, accessibility, travel time, travel cost, capacity, safety, vehicle technology, air traffic control, communications technology, airport facilities, demographics, and social, economic, political, and environmental factors.

Three alternative forms (verbal, visual, and mathematical) of the model are being developed. The verbal description is a mental model of the SATS system expressed in words. The visual description is diagrammatic and shows the cause-and-effect relationships between many variables in a simple and concise manner. The visual model, or “causal diagram,” is being translated into a mathematical/computer model. The tentative framework for the SATS computer-based decision-support system/model is based on the 23 submodels (demand forecasting, infrastructure planning, infrastructure design, regulatory and policy, market analysis, vehicle technology, air traffic control, pilot training, terminal area, airfield design, ground transportation access, safety, security, socioeconomics, environment, technology, politics, operations, administration, performance, implementation, organization, and public outreach). Initially, the SATS decision-support model is used to evaluate different scenarios of planning, design, and implementation of the small aircraft transportation system in Nebraska. The framework of the model is transferable to other states, and it is anticipated that an integrated form of the model will be developed at the regional and national levels in the future.

Great Plains SATS Network

On May 11–13, 2000, the Great Plains SATS 2000 Symposium was held in Rapid City, South Dakota. Representatives from 15 states participated in the program sessions and discussions, which focused on the issues surrounding SATS. Through this meeting it was determined that “the primary barriers to the implementation
of SATS in the Great Plains will be market incentives rather than local infrastructure and financial limitations" (Smith 2000).

Symposium participants unanimously endorsed the implementation of SATS. In addition, each believed that the system could be used to address several chronic needs of the region, such as encouraging economic development, providing access to basic health and human services, and increasing support for existing and emerging airports (Smith 2000). Key issues that will demand the attention of SATS supporters were found "in areas of education and awareness, finance and economic development, infrastructure and planning, access and equity, and [governmental] roles" (Smith 2000).

**Issues Regarding Policy**

Three major policy areas were identified as having an impact on the implementation of SATS: public finance and economics, awareness and environmental factors, and diffusion of technology and technology transfer (Bartle et al. 1999).

Implementing SATS in Nebraska and in other states will require a number of technical and administrative changes. SATS will require major improvements in the infrastructure of state airports. However, supporters of SATS are faced with the dilemma of financing these improvements. The primary goal is to improve airport infrastructure so that it can accommodate SATS and remain financially self-sufficient with limited federal assistance (Bartle et al. 2000).

A variety of funding sources are available for the implementation of the SATS concept. Four major sources of revenues include:

1. federal grants,
2. debt financing,
3. earmarked taxes and user fees, and
4. innovative financing approaches.

The degree of use of any of these revenue options with SATS will depend largely on federal policy (Bartle et al. 2000).

Closely accompanying the financing options for SATS is the potential impact on local economic development. The goal of UNO's SATS researchers is "to develop a model that will allow for an assessment of the financial viability of the SATS investment at any airport. This will develop the capacity on the part of federal and local
officials to judge the propriety of projects and to develop the necessary customized financial and administrative tools to implement them" (Bartle et al. 2000).

**Issues Surrounding Technological Transfer**

SATS represents a unique opportunity and fundamental effort to shift and diffuse technology throughout U.S. GA airports. However, many barriers to implementation are likely to exist. “Organizational change and the ability to accept new approaches to service delivery is a major hurdle for SATS implementation. To overcome this natural hesitancy, political support will have to be generated that outweighs the disincentives that exist” (Bartle et al. 2000).

Another barrier involves the financial resources required to modify and apply the technology appropriate to each GA facility. The differences between those developing the technology and those applying the technology must be considered. “The culture of organizations devoted to innovation and development is very different than the culture of general aviation airports and fixed-based operators who deliver services on a day-to-day basis” (Bartle et al. 2000).

Legal barriers, such as statutes and administrative procedures, must be addressed before successful implementation of SATS can take place. Each state and locality has distinct legal issues that will need to be reviewed to determine whether individual barriers exist. Then, appropriate steps must be taken to address those barriers properly. In addition, “education and training about SATS regarding how the technology works and how it can be applied successfully are key factors in implementation” (Bartle et al. 2000).

**Rural Policy Issues**

The airports most likely to be selected for SATS technology are those operated by rural and small communities. Many of these airports operate with part-time managers and staff with limited budgets. Traffic at these airports is usually local travel. “The larger of these airports receive the bulk of state infrastructure funding and support” (Bartle et al. 2000).

