Metropolitan Rail Transit Expansion

Exploring a Route for Decision Making

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New routes for metropolitan rail transit are much debated in the United States. Large metropolitan regions such as Atlanta, Georgia, and San Francisco, California, recently constructed expensive, heavy rail systems, and smaller cities such as Portland, Oregon, and San Diego, California, have opened lower-cost light rail routes. An article in the March 2000 *Railway Age* cataloged new projects, including line extensions and route enhancements, in 45 metropolitan areas (*1*); some of these—such as the consolidated metropolitan statistical area (CMSA) for New York—had as many as six separate transit agency projects.

The development of rail transit services poses a critical question for metropolitan planning agencies. Transit may influence many urban features (*2, 3*); for example,

- Transportation plays a critical role in determining a metropolitan region's land use patterns. Cities that rely on automobile transport tend to be more amorphous, with development characterized by low-density sprawl. Transit-oriented cities, however, are usually compact, with viable downtown business districts.
- Rail transit produces fewer air pollution emissions per passenger mile than automobiles—in many metropolitan areas, air quality fails to meet national clean air standards.
- Transit can relieve downtown traffic congestion.
- Transit produces fewer deaths and injuries per passenger mile than automobiles.
- Rail transit is more energy-efficient per passenger mile than automobiles—an advantage in a world of limited energy supplies.

Many regions have favored freeways over rail lines. Some have developed both in tandem; for example, Chicago Transit Authority's heavy rail line to O'Hare International Airport travels along the median of Interstate 90.

These features provide a strong rationale for developing rail transit systems. However, the infrastructure for a rail transit system is expensive compared with that for bus service. Gaining adequate funding for system development is a problem that confronts every new rail initiative; but some metropolitan regions may be inappropriate candidates for rail services because of population size or land use patterns.

One way to assess the viability of rail transit is by making comparisons with transit activity levels in other metropolitan areas. To identify differences in transit effectiveness, metropolitan regions can be compared using geographic information systems (GIS).[1]

A comparison also should include regional characteristics, which may determine the suitability of rail transit in an area. In addition, community policies influence decisions about rail transit initiatives; for example, many large cities have emphasized freeways instead of transit systems for solving urban transportation problems.

[1] ArcView GIS 3x, a product of Environmental Systems Research Institute, Redlands, California, was used in analyzing the data and producing the figures for this article.

TABLE 1 Selected Transit Data for Major Metropolitan Regions, 1998

Metropolitan Region	Annual Transit Passenger Miles	Heavy Rail Passenger Miles	Commuter Rail Passenger Miles	Light Rail Passenger Miles
New York	12,981,015,015	7,658,914,503	5,309,515,926	12,584,586
Chicago	2,512,251,417	899,321,587	1,612,929,830	0
Washington, D.C.	1,404,797,097	1,144,366,021	212,421,543	48,009,533
San Francisco	1,303,827,727	987,864,133	177,044,460	138,919,134
Boston	1,163,795,094	599,115,814	391,854,043	172,825,237
Philadelphia	815,046,545	365,230,582	398,818,686	50,997,277
Atlanta	488,747,655	488,747,655	0	0
Los Angeles	466,846,304	24,118,092	272,186,307	170,541,905
San Diego	179,631,457	0	26,886,217	152,745,240
Miami	172,410,903	104,301,738	68,109,165	0
St. Louis	95,910,549	0	0	95,910,549
Cleveland	83,277,149	54,247,521	0	29,029,628
Dallas	63,372,707	0	4,455,936	58,916,771
Portland	63,299,139	0	0	63,299,139
Sacramento	39,425,446	0	0	39,425,446
Pittsburgh	35,764,028	0	0	35,764,028
Buffalo	16,261,924	0	0	16,261,924
New Orleans	15,568,693	0	0	15,568,693
Denver	13,055,603	0	0	13,055,603

Selecting Cities

A minimum total metropolitan population determined the cities to be evaluated (see Table 1). Many cities are too small for transit development; the smallest metropolitan region with rail transit services was Buffalo, New York, with a population of 1.2 million—this therefore was used as the low threshold.

