Ottawa: Transit Productivity and Bus Rapid Transit

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Abstract

Ottawa, Canada's capital, has the most extensive bus rapid transit (BRT) services in North America. The core "Transitway" network includes busways, reserved lanes and mixed traffic operation totalling 46.3 km (28.7 mi), opened in stages from 1983.

Most performance indicators revealed significant negative trends as transitway service expanded. Ridership did not grow as anticipated prior to construction. Ridership declined during 1984-1997 despite increasing population and employment; ridership per-capita fell by almost 40 percent. The previous doubling of ridership during 1971-1984 was not sustainable absent major productivity gains: bus-km per capita tripled, inflation-adjusted operating expense per capita increased 2.5 times, and the revenue : cost ratio fell from 98 to 60 percent.

Productivity did not increase as transitway service expanded. Real wage rates remained stable during 1982-2002 but operating cost per revenue service hour rose by nearly 60 percent. Maintenance costs, fuel consumption, non-revenue ("deadhead") km and road calls all increased while labor utilization became less efficient. Available data suggest, but merely suggest, a sharp increase in customer complaints coinciding with a period of decreasing service reliability and declining ridership. However, the undertaking managed to improve service effectiveness and so moderated the negative trends in cost-effectiveness.

The 1984-1997 ridership decrease is unfortunate but less troubling than productivity declines during the same period. These suggest "inherent" or "structural" inefficiencies associated with Ottawa's transitway program. The implied annual cost is (2002 CAD) 65 million (2002 USD 42 million) based on 2002 service levels; the implied cumulative cost during 1982-2002 is (2002 CAD) 1,360 million (2002 USD 865 million). Additional research is indicated to identify underlying causal factors and possible counter-strategies.

Introduction

Ottawa, Canada's capital, opened its first busway ("Transitway") segment in 1983 and developed the most extensive and intensively-used bus rapid transit (BRT) services in North America over the next 15 years. The aggregate system length reached 46.3 km (28.7 mi) at 2001.

Although lauded worldwide as a model BRT facility, Ottawa's transitway system came under growing local criticism during the 1990s. Annual ridership more than doubled from 1971 to 1984, then fell thereafter as successive transitway segments were placed in service. The 1984 ridership level was not exceeded until 2002. Transit operating expense became a political issue by the end of the 1980s. Local controversies over transit financing intensified after 1995, when the Province of Ontario terminated all funding for transit, and labor disputes culminated in a lengthy strike at the end of 1996. A short diesel light rail transit (DLRT) service was started in 2001 October; this pilot project is marketed as "O-Train." At 2005 February, the Ottawa city council approved by unanimous vote a plan for a build two new LRT lines over 20 years.

> *The transitway as we know it today will be scrapped* (Ottawa Mayor Bob Chiarelli, *The Ottawa Citizen*, 2005 May 1).

It should be obvious that a review of transitway operating results would be informative and useful. OC Transpo, Ottawa's municipal transit service provider, publishes an excellent annual compilation of operating statistics, which is the primary reference for this paper. Although corrridor-level analysis would require additional research, OC Transpo statistics provide much useful information about trends systemwide.

Ottawa, which was then named Bytown, was incorporated as a town in 1850. Renamed and incorporated as a city in 1855, Ottawa was chosen by Queen Victoria as Canada's capital in 1857. Carleton County, including Ottawa and adjacent townships, became the Regional Municipality of Ottawa-Carleton (RMOC) in 1969 (together with one township from neighboring Russell County). RMOC was created to manage municipal services that crossed political boundaries. In 2001, in order to simplify the structure of local government and reduce costs, all suburbs and rural townships within the RMOC, and the RMOC itself, were amalgamated into an expanded City of Ottawa. The 2001 census counted 774,075 residents.

Ottawa transit came under public ownership in 1948, when the local authority purchased the Ottawa Electric Railway Company and organized the Ottawa Transportation Commission (OTC). This operator was succeeded by the Ottawa-Carleton Regional Transportation Commission, trading as OC Transpo, in 1972. Following amalgamation, OC Transpo is currently oper-

ated by the municipal Transportation, Utilities and Public Works department. The Public Works, Transit and Infrastructure Services Committee of the municipal council oversees OC Transpo's budget and operations.

Canada's Capital Region, with approximately 1.1 million residents, is now the fourth-largest conurbation in Canada. It includes the city of Gatineau, Quebec. This was expanded in 2002 to incorporate five municipalities on the left bank of the Ottawa River (including Hull, which was founded half a century before Ottawa). The 2001 census counted 226,296 residents. Transit services are operated by Société de transport de l'Outatoais (STO).

CAPITAL REGION TRANSIT OVERVIEW	OC Transpo	STO
Data Year	2003	2004
Service Area	397 km^2 (153 sq mi)	589 km^2 (226 sq mi)
Population Served	737,000	240,000
Annual Passengers	87.9 million	16 million
Average Weekday Ridership	340,000	60,000
Fleet	924	219
Staff	2,152	523

OTTAWA TRANSITWAY OVERVIEW	
Data Year	2003
System Length	46.3 km 28.7 mi
Stations	36
Weekday passenger volume	* 200,000
Peak hour one-way passenger volume	** 10,000

OTTAWA TRANSITWAY OVERVIEW	
Buses per hour, peak hour, CBD	190
Park & Ride Spaces	3,590

The transitway system length of 46.3 km (28.7 mi) included:

--dedicated (exclusive) transitway, 27.0 km (16.7 mi).

--reserved bus lanes, Ottawa business center (CBD), 2.0 km (1.2 mi).

--reserved bus lanes, Woodroffe Avenue, 2.5 km (1.5 mi).

--operation in mixed traffic, Ottawa River Parkway, 3.3 km (2.0 mi).

--freeway shoulder lanes, 11.5 km (7.1 km).

The CBD bus lanes consist of a one-way couplet on Albert and Slater streets, with curb lanes reserved for buses.

Only seven stations have park and ride spaces, and one station (Eagleson) accounts for 32 percent of these. Twenty stations are designated as “Bike & Ride locations.”

The authors note that the weekday transitway passenger volume reported by OC Transpo includes all passengers who travel along the CBD bus lanes in Albert and Slater streets. These are used by several routes that do not operate over other parts of the transitway system.

