
Portland and Seattle Transit Operating Cost: Alternative Strategies Compared

publictransit.us Special Report No. 6

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A web-based publication of
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Introduction

The analysis of operating-cost “economy of scale” with regard to Portland light rail transit suggests a comparison to determine the relative cost efficiency of the “trunk-feeder” strategy with one emphasizing “one-seat” peak-period service connecting as many points as practical.

Portland opened a 30-mile east-west light-rail line between 1986 and 1998. Seattle, by contrast, developed extensive express-bus services from the early 1970s, and opened its downtown bus tunnel in 1990. The following comparison uses data for the 2001 fiscal year, reported to the Federal Transit Administration (FTA) by the Tri-County Metropolitan Transportation District of Oregon (Tri-Met) and the King County Department of Transportation (King County Metro).

1) Data

Fiscal Year 2001 (NTD)	Tri-Met (Portland)	King County Metro (Seattle)
Service area population	1,172,158	1,758,300
Annual revenue service hours	2,487,087	3,886,407
Annual passenger-miles	366,909,122	547,685,904
Annual unlinked trips	91,186,336	101,000,283
Annual operating expense	\$203,654,043	\$346,157,039
Annual fare revenue	\$54,117,025	\$78,442,712

2) Estimate of Linked Trips

Estimation of linked trips (i.e. end-to-end trips) from unlinked trips (“boardings”) can be carried out in reasonable fashion so long as one addresses the mathematical relationship among:

- linked trips.
- passenger-miles.
- average distance traveled per linked trip.

--average passenger "speed," or total travel time – including "out of vehicle" time for transfers.

The existence of this relationship is not subject to debate, and may be demonstrated as follows:

- 1.) $\text{unlinked trips} * (1 - \text{transfer rate}) = \text{linked trips}$.
- 2.) $\text{passenger-miles} / \text{linked trips} = \text{average length of linked trip}$.
- 3.) $\text{average travel time} / \text{average length of linked trip} = \text{average passenger speed, including "out of vehicle" time for transfers}$.

(It should be obvious that the number of passenger-miles is independent of the transfer rate.)

As Equations 1.) and 2.) demonstrate, successively larger transfer rates lead to successively smaller numbers of linked trips. This in turn leads to successively higher values for average distance traveled per linked trip.

For example, if one asserts that the 91 million annual boardings reported by Tri-Met should be discounted to account for a (postulated) 50 percent transfer rate, this also implies a doubling of average distance traveled per transit trip, from four to eight miles. In addition, the average passenger speed will also increase. In very rough terms, the nationwide "average" journey-to-work time by transit is 30 minutes. A four-mile average travel distance implies a passenger-speed of eight mph. Eight miles, however, implies 16 mph, and carries the additional caveat that "out-of-vehicle" time is included in the overall "average" travel time.

The authors attempted to estimate the following:

- 1.) The **maximum** average distance traveled per linked trip for Tri-Met and King County Metro.
- 2.) The corresponding number of linked trips, which represents a "threshold" **minimum**.

Results for Tri-Met: To the nearest whole, an average distance traveled per linked trip (ADLT) of seven miles implies an average passenger speed of about 15 mph, including out-of-vehicle time spent during transfers. This latter was judged to be the likely maximum. A seven-mile ADLT implies 52 million annual linked trips. The authors rounded this to a single significant digit, giving 50 million annual linked trips.

Results for King County Metro: The service area has 50 percent more people than that of Tri-Met but covers more than three times the land area. This implies that the ADLT should be longer. On the other hand, roughly 50 percent of King County Metro traffic is carried within the Seattle city limits. A significant share of these trips are short: the trolleybus network, which carries about 25 percent of all Metro boardings, also carries an average travel distance per boarding of 1.7 miles. To the nearest whole, the largest likely ADLT was judged to be eight miles, for larger figures imply implausibly high passenger speeds – and implausibly long “suburban” travel distances. An eight-mile ADLT implies 68.5 million annual linked trips, or 70 million, rounded to a single significant digit.