Thus, states with smaller, more rural populations and airports face serious capacity issues. In addition, “public attitudes toward taxing and spending have increasingly restricted government” (Bartle et al. 2000). The rapid change and increasing dependency of local economies has greatly reduced rural communities’ control over their local economies.
The implementation of SATS polices and its required technology depends heavily on the involvement of its supporters. Government officials must be committed to providing underserved communities with the resources they need to compete in the future aviation market. "The installation of advanced technologies and appropriate management systems throughout the nationwide network of general aviation airports can be delayed, slowed, and even halted at any one of many possible points at which a decision to commit resources must be taken" (Bartle et al. 2000). Consequently, a major component of the SATS planning phase must include a substantial effort to identify obstacles to implementation and the strategies for overcoming them.

The widescale adoption and implementation of SATS technology will require the review, modification, and creation of innovative public policies and management systems. "An analysis of current public policy and management frameworks that identifies gaps, as well as existing contradictory or countervailing policies that discourage innovation of new technologies, would be necessary to illuminate potential barriers to SATS adoption" (Bartle et al. 2000).

**Utilizing U.S. GA Airports**

According to the U.S. General Accounting Office's 1998 report, the United States has the largest, most extensive aviation system in the world (U.S. GAO 1998). This system ranges from large transportation centers to small grass landing strips. Of the 18,000 total U.S. airports, 3,344 smaller public-use airports are included in the national airport system. "Analysis shows that small airports have fewer flight operations, thus indicating that most general aviation airport use is by locally based aircraft rather than intercity travel" (Smith and Wachal 1999). These underutilized airports could provide a web of landing facilities for SATS operations to take place.

U.S. aviation operations have fallen off since the early 1980s. The "number of aircraft has declined by just under 20 percent," while the pilot base has declined by 11.9 percent (Smith and Wachal 1999). This reduction has been felt in Nebraska by a 15 percent decrease in its aircraft and a 23.3 percent decrease in its pilot base. Although the GA airport in Nebraska serves as a base for 14 aircraft, almost 25 percent base 4 or fewer aircraft (Smith and Wachal 1999).

SATS airports have certain basic technological requirements, which will be necessary to introduce to selected airports when implementation takes place. Nebraska's aviation industry is composed of basic utility airports, general utility airports, and jet transport airports with the following characteristics (Smith and Wachal 1999):
• 77 (85%) have a paved runway;
• 82 (90%) have a lighted runway; and
• 56 (65%) have an instrument approach.

However, current governmental plans for Nebraska airports do not include changes to support SATS. Rather, most state and federal funding is issued for repairs and maintenance. “The most recent comprehensive statewide airport planning effort in Nebraska (1992) recommended no infrastructure improvements for 27 (32.5%) airports. Although some airports had low operations and based aircraft numbers, most appeared to have adequate infrastructure for their assigned aviation role (Smith and Wachal 1999). The implementation of SATS would require selected small Nebraskan airports to become equipped with new technology and new operating procedures. These changes may prove difficult especially when “more than one-third (30) of the GA airports do not have a primary runway that meets the recommended length and/or width for the airport” (Smith and Wachal 1999).

Nebraska facilities and airspace are available for increased operations. Such an increase would revitalize many small, underutilized airports and their surrounding communities. Nebraska aviation represents a fertile environment for the implementation of SATS technology and aircraft.

Conclusions
The implementation of SATS would be a dream come true for communities that urgently need air service and medical air transport. This system is a clear concept, made credible by extensive research. Although SATS is not an additional system for commercial airlines, it should not be thought of as a competitor. Rather, SATS should be viewed as a component of aviation that will help alleviate congestion at airline hubs to allow for increased customer satisfaction.

SATS Advantages
SATS will provide access to more communities in less time. This safe travel alternative will free both passengers and products from transportation system delays. SATS will better serve existing markets and extend air service to communities currently neglected by the airline industry. This will be accomplished through the use of advanced small aircraft, new innovations in navigation and communication technologies, and new business models.
SATS offers a variety of benefits to the aviation industry as a whole as well as to the individuals who use the industry's services. The development of key airborne technologies and precision guidance of small aircraft create a safer and more efficient environment in which to fly. By occupying underutilized airports and airspace, SATS encourages less hub congestion and more rural travel. This is both an exciting opportunity and an economic development tool for those living in rural and isolated communities. High-speed mobility and accessibility will give travelers more time to complete their business.

In addition, SATS will likely reenergize the economies of the rural and isolated communities it serves. With fewer travelers frequenting highways and airline hubs, new innovations in intermodal travel will be required and thus created. New businesses will be needed, thus creating new jobs to facilitate the increase in traffic at small airports.