The authors have concluded that the “peak-hour one-way passenger volume” statistic reported by OC Transpo is in fact derived from the maximum passenger flow during a shorter interval, scaled up to an hourly rate. The actual maximum “volume,” the number of passengers transported past the maximum-load point during a 60-minute interval, is in the range of 4,000 - 5,000 passengers per hour per direction. Details will be presented in a companion paper.

1) Outline

The authors selected 1982, the last "no-transitway" year, as the baseline, and examined data at five-year intervals to 2002 in order to explore "short-term" impacts and "long-term" trends.

Data are presented below, following references, and are exclusive of paratransit ("Para Transpo") ridership and expenditures.

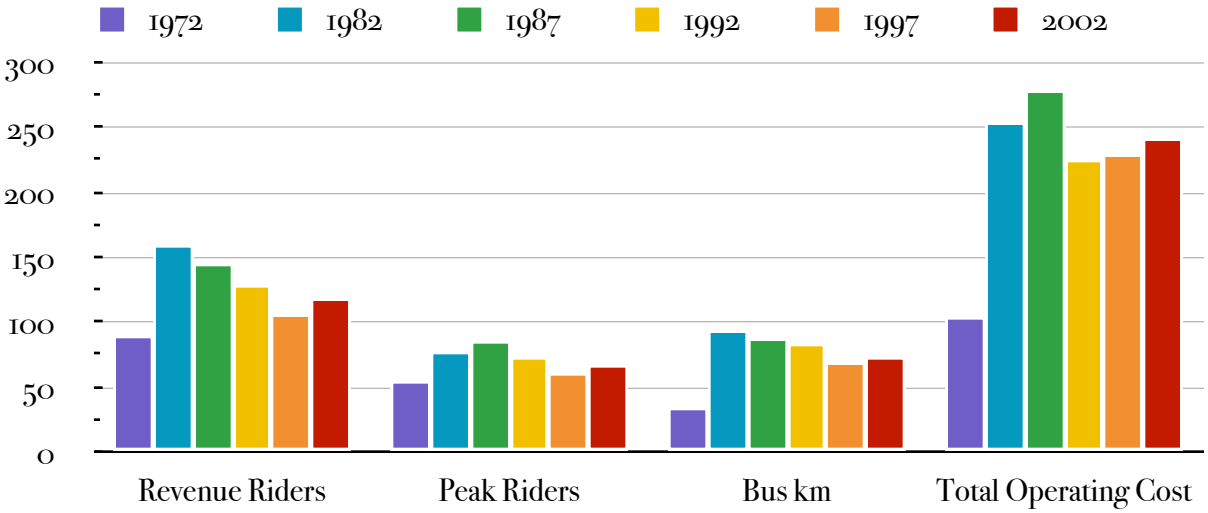
2001 was the last year of "all-bus" operation prior to startup of the "O-Train" diesel light rail transit (DLRT) service. Data for 2002 are believed to incorporate O-Train ridership and expenditures. However, the uncertainty introduced is believed to be minimal, for the O-Train service was worked with a single leased train and carried less than 1.5 percent of total ridership.

The authors have avoided making changes to terminology used in tables published by OC Transpo for reasons of style (e.g. retaining "Rider km" rather than changing to "Passenger-km"). A small number of data table headings were reworded for clarity.

Readers are advised that the term "rider," as used by OC Transpo, refers consistently to "revenue passengers" (or "linked trips") in accordance with Canadian practice. In contemporary U.S. parlance, the term "rider" refers generally to "boardings" (or "unlinked trips"). OC Transpo passenger statistics and derived performance indicators (e.g. operating cost per "passenger") are not compatible with U.S. National Transit Database (NTD) passenger statistics and derived performance indicators (e.g. operating cost per "boarding").

Conversions to U.S. dollars (USD) should be interpreted with care. Operating cost comparisons between Canadian and U.S. transit operators can be misleading because of differences in wage levels (which are higher in the U.S.).

2) Per-Capita Indicators



PER CAPITA	1972	1982	1987	1992	1997	2002
Revenue riders	91	160	146	130	107	120
Index (1982 = 100)	*57*	*100*	*91*	*81*	*67*	*75*
Peak Riders	55	78	87	73	61	67
Index (1982 = 100)	*70*	*100*	*112*	*94*	*78*	*86*
Bus km	35.6	93.5	87.8	84.3	69.1	73.1
Bus mi	22.1	58.0	54.4	52.3	42.8	45.3
Index (1982 = 100)	*38*	*100*	*94*	*90*	*74*	*78*
Standard Equivalent km	N/A	92.6	93.1	91.9	73.9	79.7
Standard Equivalent mi		57.4	57.7	57.0	45.8	49.4
Index (1982 = 100)		*100*	*101*	*99*	*80*	*86*
Total Operating Cost, 2002 CAD	105	255	280	226	231	243
2002 USD	US$ 67	US$ 162	US$ 179	US$ 144	US$ 147	US$ 155
Index (1982 = 100)	*41*	*100*	*110*	*87*	*91*	*95*
REVENUE : COST RATIO	0.98	0.60	0.57	0.56	0.58	0.59

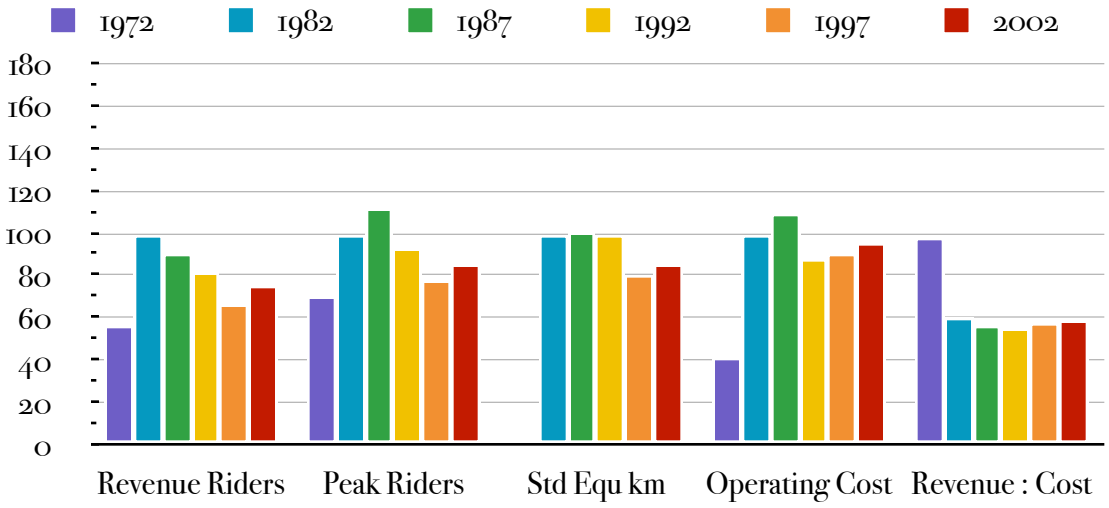
1972 data were included above to provide historic reference.