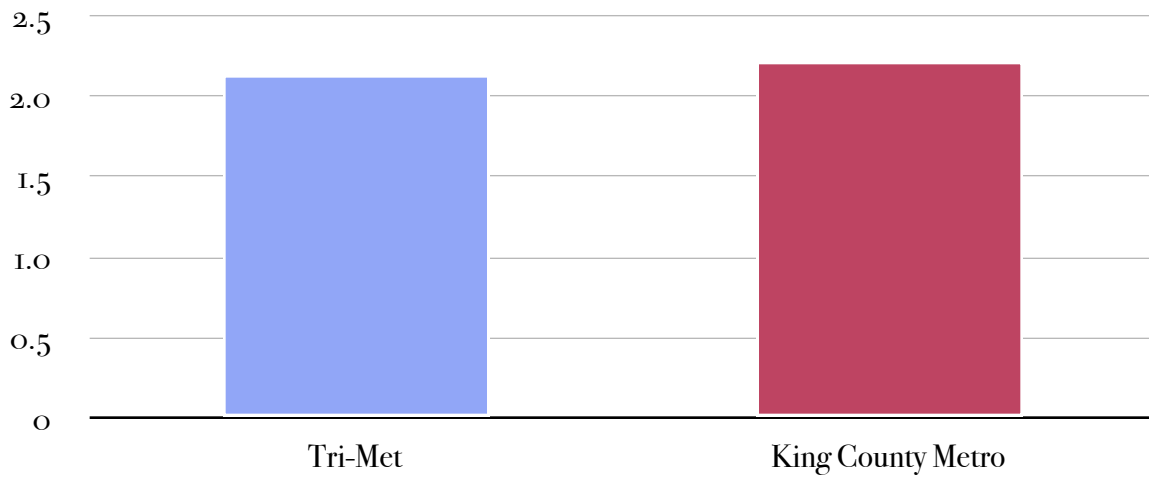
Summary of results:

	Tri-Met	King County Metro
Threshold minimum, annual linked trips	50 million	70 million
Implied average length of linked trip	7 miles	8 miles
Implied transfer rate	0.45	0.31
Threshold minimum, annual linked trips per capita	40	40

The threshold minimum statistics for annual linked trips per capita were rounded to a single significant digit. It is likely that the “actual” figure for King County as a whole is larger, owing to transfer of a number of suburban routes from King County Metro to Sound Transit from the late 1990s. However, Sound Transit also operates routes that cross the county line, and disaggregate data for services within King County are not available.