Metropolitan population can be measured by the city limits, the urbanized area, or the metropolitan statistical area (MSA), among other categories; large cities have data for the CMSA. Population totals from CMSAs and MSAs best identify the areas already served by metropolitan transit systems.

The study defines a metropolitan rail site as a fixed-rail guideway route of five miles or more. The shortest qualifying routes are Buffalo's light rail line of 6.2 miles and the Carrollton Line in New Orleans, Louisiana, 6.6 miles. In comparison, the various transit systems of the New York CMSA comprise more than 1,000 route miles. All rail system data are from *Transit Profiles 1998* (4), which does not provide data for tourist people-movers or for tourist rail operations.

Some bus transit agencies with annual totals of less than 50 million passenger miles are excluded from the analysis for large CMSAs, like New York. However, regions with a primary transit agency generating close to 50 million passenger miles annually were included—for example, Hartline of Tampa, Florida, with a ridership of 45.8 million passenger miles.

Defining Modes

The definitions of rail transit modes are much debated. The study identifies modes according to the *Transit Profiles* categories.

- **Commuter rail** consists mainly of services that operate on freight or Amtrak rights-of-way. Some of these services have been operating since the 1860s. Commuter rail operations may include high-speed services (Northeast Corridor trains attain 150 miles per hour) as well as at-grade operations and street operations with slow speed limits.
- **Heavy rail** systems are grade-separated systems on expensive subway or elevated rights-of-way, with capacities for large volumes. Since 1970 six heavy rail systems have been constructed in the United States.
- **Light rail** lacks a standard definition.[2] The rail itself is usually the same weight as that of other systems—115 or 132 pounds per yard. Construction costs for light rail routes are usually far less than for heavy rail lines. Light rail routes are often constructed at grade and sometimes operate in the street on former streetcar lines, as in Philadelphia, Pennsylvania, and San Francisco. Generally, light rail systems convey passenger loads ranging from 75 to 750 people per trip and operate at slower speeds up to a maximum of 55 miles per hour.

[2] For a proposed definition of light rail, see *Transportation Research Circular E-C033: This Is Light Rail Transit*, TRB, National Research Council, 2001, p. 5. http://www.trb.org/trb/publications/circulars/ec033.pdf.

Rail Transit Characteristics

Cities Without Rail Transit

The absence of rail transit service in 17 large U.S. metropolitan regions as of 1998 is notable. Three features characterize urban regions without rail transit:

- Many have extensive freeway networks for commuters;
- Many have above-average growth rates and limited experience with commuter rail services; and
- Many have populations ranging from 1.2 to 2 million, just above the suitability threshold for commuter rail services.

Figure 1 shows rail as a percentage of total transit in U.S. metropolitan areas; the 17 cities without rail transit in 1998 fall into the legend category of 0 percent. However, two of these cities—Salt Lake City, Utah, and Seattle, Washington—inaugurated services in 1999 and 2000, respectively.

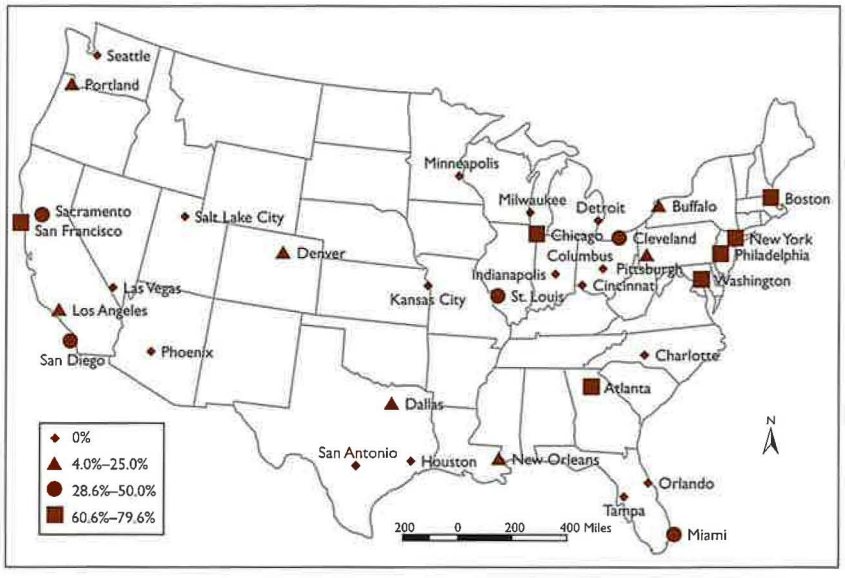


FIGURE 1 Rail as a percentage of total transit, scaled by size of metropolitan area (1998 data).