SATS has the potential to dramatically improve access to small and isolated communities while developing over 5,000 GA airports into operational business centers. New consumers and producers will be linked to the global economy rather than being confined to their immediately surrounding areas. Time is of the essence in the SATS endeavor. The opportunity to educate the public is upon us. When this phase of implementation is complete, travelers will be more knowledgeable about their transportation options, and able to actively participate in saving the future of transportation.
References


Smith, R. 2000. Great plains small aircraft transportation system (SATS) symposium communiqué.


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Restructuring Urban Public Transport in India

Kaushik Deb, Tata Energy Institute, India

Abstract
Transportation in the urban context assumes great economic significance, as the productive efficiency of urban areas will be maintained only if mobility requirements in the cities are fully met. However, this productive efficiency is now threatened by the increasing number of vehicles causing congestion, and thus slower speeds on roads. An effective way to address this problem is to encourage greater use of public transport instead of personal vehicles. This requires both an increase in the carrying capacity of the public transport system and a quantum improvement in the quality of public transport.

In addition, despite the high volumes of traffic, most urban centers in India do not have any rail transit system to cater to intracity movements. Hence, there would be substantial dependence on bus services to meet public transport needs for the next several years. This is likely to result in a major restructuring of the current provisioning of public transport in the urban centers. This article highlights various options for restructuring the provision of road-based public transport and synthesizes them into a strategy for reform, given the commercial viability of the various activities carried out by public transport operators in India.

Introduction
Transport plays a significant role in the overall development of a nation's economy, particularly in the urban context, where cities are considered vertices of economic
growth. However, concerns are being voiced about the sustainability of development in the transport sector as this sector accounts for a substantial and growing proportion of air pollution in cities. The most effective strategy for ensuring the sustainability of the urban transport sector is to check the decline in the share of public transport. This article outlines issues and concerns in the public transport sector and the need for reforms. It also suggests a reform strategy for the sector.

Transport Sector in India

India has witnessed rapid growth in the number of total vehicles registered in the last two decades. As of March 31, 1998, there were 41 million registered vehicles in the nation (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Vehicles</th>
<th>Two Wheelers (%)</th>
<th>Car, Jeep, &amp; Taxi (%)</th>
<th>Buses (%)</th>
<th>Good Vehicles (%)</th>
<th>Others (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>306</td>
<td>8.82</td>
<td>51.96</td>
<td>11.11</td>
<td>26.80</td>
<td>1.31</td>
</tr>
<tr>
<td>1961</td>
<td>665</td>
<td>13.23</td>
<td>46.62</td>
<td>8.57</td>
<td>25.26</td>
<td>6.32</td>
</tr>
<tr>
<td>1971</td>
<td>1,865</td>
<td>30.88</td>
<td>36.57</td>
<td>5.04</td>
<td>18.39</td>
<td>9.12</td>
</tr>
<tr>
<td>1981</td>
<td>5,391</td>
<td>48.56</td>
<td>21.52</td>
<td>3.01</td>
<td>10.28</td>
<td>16.64</td>
</tr>
<tr>
<td>1986</td>
<td>10,577</td>
<td>59.04</td>
<td>16.83</td>
<td>2.15</td>
<td>8.16</td>
<td>13.82</td>
</tr>
<tr>
<td>1991</td>
<td>21,374</td>
<td>66.44</td>
<td>13.82</td>
<td>1.55</td>
<td>6.34</td>
<td>11.85</td>
</tr>
<tr>
<td>1996</td>
<td>33,783</td>
<td>68.83</td>
<td>12.44</td>
<td>1.33</td>
<td>6.01</td>
<td>11.39</td>
</tr>
<tr>
<td>1997</td>
<td>37,231</td>
<td>69.01</td>
<td>12.52</td>
<td>1.31</td>
<td>6.07</td>
<td>11.09</td>
</tr>
<tr>
<td>1998</td>
<td>40,939</td>
<td>69.23</td>
<td>12.35</td>
<td>1.31</td>
<td>6.18</td>
<td>10.94</td>
</tr>
</tbody>
</table>


Along with the rise in vehicle population, the increased mobility demand is reflected in rising usage rates of personal vehicles. The problem has been accentuated by the gradual reduction of public transport in India as reflected in the declining share of buses in the total vehicle fleet in the country (a decline from more than 11% in 1951 to just over 1% in 1998).