“Standard equivalent km” is defined as “The total number of service kilometres if the total fleet was comprised only of 40 foot standard buses” (OC Transpo 2003). This indicator accounts for relative vehicle size, and therefore the increased use of articulated buses after 1982.

On a per-capita basis, OC Transpo increased service nearly threefold from 1972 to 1982. Ridership increased by more than 75 percent, while the number of peak riders per capita increased by 42 percent. This suggests that the majority of the 1972-1982 ridership increase occurred outside of weekday peak travel periods. However, inflation-adjusted total operating cost per capita more than doubled. The change in “revenue : cost ratio” during this period, from 98 to 60 percent, suggests that absent major increases in productivity, the 1972-1982 trends were not sustainable.

Trends - Per-Capita Ridership, Service and Operating Cost

(1982 = 100)

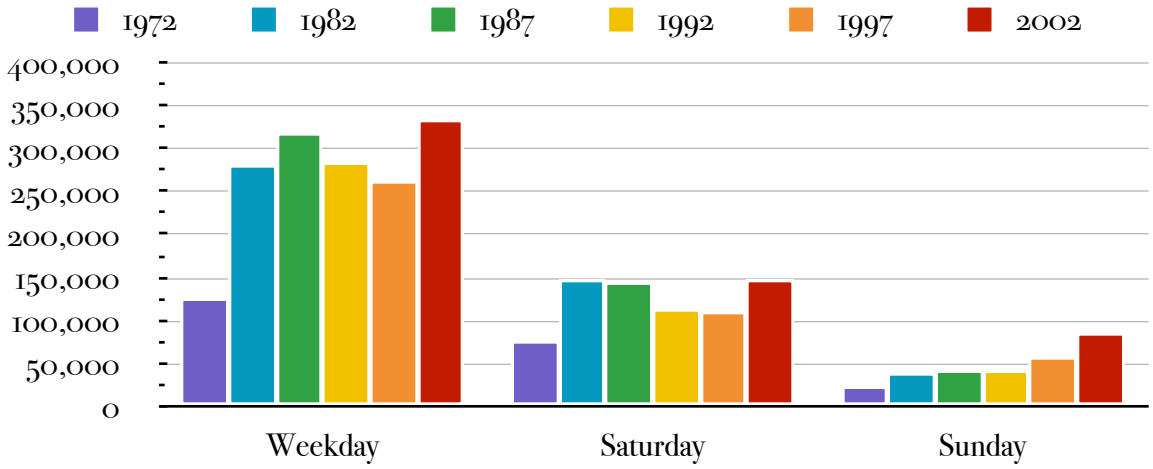


Taking relative vehicle size into consideration (“standard equivalent km”), OC Transpo increased service from 1982 to 1992 at a rate matching the UTA population increase. However, the abso-

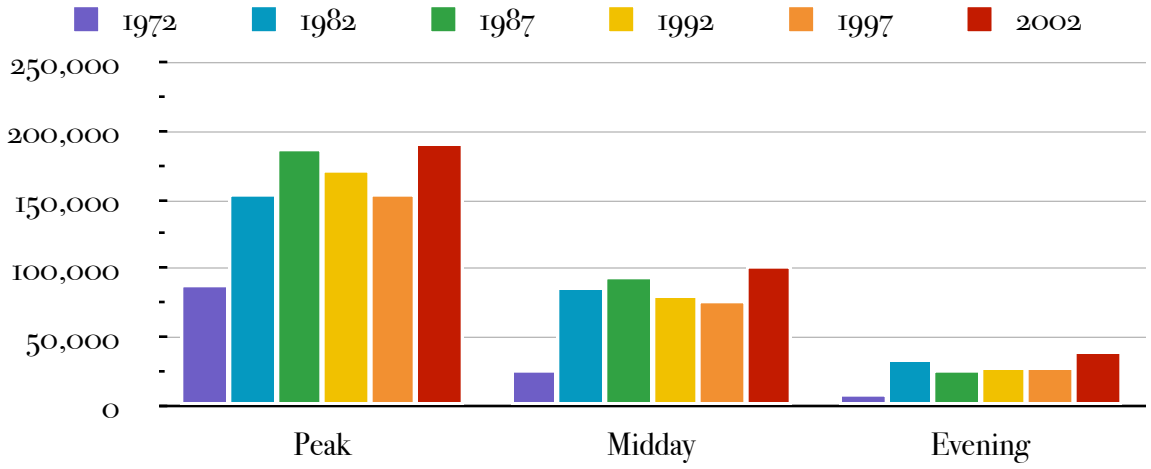
lute number of “revenue riders” (“linked trips”) fell after 1984. Therefore, the number of revenue passengers per capita (an indicator known traditionally as “riding habit”) also declined after 1984. The absolute number of “weekday peak period riders” increased to 1985, then remained relatively static until 1989. For this reason, the number of peak riders per capita also declined after 1989.