Cities with Rail Transit

The strongest legend category in Figure 1 comprises cities that have a large portion of commuter rail activity; this group includes 6 of the 19 metropolitan regions. A majority of the transit patrons in these six cities use rail. In New York, rail accounts for 79.6 percent of transit passenger miles (12.98 billion of a total of 16.3 billion in 1998).

The other legend categories show less focus on rail transit use. Despite a new light rail system, Denver, Colorado, logged only 4 million rail passenger miles, ranking last; however, rail transit use is growing rapidly since the opening of Denver rail's Southwest Corridor in the summer of 2000.

Seven metropolitan regions generated large increases in rail transit ridership. For example, Washington, D.C.–Baltimore, Maryland, and Atlanta had no rail transit in 1965. In 1998 the Washington, D.C.–Baltimore region generated more than 1.4 billion rail passenger miles, and the Atlanta region produced 488 million rail passenger-miles. New light rail systems in San Diego; Portland; Los Angeles, California; and St. Louis, Missouri, also generated substantial rail transit patronage. The ridership pattern shown in Figure 1 has changed substantially in 30 years.

Rail Transit Modes

Modal distribution of urban rail traffic is presented in Figure 2. The figure shows urban regions with rail traffic, scaled by population size, and the shares of total passenger miles among heavy rail, commuter rail, and light rail. Cities without rail transit are represented by small solid squares.

The map indicates that commuter rail and heavy rail traffic are focused in the larger consolidated metropolitan areas; Los Angeles is the only exception. Rail transit returned to Los Angeles in 1990 with the restoration of service on the former Pacific Electric Los Angeles–Long Beach line (referred to in the film, *Who Framed Roger Rabbit?*). In many of the cities, light rail transit represents new operations.

Passenger Miles

Per capita rail passenger mile data are presented in Figure 3; rail passenger miles for 1998 were divided by the CMSA or MSA population estimates for 1996.

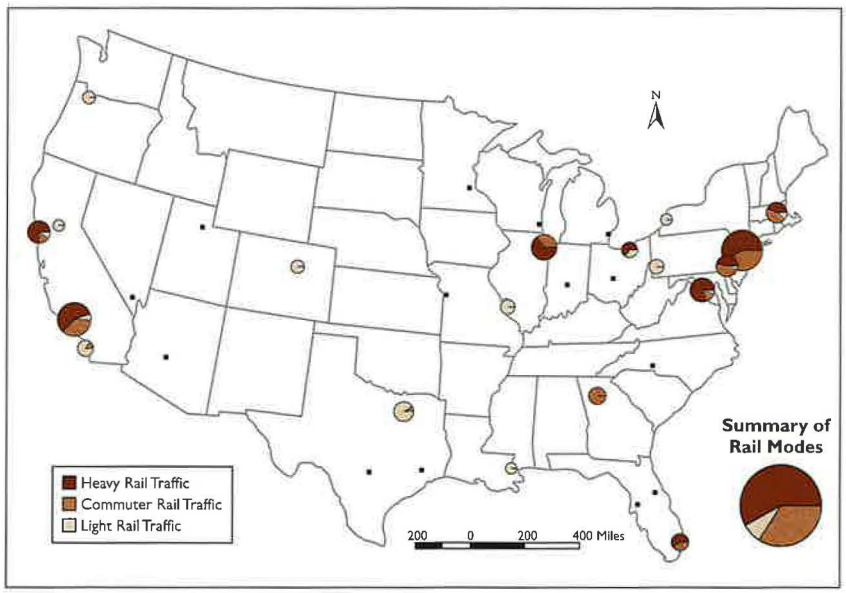


FIGURE 2 Modal distribution of rail transit, scaled by size of metropolitan area (1998 data).