The rapid increase in the number of motor vehicles in India calls for urgent measures to deal with the resultant congestion and pollution. In particular, encouraging greater use of public transport instead of personal vehicles, thereby slowing the trend toward increasing use of personal vehicles, is key. However, unless the quality of public transport services improves substantially, the trend of increasing
preference for personal vehicles will continue. This calls for a complete change in the mindset of the operators. It is extremely important that the provision of public transport services be restructured to ensure service delivery that matches consumers' expectations. One way to do this is to organize the private sector to more effectively provide useful services. Improving the quality of services from public transport would also require restructuring of the State Road Transport Corporations [or State Road Transport Undertakings (SRTUs)] so that policy, planning, and regulatory functions are carried out by an entity other than the one involved in direct operations. There would also be a need for a regulatory framework to oversee all modes of public transport particularly, urban and suburban railways.

**Performance of Public Transport in India**

Public transport in India can be classified into two modes: rail and road. Out of the country's total passenger movement, 80 percent is met by road transport while the remaining 20 percent is carried by railways.

**Road Transport**

Road transport in India is operated by both the public and private sectors—comprising about 28.7 percent and 71.3 percent, respectively, of the total bus system. Government participation in road transport commenced in 1950, and since then SRTUs have been formed in every state.

As of March 1999, there were about 67 SRTUs in the country operating a fleet of more than 115,000 buses and employing about a quarter of a million people. Out of 59 corporations, 14 operate exclusively in the urban areas and the remaining 45 in mofussil areas (including 9 corporations operating in hilly regions) (Table 2). Further, of the corporations operating in mofussil areas, about 8 operate only in rural areas (including the hilly regions); the remaining corporations operate in both rural and urban areas. Of the total number of buses held by corporations, 17,455 render services in urban areas; the remaining 95,310 vehicles operate in mofussil areas (including 2,659 in hilly regions) (ASRTU 2000).

**Table 2. State Road Transport Undertakings in India**

<table>
<thead>
<tr>
<th></th>
<th>Rural</th>
<th>Urban</th>
<th>Rural &amp; Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRTUs</td>
<td>8</td>
<td>14</td>
<td>37</td>
</tr>
<tr>
<td>Buses</td>
<td>115,424</td>
<td>17,455</td>
<td></td>
</tr>
</tbody>
</table>

*Source: ASRTU, 2000.*
The organizational form for public sector bus transportation varies from state to state, with the most common being a corporation constituted under the provisions of the Road Transport Corporation Act of 1950. There are 22 such corporations. In addition, 26 undertakings have been formed under the Indian Companies Act of 1956, while public transport is also operated by 11 municipal councils under various municipal legislations. Eight undertakings function as part of government departments (Figure 1).

Public bus transport in India is provided through a multiplicity of mechanisms. These include:

- **Own services**: Under this mechanism, the SRTU uses its own fleet.
- **Kilometer scheme**: Private buses are hired to run services as required by the SRTU.
- **Direct permits**: Permits from the State Transport Authority (STA) are given directly to private operators to operate on specified routes. The buses are owned and operated by the private permit holder who also collects the fares. Fares and routes are as allowed by the STA under the Motor Vehicles Act of 1988. The private entities operate under the conditions of the permit granted to them. These operators have no relationship to the SRTU and operate on their own.

**Operational Performance**

The total strength of the urban SRTUs grew from just about 10,000 in 1991 to about 13,500 in 1999, an increase of 28 percent. However, while the total vehicle fleet strength grew at almost 10 percent per year in the 1990s (Table 1), the urban SRTU fleet grew by less than 3 percent per year (Figure 2). Given that the increase in the bus fleet during this period has also not been spectacular (Table 1), the size and spread of public transport has seen a decline in the last five years.

The operational characteristics, on the other hand, do not show any distinctive trend (Figure 3). While the kilometers operated daily by each bus have shown a steady increase, the proportion of the total fleet on road has been declining.
Restructuring Urban Public Transport

Financial Performance

The overall financial performance of urban SRTUs in India appears to be gloomy, with the SRTUs headed toward a severe financial crisis in the very near future. As of March 1999 these corporations had incurred an accumulated loss of about 13 billion rupees—nearly as large as the aggregate amount of equity of both the union government and the state governments and reserves (14.60 billion rupees). Further, this debt is larger than the total assets of the SRTUs.

As earnings per kilometer have grown more slowly than costs per kilometer, losses per kilometer have grown by nearly 7 percent per year (Figure 4). This situation has developed because of continuing inefficiency in operations, uneconomical operations to meet the universal service obligation, and universal subsidization of...
services. In addition, the motor vehicle taxation regime taxes buses more than personal vehicles, resulting in higher cost of operation for public transport.