3) Analysis

PER CAPITA TRANSIT SERVICE SUPPLY (ANNUAL REVENUE SERVICE HOURS), FY 2001

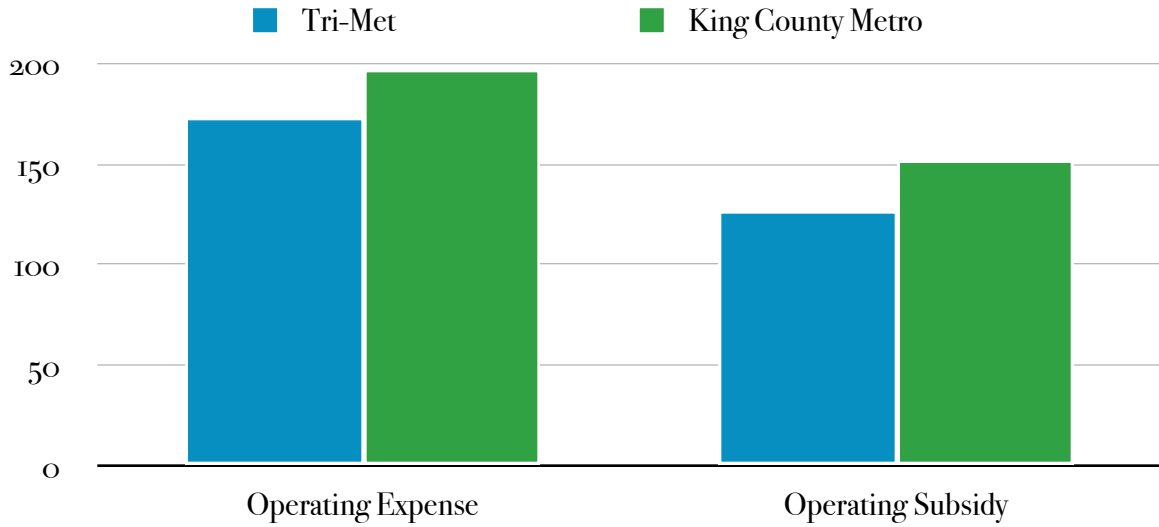


	Tri-Met	King County Metro
Annual Revenue Service Hours Per Capita	2.12	2.21

PER CAPITA TRANSIT SERVICE CONSUMPTION, FY 2001

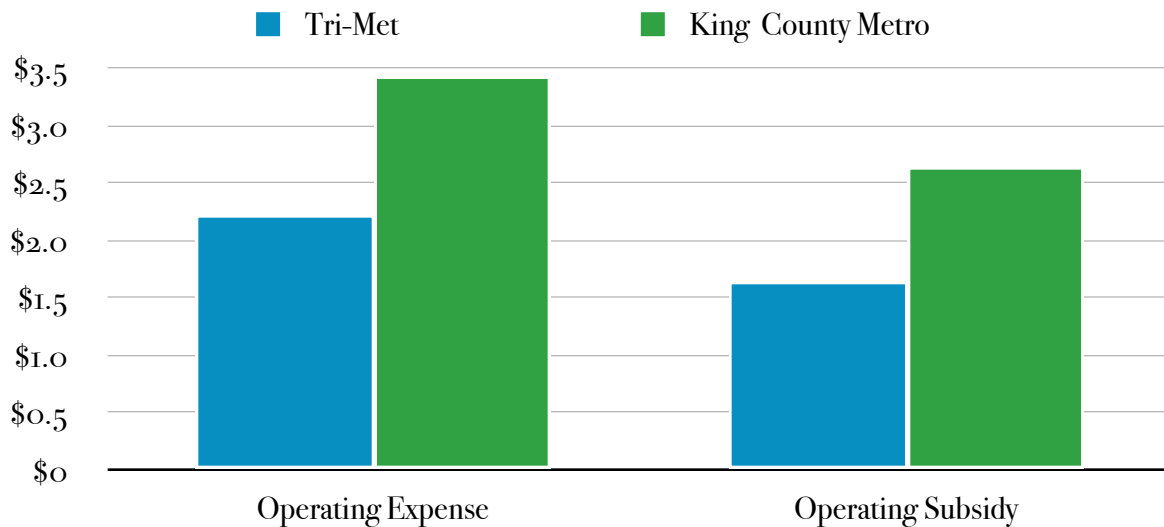
	Tri-Met	King County Metro
Annual Unlinked Trips Per Capita	78	57
Annual Linked Trips Per Capita	40	40
Annual Passenger-Miles Per Capita	313	311