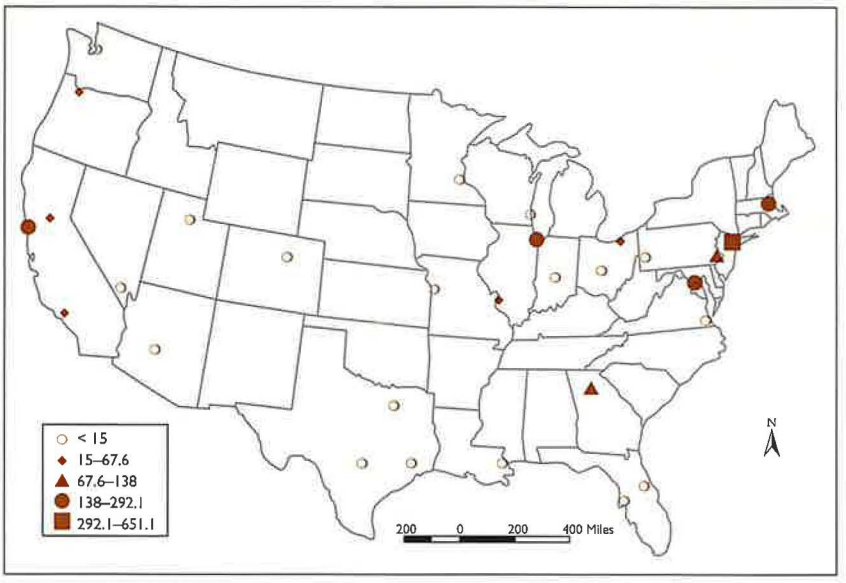


FIGURE 3 Annual rail passenger miles per capita (1998 rail passenger miles; 1996 population estimates).

For Figure 3, per capita values were calculated to classify the cities.

A strong correlation emerges between population size and per capita annual rail passenger miles. Five CMSAs register high per capita rail transit usage:

- New York, 651 miles;
- Chicago, 292 miles;
- Boston, 209 miles;
- San Francisco, 197 miles; and
- Washington, D.C.–Baltimore, 196 miles.

At the low end of regional per capita rail use are 13.8 miles per person per year in the Buffalo MSA and 11.9 miles per person per year in the New Orleans MSA. Population size also is associated with commuter rail and heavy rail transit use.

Many of the triangles in Figure 3 represent smaller cities that recently initiated light rail services; 11 of the 19 cities in Figure 3 had values of 0 (no service) in 1970. Values for the remaining eight rail cities in this figure increased substantially in the 30-year period.

Light Rail Mileage

Transit mileage for light rail systems is presented in Figure 4. Four metropolitan regions produced light rail patronage of more than 135 million passenger miles in 1998:

- Boston, 173 million passenger miles;
- Los Angeles, 171 million passenger miles;
- San Diego, 153 million passenger miles; and
- San Francisco, 139 million passenger miles.

The next four cities by magnitude were

- St. Louis, 95 million passenger miles;
- Portland, 63 million passenger miles;
- Dallas, 59 million passenger miles; and
- Philadelphia, 51 million passenger miles.

Light rail transit values should increase substantially, because many metropolitan regions have added segments since 1998.

Five of the top eight metropolitan regions for light rail had no rail transit in 1980. Of the 16 cities in Figure 4, 7 operate on former streetcar routes. With the exception of New Orleans, improved track structure and improved rights-of-way have enhanced carrying capacity. The light rail systems in San Francisco, Philadelphia, and Pittsburgh, Pennsylvania, have lengthy subway sections that resemble heavy rail and could be classified as combination systems.