A result of the continuing losses has been the inability to generate adequate funds for capital expenditure and replacement of rolling stock. There exists a vicious circle of continuous losses leading to inadequate funds for capital expenditure and poor management of the fleet, which in turn leads to poor operational performance, causing even higher losses. The mounting losses imply a substantial commitment from the government for the provision of public transportation services in urban India. The following sections review current operations and identify areas for reform.

**Rationale for Restructuring**

Improved transport systems are essential for accelerated economic growth. Transportation in the urban context assumes even greater significance. Large agglomerations are seen as the vertices of continued economic growth. The productive efficiency of urban agglomerations will be maintained only if mobility requirements in the cities are fully met. However, this productive efficiency in urban India is now threatened by the increasing number of vehicles, causing congestion and thus slower speeds on roads. Transportation infrastructure could be the primary bottleneck for the unimpeded growth of the state. Thus, it is important that the existing transportation infrastructure is utilized optimally. This requires meeting mobility needs efficiently through a greater modal share of public transport.

Another major consideration for restructuring public transport is the continued drain on the exchequer. With greater emphasis on fiscal discipline, it is becoming increasingly difficult for governments to continue funding such loss-making
ventures. In addition, the role of the state in provisioning services that can be more efficiently provided by private operators is being questioned in a variety of fora.

**Augmenting Public Transport**

While it is recognized that the share of public transport in India is considerably higher than that in most developed countries, the cause for concern is the declining share. Among the major reasons for this decline are the inability of public transport operators to keep pace with the increasing demand and the deteriorating quality of service arising from continued losses and thus inadequate capital generation for capacity augmentation. This issue is dealt with in detail in the next section.

Another problem is the relatively little concern for consumer satisfaction. In most cities, government-owned agencies operate and manage public transport services. Given the virtual monopoly that public sector service providers enjoy, service planning has been largely dominated by operating convenience rather than by consumer convenience. With fares and tariffs not linked to costs of operation, there is little incentive for service providers to improve efficiency. Also, being public sector concerns, the emphasis on commercial orientation is limited. As a result, ridership changes and costs of operation are not concerns of the management. Thus, a change in the incentive regime is necessary to ensure attention to consumer satisfaction. This requires regulatory reforms and institutional restructuring in the urban public transport sector. It means splitting up monolithic public entities and allowing public sector suppliers to offer services in areas where they are better equipped to provide them.

**Mounting Losses of SRTUs**

The considerations for restructuring SRTUs also stem from mounting losses and poor operational performances, resulting in a continuous drain on scarce budgetary resources. A number of SRTU activities can be efficiently provided by the private sector. Also, private sector funds could be tapped to generate revenues for fleet augmentation and replacement.

In the postliberalization era, it would be difficult for governments to continue to provide financial support to such loss-making ventures, especially with the growing emphasis on fiscal discipline. Indications of such concerns can also be gauged from the Ninth Plan document where the union government's policy regarding the funding of SRTUs is outlined. The thrust of the policy is to fund the acquisition
of buses for replacement only, and not for fleet expansion. Public bus fleet expansion is to be funded from the private sector. In fact, the Ninth Plan document also states that, given the financial constraints facing the SRTUs, 75 percent of the public transport services should be made available from the private sector (Planning Commission 1999). Thus, it would be difficult for the state government to perpetually finance public transport losses, let alone make a capital contribution for fleet augmentation.

Activities that can be performed by several operators (i.e., those on which scarce public funds need not be spent) should be separated from those best performed by a monopolistic service provider. Thus, public funds would be used only for those activities in which private funds are either not available or public funding and management is desired. Such a separation of activities would also open up other opportunities for revenue generation (e.g., commercial exploitation of land resources).

**Comparative Advantage of SRTUs**

Some SRTU functions, such as the workshop activities, are not natural monopolies based on economies of scale and are currently being provided by a number of private sector operators. It may be difficult to justify continued public expenditure on such activities, especially if these services can be provided more efficiently by the private sector. Charles Lave uses this idea as the foundation for his argument that policy making should be separated from operating functions. He sees the role of the government authority as arranging or sponsoring public transportation rather than supplying the transportation itself (*Urban Transit* 1975).

A review of the current market structure in the urban public transport sector also reveals that SRTUs do not have a comparative advantage in a number of activities they are undertaking. This is particularly true for bus operations where private operators provide these services in a more cost-effective manner (though given the universal service obligations in the sector, private operations would have to be appropriately regulated). Similarly, the SRTUs do not have any comparative advantage in operating workshop facilities, which are competitively provided by the private sector for all types of vehicles.