3) Ridership Indicators

Average Weekday, Saturday and Sunday Ridership (Revenue Passengers)



Average Weekday Peak, Midday and Evening Ridership (Revenue Passengers)



	1972	1982	1987	1992	1997	2002
Weekday Riders	127,000	283,585	318,961	285,072	264,600	335,468
Index (1982 = 100)	*45*	*100*	*112*	*101*	*93*	*118*
Weekday Peak Period Riders (a.m. & p.m)	89,281	155,924	188,506	171,943	155,407	191,400
Index (1982 = 100)	*57*	*100*	*121*	*110*	*100*	*123*
Weekday Midday Riders	27,178	87,943	95,050	81,949	76,870	101,921
Index (1982 = 100)	*31*	*100*	*108*	*93*	*87*	*116*
Weekday Evening Riders	9,398	34,232	27,016	28,657	29,946	40,692
Index (1982 = 100)	*27*	*100*	*79*	*84*	*87*	*119*
Saturday Riders	79,000	148,977	144,519	113,744	110,171	147,617
Index (1982 = 100)	*53*	*100*	*97*	*76*	*74*	*99*
Sunday Riders	24,000	40,395	43,562	44,623	60,362	87,344
Index (1982 = 100)	*59*	*100*	*108*	*110*	*149*	*216*
Rider km per Revenue Rider	5.6	8.7	10.0	10.0	10.0	10.0
Rider mi per Revenue Rider	3.5	5.4	6.2	6.2	6.2	6.2
Index (1982 = 100)	*64*	*100*	*114*	*115*	*115*	*115*
Transfers per Revenue Rider	0.25	0.29	0.40	0.41	0.40	0.40
Index (1982 = 100)	*86*	*100*	*137*	*141*	*137*	*137*
Customer Contacts per Million Revenue Riders	N/A	75.4	106.4	91.1	100.5	185.0
Index (1982 = 100)		*100*	*141*	*121*	*133*	*245*

1972 data were included above to provide historic reference. Annual “revenue riders” (or “linked trips”) fell after 1984, and this overall downward trend was not reversed until 1998. The number

of weekday peak period riders increased to 1985, remained relatively static to 1989, then declined to 1997.

The number of "weekday peak period riders," "weekday midday riders" and "weekday evening riders" reported by OC Transpo was based on a 1985 origin-destination survey before 1990 and on APC (Automatic Passenger Counting) boarding data from 1990 ("September booking"). This change in methodology might account for some of the declines apparent post-1990. However, a clear downward trend in peak-period ridership was visible by 1993, and this was not reversed until 1997. Weekday midday ridership remained relatively static to 1999, then increased thereafter. Weekday evening ridership peaked at 1985, then fell sharply for two years thereafter. This indicator remained relatively static to 1997, and increased through 2002.

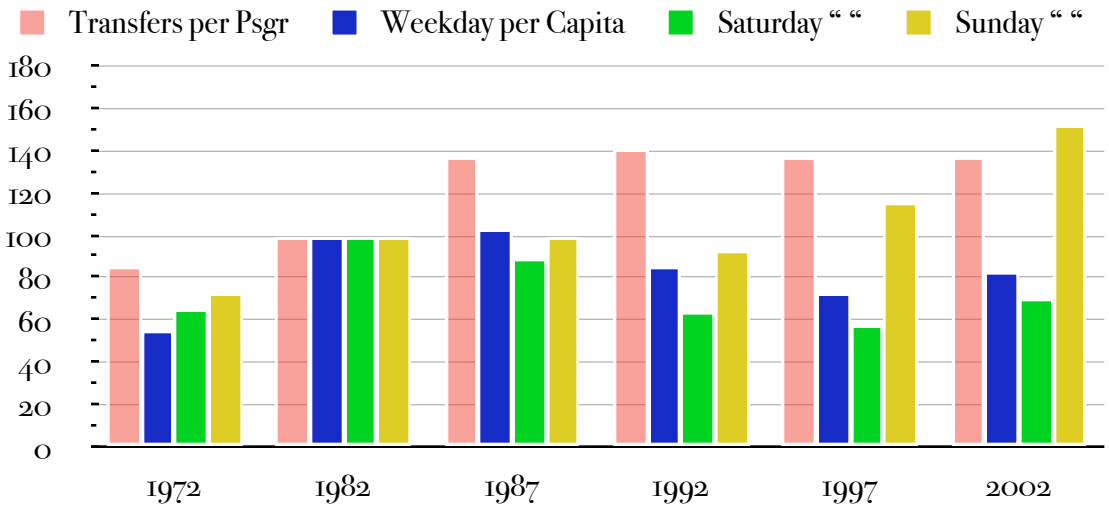
The number of Saturday and Sunday reported by OC Transpo was based on the 1985 origin-destination survey before 1993 and on APC (Automatic Passenger Counting) boarding data from 1993. Reported Saturday ridership increased to 1982, fell during the subsequent four years, then increased to 1987 and remained relatively static to 1989. Following a period of volatility (which does not coincide with implementation of APC), Saturday ridership increased from 1997 to 2002.

Reported Sunday ridership increased to 1982, then remained stable except for peaks during 1984-1986 and 1990-1991. (These might reflect changes in demand factors such as motor fuel prices.) Sunday ridership increased with the overall upward trend from 1997 to 2002.

Trends - Weekday, Saturday and Sunday Ridership per Capita;

Transfers per Revenue Passenger

(1982 = 100)