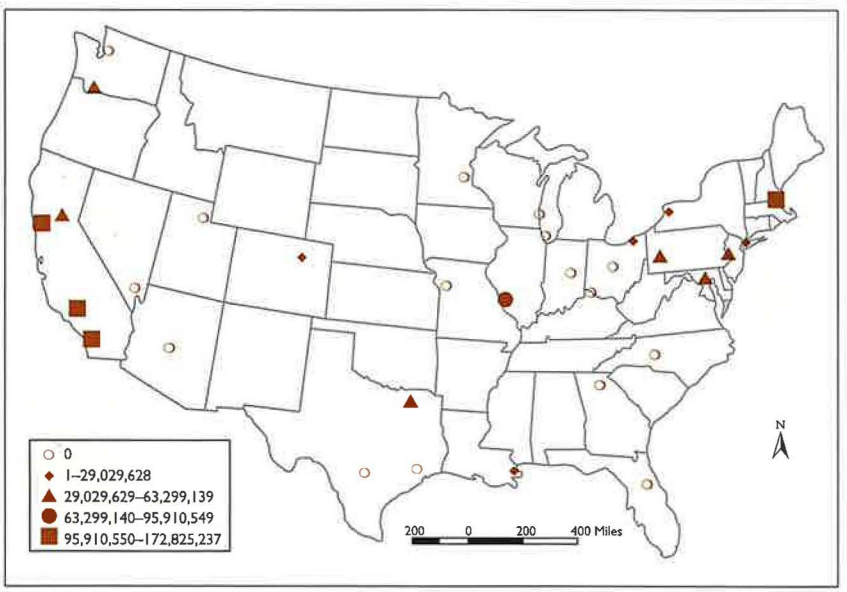


FIGURE 4 Light rail transit activity (1998 annual passenger miles).

Constructing New Ventures

During the past 30 years, many cities have constructed new rail transit services. Some new systems have attracted riders, but patronage in others is mediocre. The construction of heavy rail systems involves large expenditures; the development of commuter rail or light rail projects results in more modest costs.

Potential ridership is a primary consideration in deciding which mode is appropriate for expansion or startup. Balancing the anticipated costs are such benefits as increased numbers of riders, congestion mitigation, air pollution reduction, and the potential for economic development.

The decision to develop a rail transit option is frequently controversial. New subway rail construction may cost more than $100 million per mile. Although significantly less in cost, light rail construction still entails major budget allocations.

Nonetheless, new proposals for metropolitan rail development are on the increase. Many transit systems are requesting extensions of routes or new lines. Many smaller cities, such as Austin, Texas, and Louisville, Kentucky, have advanced proposals for rail development; 25 new transit initiatives have been proposed.[3]

Yet funds for new rail transit are limited. For fiscal year 2001 the total allocation for new starts is $1.07 billion, which includes system expansion as well as new starts (5)—leaving a large gap between rail transit goals and funding.

Boston's light rail transit generates more than 173 million passenger-miles.

Considerations in Decision Making

The standard transit study sketches out desired trip routes by origin and destination and then adjusts for projected growth (6). The formulated travel demand then is matched against current and proposed transportation facilities.

The transit decision-making process, however, also should include other qualitative and quantitative considerations. Rail transit may not be appropriate for some metropolitan areas despite the results of a standard transit planning study. Additional considerations in the decision-making process could include (3)

- Structural form:
  - Does the metropolitan region have a radial corridor type of land use pattern, which may favor rail transit?
  - Is the density of land use activity appropriate for rail transit development?
  - Are high-activity focal points situated in the proposed transit corridors?
- Historic potential:
  - Is there a pattern of substantial transit use?
  - Is there a potential for developing connectors such as "trunk and branch" feeder routes?
  - Is there a prospect for developing cross-town connectors to facilitate rail transit use?

The data in this study show large variations among metropolitan regions in the use of automobiles compared with rail transit. Some metropolitan candidates for new rail have low transit utilization; a critical issue is whether people will switch from automobiles to transit.

Are potential facilities already available? Development may cost far less, for example, if railway lines are available for transit use. Construction of the St. Louis MetroLink system cost approximately $10 million per mile—incorporating a surplus rail line and the unused Eads Bridge and tunnel rail route reduced the development costs (7). In contrast, the cost estimate for extending the Washington, D.C., Metropolitan Area Transit Authority's Metrorail system is $135 million per mile.

Air pollution is a problem in many metropolitan regions. Substantial reductions in emissions are

Cost and transit usage were considered by decision makers in determining whether to extend Washington, D.C., Metro's Green Line to its Branch Avenue station.

PHOTO: PHIL PORTLOCK

[3] The March 2000 *Railway Age* (1) detailed expansion plans and proposals for new starts; Detroit, Michigan, and Las Vegas, Nevada, are the only cities in this study not on the *Railway Age* list.