**International Experience in Reforming Public Transport**

The situation of existing public transport institutions being grossly inadequate to provide required levels of service to effectively deal with the rapidly increasing congestion and pollution is not peculiar to India alone. It has been faced in most major
cities around the world. Several of them have undertaken reforms and restructured their public transport operations to meet the required demand and the expected quality of service.

An examination of the reforms carried out around the world reveals two main trends in the restructuring of public transport. The first is to unbundle the monolithic and integrated services into more manageable and compact constituent units. This has generally resulted in greater involvement of the private sector in providing services in a competitive environment. The second trend is to segregate policy and planning from operational functions. This enables a separation of activities that are natural monopolies from activities that are not natural monopolies. Such separation makes it possible to bring in competition in activities that are not natural monopolies. Competition, in turn, enables improvements in efficiency, enhancement of capacity by tapping private financial resources, and induction of more professional management. In addition, it becomes possible to channel scarce public funds into activities the public sector is best suited to perform and not use them in activities that the private sector is better equipped to perform.

Models of Private Sector Involvement

Private sector participation can take different forms in infrastructure sectors. The public transport sector, in particular, can either be unbundled and opened in a segmented fashion to private sector participation, or the complete sector can be opened to such processes. These options are discussed below.

Service Contracts. This is a type of short-duration contract in which a private operator performs specific tasks such as provision of buses. By using this option, it is possible to take advantage of private sector expertise in performing technical tasks, or even to open such tasks to competition. Under this option, the public utility manager coordinates the tasks performed by private operators and ensures the investment in the sector. It is not possible to bring management expertise or improve operating efficiency in this option. However, unlike other infrastructure sectors, it is possible to bring additional investment under this option in the public transport sector as discussed below.

The most common form of the service contract in the public transport sector is the gross cost model for private sector participation in bus operations. This requires the government authority to set the routes operated and fares to be charged. Fare revenue accrues to the government authority, which then pays the private operator an agreed amount, irrespective of the occupancy and
ridership. The operator is simply a supplier of a service, bearing the operating risks but insulated from revenue and ridership risks. This way each route can be operated by multiple private operators and the private operators do not have any incentive to recklessly race each other to each bus stop to gain more passengers. Furthermore, private operators are not hurt by fares that do not correspond to costs. Hence, this approach is suitable in cases where fare revenues are likely to be uncertain (e.g., new routes, low-density corridors, and in cases where government wants to subsidize commuters).

The quality actually achieved needs to be monitored by a public entity with a system of penalties to deter underperformance. The government authority awards routes via competitive tender to the lowest bidder. Preference is given to private operators who have achieved high standards of quality. This prevents private operators from concentrating only on dense routes and provides them with the incentive to improve quality.

The terms of the gross cost approach are somewhat similar to that of the kilometer scheme except that in the kilometer scheme payments are fixed regardless of the type of route or the time of day. In the gross cost scheme, the operator bids for the compensation. Such a bidding process permits an operator to factor the type of route and service quality expected into the amount being bid for as compensation.

**Management Contract.** This short-term option transfers the responsibility for the operation and maintenance of the system to a private operator for a fixed fee. This fee could be related to various performance parameters. Although the public utility is still responsible for rehabilitation and new investment, this option could bring technical and management expertise to the sector and, to some extent, improve operating efficiency. Management contracts in the transport sector are particularly relevant in the management of depots and workshops of large bus operators.

**Lease Contract.** Under this option, a private firm leases assets of the public utility typically for 10 to 20 years for a fee and takes on the responsibility for operating and maintaining them without any responsibility of financing new investment, which will lie with the public utility. This contract could bring technical expertise, managerial expertise, and operating efficiency to the sector. While investment risk lies with the public utility, the commercial risk is shared
between the private operator and the public utility. This form of private participation is seldom seen in the public transport sector. Nevertheless, it is possible to develop lease contracts in the transport sector for some activities (e.g., depots and terminals).

**Concession Contract.** A concession agreement, or franchise, is a means of awarding fixed, long-term monopoly rights to provide a service to a private firm within a geographical area. Under this option, the private operator is not only responsible for operation and maintenance of existing assets but also for new investments, although the ownership lies with the government or the public utility. This option could bring technical expertise, managerial expertise, operating efficiency, and additional investment to the sector. Investment risks and commercial risks lie with the private operator.

The application of the concession type of private participation in the public transport sector is the net cost scheme in the public transport sector, whereby the operator receives the revenue from ticket sales, as opposed to a fixed payment in the gross cost approach, thus taking the risk of changes in financial performance over the contract period. A public entity continues to set routes, prescribe fares and service quality, and may either provide a fixed subsidy or receive a fixed contract fee (if the route makes profits). The government authority awards each route via competitive bid to the private operator requiring the least amount of subsidy or willing to pay the greatest fee.