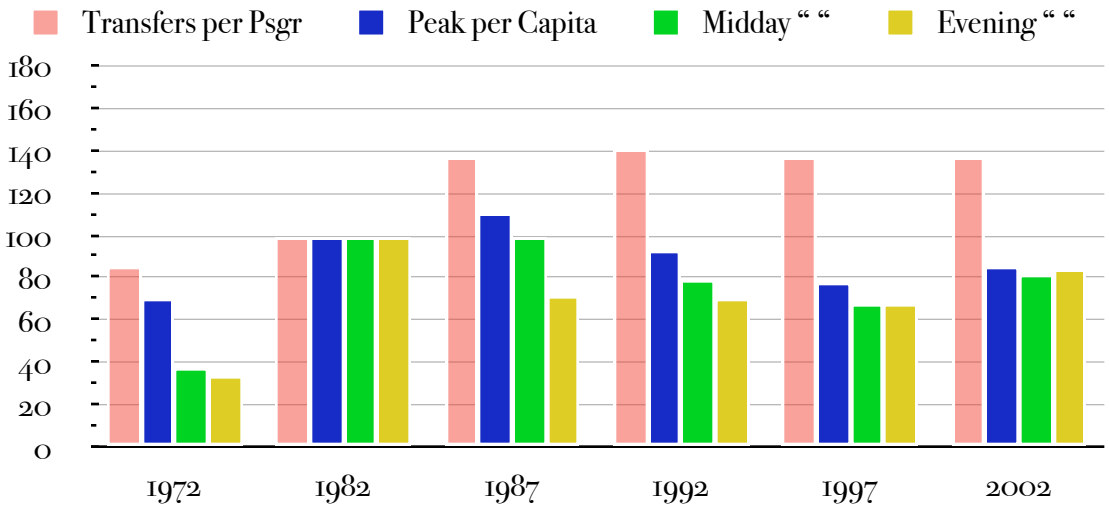
Year-to-year comparison of ridership per capita controls for the influence of population changes on absolute ridership levels. OC Transpo obtained large increases in weekday, Saturday and Sunday ridership per capita from 1972 to 1982. The greatest relative change occured in per-capita weekday ridership. This is not surprising because overall transit ridership is dominated by weekday work trips. Weekday ridership per capita remained stable to1987, fell somewhat during the following decade, then increased from 1997 to 2002. Saturday ridership per capita fell after 1982 but increased from 1992. Sunday ridership per capita, although small in absolute terms, is remarkably robust: this indicator experienced the smallest relative decline after 1982, began increasing several years before per-capita weekday and Saturday ridership also increased - and experienced the largest relative increase to 2002. Weekday and Saturday ridership per capita had not returned to 1982 levels, but Sunday ridership per capita was 50 percent greater at 2002 than at 1982.

The number of transfers per revenue passenger increased significantly from 1972 to 1982 but remained stable thereafter; the influence of this indicator is not apparent.

Trends - Weekday Peak, Midday and Evening Ridership per Capita;

Transfers per Revenue Passenger

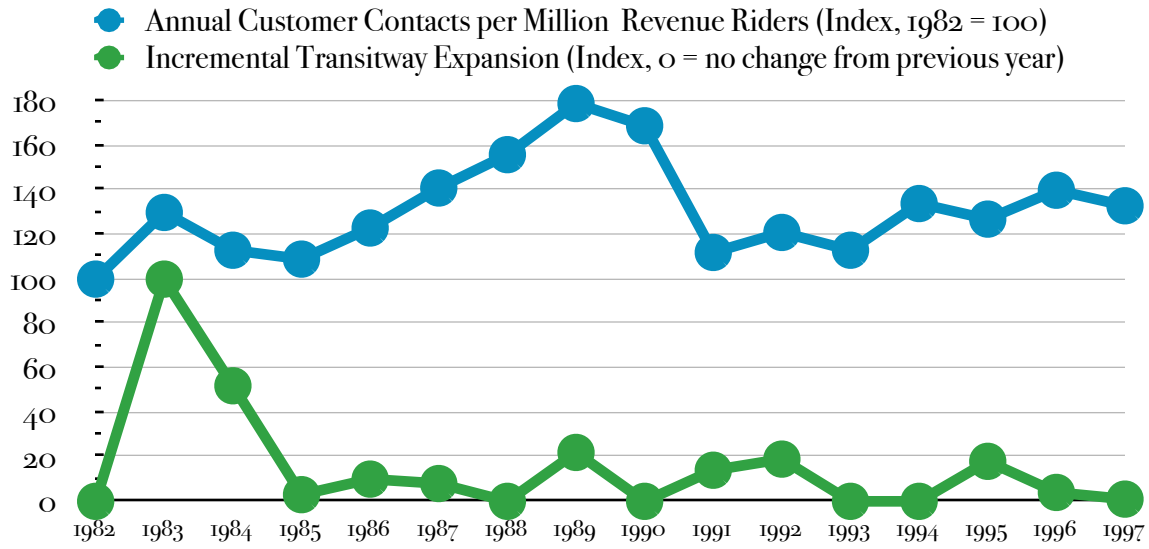
(1982 = 100)



From 1972 to 1982, OC Transpo obtained relatively larger increases in weekday midday and midday evening ridership per capita than in weekday peak ridership, although the latter was larger in absolute terms. Peak ridership per capita increased through 1987, then declined to 1997. Midday ridership per capita remained stable for several years after 1982, then declined to 1997. Evening ridership per capita fell sharply after 1982 but "bottomed out" after a relatively few years. All three indicators increased from 1997 to 2002, but midday and evening ridership per capita experienced relatively larger increases than peak-period ridership per capita.

Again, the influence of changes in the number of "transfers per revenue passenger" is not apparent.

Trends - Customer Contacts per Million Revenue Passengers and Total Transitway km In Service



OC Transpo's annual compilation of data and statistics contains no explicit indicator of customer satisfaction. The authors used the rate of annual customer contacts per million revenue passengers as a surrogate indicator of general customer satisfaction. Because the large majority of "customer contacts," other than "information calls," are typically composed of complaints, the authors believe that a positive change in the rate of "customer contacts" is likely to reflect a negative change in overall customer satisfaction - which results in increased numbers of complaints.

The authors emphasize that OC Transpo data do not distinguish between "commendations" and "complaints" (a distinction that would require some degree of judgement). Changes in the rate of customer contacts provides, at best, only a rough impression of changes in overall customer satisfaction.

In the chart above, the "Index of Incremental Transitway Expansion" shows year to year changes in transitway system length. An index value of zero indicates no change from the preceding year; an index value of 10 indicates a 10-percent increase in system length from the previous year, and so forth.