PER CAPITA TRANSIT OPERATING EXPENSE AND SUBSIDY, FY 2001



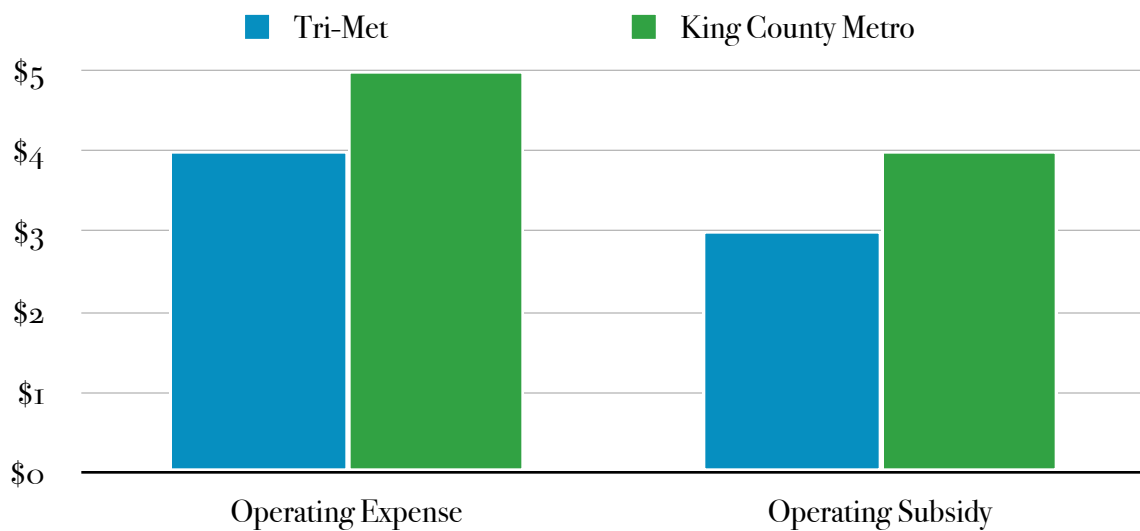
	Tri-Met	King County Metro
Annual Transit Operating Expense Per Capita	\$173.74	\$196.87
Annual Transit Operating Subsidy Per Capita	\$127.57	\$152.26

Transit Operating Expense and Subsidy per Unlinked Trip, FY 2001



	Tri-Met	King County Metro
Annual Transit Operating Expense Per Unlinked Trip	\$2.23	\$3.42
Annual Transit Operating Subsidy Per Unlinked Trip	\$1.64	\$2.65

Transit Operating Expense and Subsidy per Linked Trip, FY 2001



	Tri-Met	King County Metro
Annual Transit Operating Expense Per Threshold Minimum Linked Trip	\$4	\$5
Annual Transit Operating Subsidy Per Threshold Minimum Linked Trip	\$3	\$4

4) Estimated Tri-Met Cost Savings to Tri-Met Due to Light Rail

Fiscal Year 2001 (NTD)	Bus	Light Rail
Annual Operating Expense	\$153,860,651	\$40,035,484
Annual Revenue Vehicle Hours	1,856,166	286,115
Operating Expense per Revenue Vehicle Hour	\$82.89	\$139.93

The following “cost bases” may be estimated for Tri-Met rail and bus services (FY 2001 costs):

Assuming new low-floor buses:

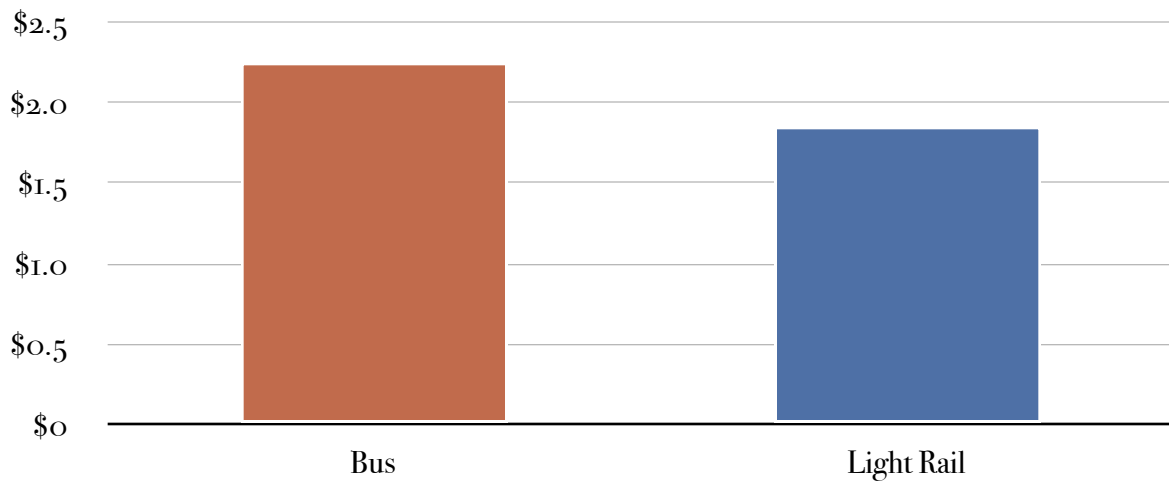
$\$82.89 \text{ per revenue service hour} / 37 \text{ seats} = \$2.24 \text{ per revenue seat-hour.}$