Due to the revenue risk, this option would be suitable for high-density corridors with only a few operators, where ridership would be more certain, so that private operators have no motivation to adopt dangerous passenger capture techniques (e.g., rash driving and speeding). However, this would imply that a private operator would have a near monopoly over an area and would require appropriate regulation to ensure that such monopoly power is not misused.

**Divestiture.** This option, achieved through the sale of assets or shares or through management buyout, can be partial or complete. It gives the private operator full responsibility for operation, management, and investment. Unlike the concession contract, it transfers ownership of assets to the private sector. This is the model that has been adopted in the rail transport industry in the United Kingdom.
Lessons for Restructuring Public Transport

The two relevant options for bus operations highlighted above are the gross cost and net cost options. In deciding between the two, a key concern is whether large private operators would come into the sector in India. If not, then the net cost option will not solve the safety problem. The gross cost option is also favorable because under this plan it is easier to integrate fares among different operators and different modes (Walters 1998). Finally, if the government perceives the need to subsidize commuters, the gross cost option would shield private operators from such revenue risks. However, the gross cost option requires more monitoring because the private operator will have no incentive to attract passengers or accurately collect fares. If the government authority cannot provide the required monitoring, then the use of the gross cost option will result in decreased quality, falling ridership, and increased costs to the government authority.

Given the lack of proven capacity of the private sector to operate large public transport fleets in urban India, the gross cost option may be a more feasible option in the short run to initiate private participation in public transport. Also, this option would allow the government to gradually phase out subsidies so as to minimize political and community resistance to restructuring. Over time, operations under the kilometer scheme would allow the private sector to develop its capability to operate and manage large public bus fleets.

Unbundling State Bus Operators

Urban SRTUs provide public transport services in India using both their own fleets and by leasing buses from private operators under the kilometer scheme. In addition to operating these bus services, SRTUs also repair and maintain the vehicles. The repairs and maintenance wing provides technical support to the SRTU buses only and not to private bus operators despite having excess staff in this category, as is the case with Delhi Transport Corporation (DTC) (DTC 2001). Thus, there exists a resource of technically competent personnel, which can be used to service additional vehicles. The SRTUs also own land for parking buses (at depots) and passenger terminals for providing traffic interchanges.
Restructuring Urban Public Transport

These activities are representative of most urban SRTUs in India. It is possible to classify the activities of urban SRTUs as:

- operating buses;
- providing parking facilities for buses, terminal facilities for passenger interchanges, and bus stations; and
- carrying out repairs and maintenance.

These three activities, though independent of each other in the sense of requiring an independent operational structure and separate staff, do not function as separate profit centers. No separate accounts are maintained to evaluate which of these is a profitable activity. Ideally, these three activities should be operated as discrete profit centers.

City Bus Operations

Operating city services is clearly not a natural monopoly because several private operators are already operating services on city roads. An international review reveals that with appropriate regulation, private operations of public bus services would be successful. In light of the precarious financial position of the Indian government and the continuing losses suffered by the SRTUs as well as the feasibility of bus services being provided in a competitive market, greater involvement of the private sector in operating services in urban areas is recommended. The government should largely concern itself with policy making, planning, coordination, and regulation, rather than with actual operation of services.

India’s experience with private operation of public transport has not always been a success. Assessments of privately operated buses in Delhi reveal poor quality of service delivered and low level of commuter satisfaction (Goel 2000). However, through private sector participation, such as in the kilometer scheme in both Delhi and Bangalore, the SRTU has increased its market share without any additional capital expenditure (DTC 2001). In using hired buses, the SRTU would save on capital investments, thus reducing the strain on the exchequer. However, it will be saddled with problems associated with the current form of the kilometer scheme, namely, the unwillingness of operators to operate on crowded routes and during peak hours or their motivation to make compromises on ridership. On the other hand, in allowing only private operators under concession contracts, the public transport system would remain uncoordinated and also run the risk of dangerous driving practices being adopted by operators.
It is recommended that SRTUs not augment their urban bus fleet. The additional ridership demand should be met by obtaining services from private operators on gross cost contracts. Over time the SRTUs should phase out their own bus services by not replenishing the fleet and substituting their services with contracted services. To avoid the pitfalls associated with the kilometer scheme, the compensation payable should vary from route to route and also by time of day. An effective monitoring system needs to be in place to ensure that there is adherence to the contractual terms.