Examination of trends year by year from 1982 to 1997 reveals that positive changes in the rate of customer contacts coincides to some degree with expansion of the transitway network. This

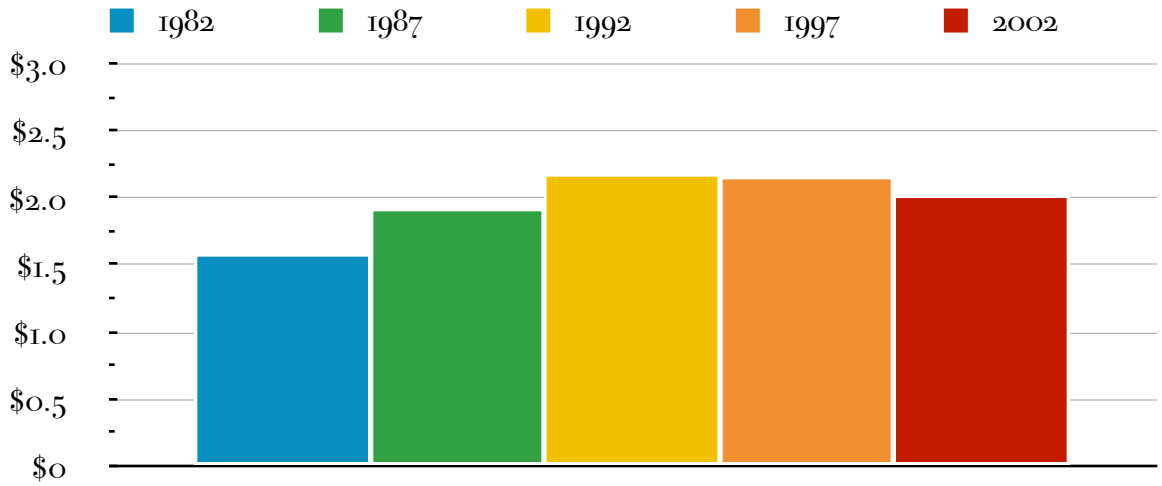
suggests - but merely suggests - that associated service changes generated increased numbers of complaints. This is not surprising. Transit professionals know that virtually all service changes generate complaints, even when overall customer satisfaction improves. A prolonged trend of increasing complaints would suggest - but merely suggest - decreases in customer satisfaction sufficient to discourage patronage.

The authors note, with interest, that the rate of customer contacts increased by 70 percent during 1985-1989. This trend coincided with a sharp increase in the rate and absolute number of "road calls" (below) - and the initial period of ridership decline post-1984. The underlying causal factors are not apparent; additional research is therefore indicated.

(OC Transpo customer contact data include "Internet" communications from 1997. The large increase in the rate, and the absolute number, of customer contacts post-1997 is believed to reflect the rapid increase in e-mail communication during this period. For this reason, the authors excluded data post-1997 from the chart above.)

4) Cost Effectiveness: Operating Cost per Revenue Passenger

Inflation-Adjusted Annual Operating Cost per Revenue Passenger (2002 CAD)

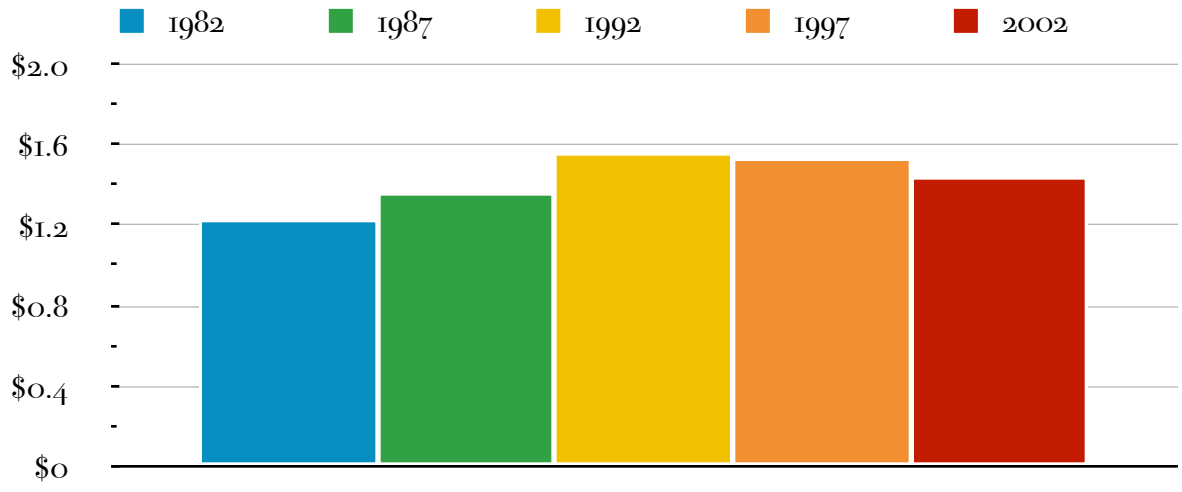


Operating Cost per Revenue Rider	1982	1987	1992	1997	2002
2002 CAD	1.59	1.92	2.19	2.16	2.03
2002 USD	US$ 1.01	US$ 1.22	US$ 1.40	US$ 1.38	US$ 1.29
Index (1982 = 100)	*100*	*121*	*138*	*136*	*128*
Rider km per Revenue Rider	8.7	10.0	10.0	10.0	10.0
Rider mi per Revenue Rider	5.4	6.2	6.2	6.2	6.2
Index (1982 = 100)	*100*	*114*	*115*	*115*	*115*

The increase in inflation-adjusted unit cost per passenger, whether "revenue passenger," ("linked trip") or "boarding" ("unlinked trip"), may be explained in part by changes in average travel distance (ATD). The number of "rider km per revenue rider" increased by 14 percent from 1982 to 1987, but remained stable thereafter.

5) Operating Cost per Boarding

Inflation-Adjusted Annual Operating Cost per Boarding (2002 CAD)