Under the Transportation Equity Act for the 21st Century, the Chicago METRA commuter rail has received funding to install double track and to extend service to Manhattan, Illinois.

achievable through all forms of transit. Sport utility vehicles carrying commuters in stop-and-go traffic on a congested roadway produce more emissions per passenger—perhaps six times more—than commuter rail or light rail tram carrying a capacity load.[4]

Toward a New Decision Model

Funding for rail transit development is ultimately a political decision. Some of the $1.07 billion allocated for route extensions and new starts in fiscal year 2000 are for projects with minimal prospects for developing viable rail transit services; these allocations could be viewed as wasted. More than 20 of the 82 regions that received new-start funding for rail transit are smaller cities with patronage loads likely to be inadequate.

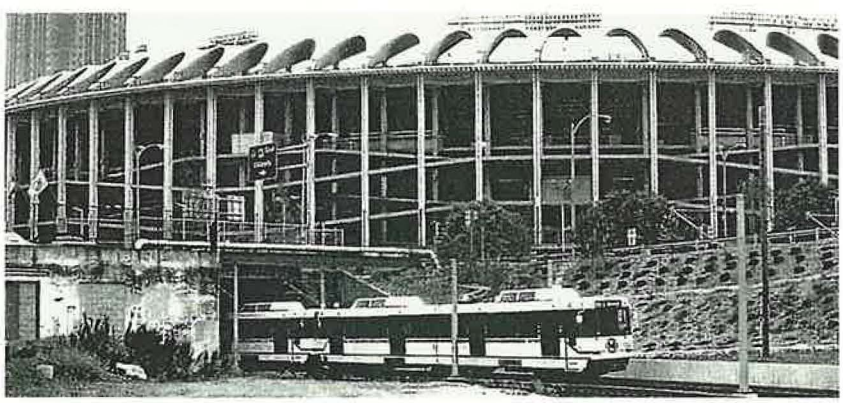
A revised model for funding decisions on new transit proposals should consider quantitative and qualitative issues. Characteristics of the metropolitan region—including the urban structure, land use activity, population density patterns, and the arrangement of focal points—provide additional decision-making criteria. Established patterns of transit use and potential route connectivity also should play a role in determining locations for new transit development.

The decision to develop new rail transit may involve choosing a few metropolitan regions in which success is probable or many cities including localities with features that only marginally favor transit development. The first alternative involves a methodology that focuses on technical assessment; the second often follows a political decision-making track.

But instead of a polarized scenario, perhaps the continuum for decision making can incorporate criteria that will channel transit funding to metropolitan regions that have distinctly greater potentials for success.

[4] Based on calculations using urban fuel consumption rates for sport utility vehicles (*Consumer Reports*, September 2001) and fuel consumption rates and average passenger loads for diesel locomotive commuter rail (*Transportation*, Vol. 5, No. 3, pp. 285–308).

The costs of building the MetroLink light rail in St. Louis were reduced by incorporating unused facilities, such as the Eads Bridge Tunnel, near Busch Stadium Station, and the former Wabash Railway's Delmar Station.



Acknowledgments

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References

1. Middleton, W. D., and J. Wolinsky. North American Rail Transit: Where It Is, Where It Will Be. *Railway Age*, Vol. 201, No. 3, March 2000, pp. G12–G29.
2. Vuchic, V. R. *Transportation for Livable Cities*. Center for Urban Policy Research, New Brunswick, N.J., 1999.
3. Warren, W. D. A Transportation View of the Morphology of Cities. *Transportation Quarterly*, Vol. 47, No. 3, July 1993, pp. 367–378.
4. *Transit Profiles*. Federal Transit Administration, U.S. Department of Transportation, 1998, www.ntdprogram.com.
5. *FY2001 Section 5309 New Start Allocations*. Federal Transit Administration, U.S. Department of Transportation, www.fta.gov.
6. *Statistical Abstract of the United States*. U.S. Bureau of the Census, September 25, 1998, pp. 40–43.
7. Warren, W. D. "Why Success in St. Louis," *TR News*, No. 180, September–October 1995, pp. 22–27.