Over time the private sector operations would mature and the government could withdraw from operation of public buses completely and only regulate the sector. Such a gradual process would also allow the SRTUs to recover their investments in the public transport sector completely. Also, public bus operations for an initial period in competition with the private sector would enable a regulatory agency to set benchmarks for quality and also allow time for experience to be gained with net cost contracts before public operation is completely stopped. A gradual process would also help build support for such reforms. Finally, a gradual rationalization of the tariff regime would ensure financial viability of the sector and it would be feasible to transfer the revenue risk to the private sector.

Apart from restructuring the SRTU operations, another area of concern in the public transport sector is the operation of individual services. Clearly, such operations would not fit into the new scheme. However, it would be legally difficult to terminate these services, as they are operating under valid permits. Nevertheless, recourse could be taken to the provisions of section 103 (2) of the Motor Vehicles Act of 1988, which permits the state government to cancel an existing permit or modify the terms of an existing permit. However, there may be a disruption in public transport services if these operators do not join the kilometer scheme immediately. Another alternative would be for the operators to form large cooperatives, which would be given operating contracts. These permits could be allowed to lapse and not be renewed. This alternative would permit a gradual withdrawal of private individual bus services. Hence, it is recommended that existing permits be canceled and brought under the ambit of gross cost contracts.

**Depot and Terminals**

Ownership and management of depots, terminals, and bus stations are a natural monopoly, and it would be inefficient for a multiplicity of operators to own and manage these infrastructure facilities. These properties should be provided as common facilities for all operators. Nevertheless, the activities can be still operated as a
Restructuring Urban Public Transport

separate profit centers in the form of a separate corporation. Due to the monopoly nature of the activities, it is recommended that the state government retain a controlling stake in the corporation, thus effecting partial divestiture. Another alternative would be to allow professional management of these properties by the private sector using lease contracts. In either case, unbundling these activities from bus operations by setting up a separate corporation would facilitate the lease contracts.

The corporation should enter into contracts with the intercity bus corporations and the SRTU or any private operators to allow parking within its premises for an appropriate fee. Also, the company could earn substantial revenues through property development and advertising. It could lease space for suitable retail outlets for additional revenues. This would have the twin benefits of revenue generation as well as improving access to public transport. As the SRTU lacks professional expertise to develop or manage commercial property, it is suggested that separate Special Purpose Vehicles (SPVs) be considered for each property as a joint venture with a strategic partner such as a reputed property developer company so that the requisite property development and management skills are available.

It is important to recognize that commercial development of the properties allocated to this company could be more remunerative than provision of parking facilities for buses or interchanges for passengers. Thus, if the company is to operate on commercial considerations only, there might be a conflict in the provisioning of such services and operating only on profit considerations. While it is recommend that the company operate only on commercial considerations, for commercial development of its properties it would need approval from appropriate regulatory agencies.

**Repairs and Maintenance Workshops**

Management of the workshops and repair facilities is not a natural monopoly. There are several private workshops at which repairs could be carried out and there is no need for public funds to be spent on these facilities. However, given the fact that substantial infrastructure for repairs already exists with SRTUs, they may be used for repairs and maintenance of all buses and other motor vehicles. The second advantage is that SRTUs also have technically competent personnel who can service the city vehicle fleet. However, repairs should be done on a purely commercial basis by charging market-based fees. If this activity can not be sustained in the
public sector, then it should be privatized. A separate company should be used to facilitate this operation.

Other Issues to be Resolved
Restructuring SRTUs would help improve their financial performance and conserve public funds. Using the private sector to provide bus services would result in improved performance and additional capacity. Yet, the restructuring of SRTUs alone would not be sufficient for bringing about a marked improvement in the quality of public transport. To bring about the required improvements and attract private investments in public transport, it is necessary that several planning, licensing, and monitoring functions be performed effectively. These functions include:

- fixation of fares and fees;
- route and network design;
- route allocation and issue of permits;
- specification, monitoring, and enforcement of quality of service standards;
- coordination;
- data collection and management;
- dispute resolution; and
- making recommendations to government on policy matters.
Endnotes
1. The area outside the city is called “mofussil.”
2. This means a firm is more competitive in the delivery of that service.
3. Interestingly, while the privately operated public buses (Blueline buses) in Delhi are permitted to use the terminal facilities for picking up passengers, for which they pay a charge of Rs 2,500 per month for using the bus stands and Rs 5,000 per month for using terminals, there is no provision to let them use the depot facilities for parking. DTC collected nearly 20 million rupees in 2000–01 for such charges.
References


New Delhi: Delhi Transport Corporation.


About the Author

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