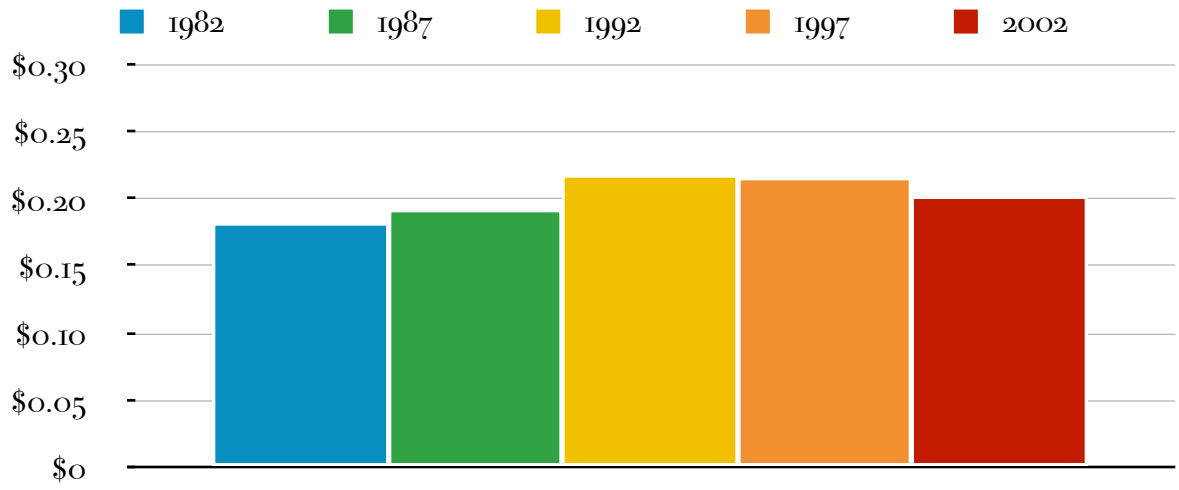


Operating Cost per Boarding	1982	1987	1992	1997	2002
2002 CAD	1.23	1.37	1.56	1.54	1.45
2002 USD	US$ 0.78	US$ 0.87	US$ 0.99	US$ 0.98	US$ 0.92
Index (1982 = 100)	*100*	*111*	*126*	*126*	*118*
Rider km per Boarding	6.8	7.1	7.1	7.2	7.2
Rider mi per Boarding	4.2	4.4	4.4	4.4	4.4
Index (1982 = 100)	*100*	*105*	*105*	*106*	*106*

With few exceptions (e.g. Metropolitan Atlanta Rapid Transit Authority, Metropolitan Transit Authority of Harris County, Texas [Houston], most U.S. transit undertakings do not report "revenue passenger" ("linked trip") statistics. The chart and table above were included for consistency with prevailing U.S. practice. However, readers are advised that direct comparisons between OC Transpo unit operating costs and those reported by U.S. systems may be misleading. Labor accounts for roughly 80 percent of total transit operating cost, and average U.S. wage rates are higher than those paid in Canada. Conversion between currencies does not incorporate adjustment for differences in wage levels between countries.

6) Operating Cost per Passenger-km

Inflation-Adjusted Annual Operating Cost per Passenger-km ("Rider km;" 2002 CAD)



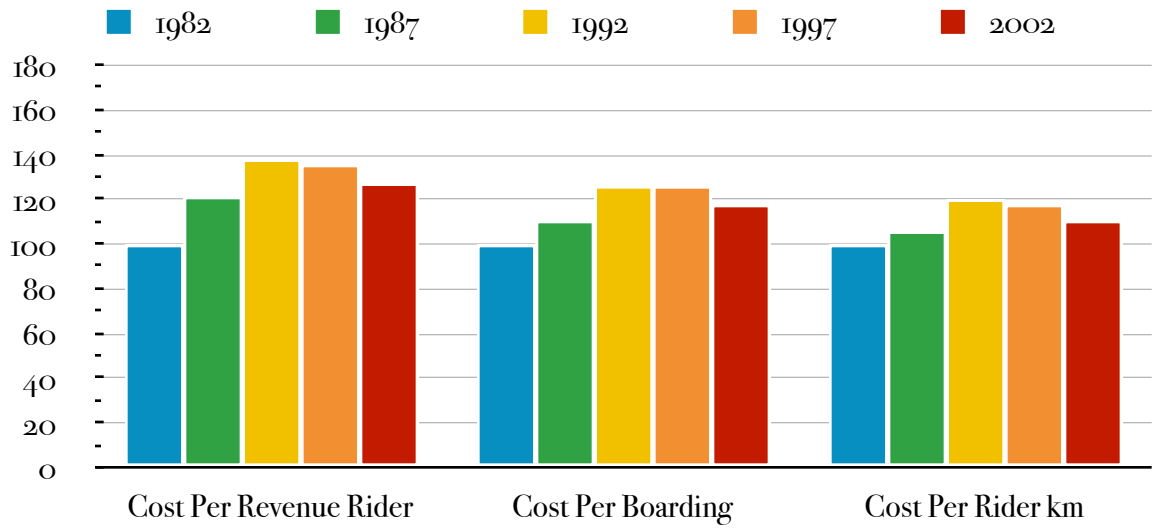
Operating Cost per Rider km	1982	1987	1992	1997	2002
2002 CAD	0.182	0.193	0.219	0.216	0.203
Operating Cost per Rider mi, 2002 USD	US$ 0.19	US$ 0.20	US$ 0.22	US$ 0.22	US$ 0.21
Index (1982 = 100)	*100*	*106*	*120*	*118*	*111*

Operating cost per passenger-kilometer is the fundamental indicator of public transport cost-effectiveness. OC Transpo managed to hold increases in this "consumption-side" unit cost indicator below the levels of "supply-side" unit cost increases. This fact reflects management's success at improving service effectiveness to a degree that partially offset declining cost efficiency and declining productivity.

Trends - Cost Effectiveness ("Consumption-side" indicators):

Inflation-adjusted annual operating cost per passenger and per passenger-km

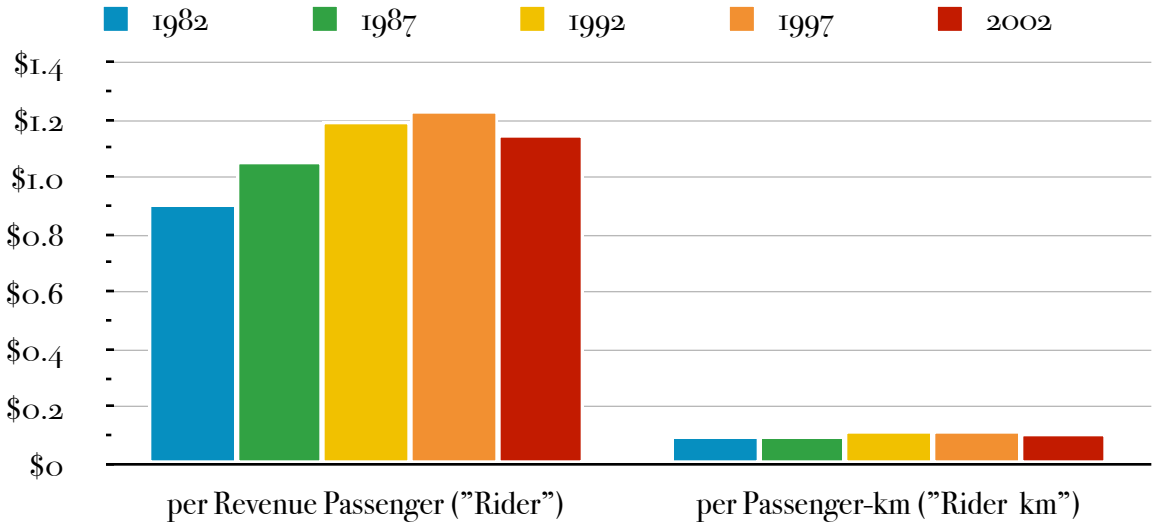
(1982 = 100)



The undertaking experienced sharp increases in unit operating costs from 1982, but managed to reverse this trend after 1992. However, in "real" (inflation-adjusted) terms, consumption-side unit operating costs remained 6-15 percent higher at 2002 than at 1992.