Assuming existing light rail vehicles:

$\$139.93 \text{ per revenue service hour} / 76 \text{ seats} = \$1.84 \text{ per revenue seat-hour.}$

The cost bases above adjust for differences in vehicle size.

OPERATING EXPENSE PER REVENUE SEAT HOUR - TRI-MET, FY 2001



Difference in operating expense per revenue seat-hour:

$(\$2.24 - \$1.84) = \$0.40$

$\$0.40 / \$1.84 = +21.7 \text{ percent.}$

On a 1:1 service-substitution basis, Tri-Met would have needed to spend nearly 22 percent more than in FY 2001 to provide the “light-rail” component of its service with buses.

This analysis does not take into account various factors (i.e. street and freeway congestion; lower peak-period vehicle occupancy carried by buses) that would tend to require more service with buses than necessary with light rail.

Additional operating cost of an “all-bus” system:

$$\$40,035,484 * 0.217 = \$8.7 \text{ million.}$$

This amount is sufficient to pay back roughly \$110 million worth of invested capital, including “opportunity cost,” based on a 7 percent discount rate and a 30-year project life (discount rate and project life selected to conform with those used for FTA alternatives-analysis purposes).

5) Estimated Tri-Met Cost Savings Due to “Trunks & Feeders”

King County Metro operated slightly more revenue service hours per capita. This, together with the population of the Tri-Met service area, implies that Tri-Met would have needed to operate nearly 106,000 more annual revenue service hours if its system had been configured as that of King County Metro:

Difference in Annual Revenue Service Hours per Capita

$$\text{King County Metro (2.21) - Tri-Met (2.12) = 0.09.}$$

$$0.09 * \text{Tri-Met Service Area Population (1,172,158)} = 105,494.$$

The above, based on the FY 2001 unit cost of \$83 per revenue vehicle hour for bus operation, implies \$8.7 million in additional operating expense from the less-efficient network configuration. \$8.7 million in direct operating cost savings from light rail, plus \$8.7 million from operation of a more efficient network configuration, totals \$17.4 million, or more than eight percent of Tri-Met’s total operating expenditures for FY 2001. This amount is sufficient to pay back roughly \$220 million worth of invested capital, including “opportunity cost,” based on a 7 percent discount rate and a 30-year project life.

6) Conclusions

- 1.) Annual transit use per capita, in terms of end-to-end or linked trips, was roughly equivalent in Portland and Seattle at FY 2001.
- 2.) Seattle spent \$23 more per capita, or 13 percent more than Portland, for the same result.
- 3.) King County taxpayers spent 61 percent more in subsidy per annual boarding than Metro Portland taxpayers.
- 4.) King County taxpayers spent approximately 25 percent more in subsidy per linked transit trip than Metro Portland taxpayers. Part of this reflects Seattle's longer travel distances, but the average linked transit trip in Seattle was not 25 percent longer than in Portland.
- 5.) Prospective savings to King County taxpayers were in the range of \$70-\$100 million annually if King County Metro achieved the same cost savings as Tri-Met from light-rail construction and operation of a trunk-feeder system configuration.
6. \$70-\$100 million in annual savings, assuming a 7 percent discount rate and 30-year project life, would offset capital investment in the range of \$1 billion - \$1.3 billion.

(The authors express sincere appreciation to Edson L. Tennyson, PE, for input and feedback.)