7) Cost Recovery: Average Fare per Passenger and per km

Inflation-Adjusted Average Fare Paid (2002 CAD)



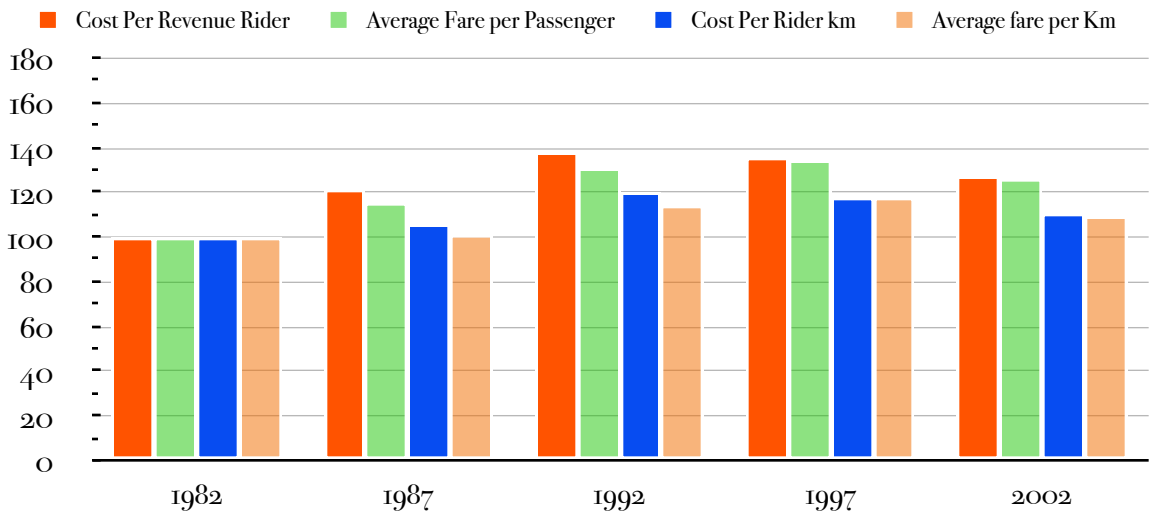
Average Fare Paid	1982	1987	1992	1997	2002
Per Passenger, 2002 CAD	0.909	1.054	1.195	1.231	1.150
2002 USD	US$ 0.579	US$ 0.671	US$ 0.761	US$ 0.784	US$ 0.732
Index (1982 = 100)	*100*	*116*	*131*	*135*	*126*
Per km, 2002 CAD	0.105	0.105	0.119	0.123	0.115
per mi, 2002 USD	US$ 0.107	US$ 0.108	US$ 0.123	US$ 0.126	US$ 0.118
Index (1982 = 100)	*100*	*101*	*114*	*118*	*110*

Given significant increases in operating costs, transit managements have few strategies other than increasing real fares (absent increases in operating efficiency, productivity - or subsidy).

Changes in average fare paid per kilometer lagged behind the increase in average fare paid per passenger during 1982-1987, reflecting the increase in “rider km per rider” during this period.

Trends - Cost Effectiveness and Cost Recovery:

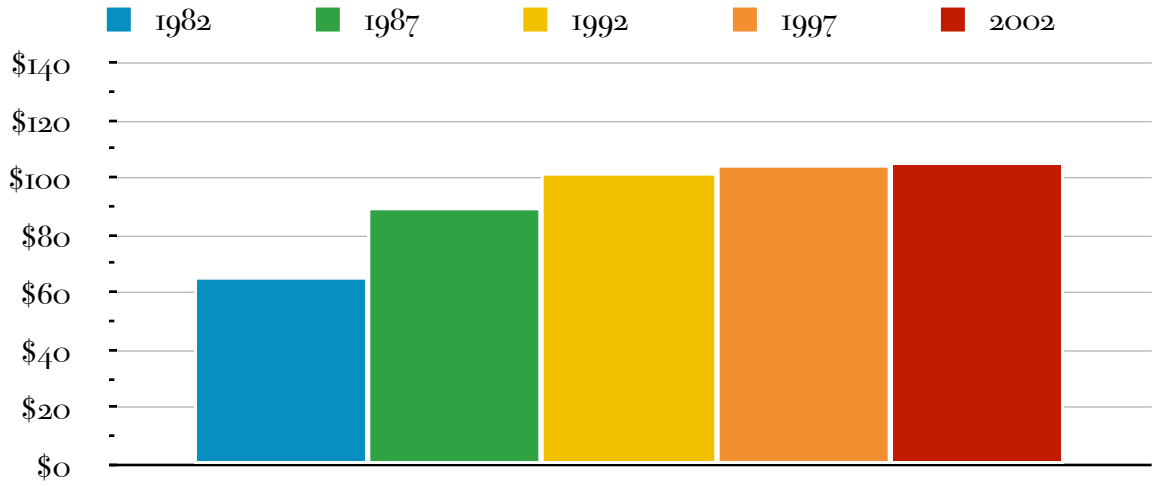
(1982 = 100)



Over the long term, OC Transpo increased real fares per passenger and per km in proportion with increases in real unit operating costs. Cost recovery (revenue : cost ratio) remained quite stable during this period, within the range of 55-60 percent.

8) Cost Efficiency: Operating Cost per Revenue Hour

Inflation-Adjusted Annual Operating Cost per Revenue Service Hour (2002 CAD)



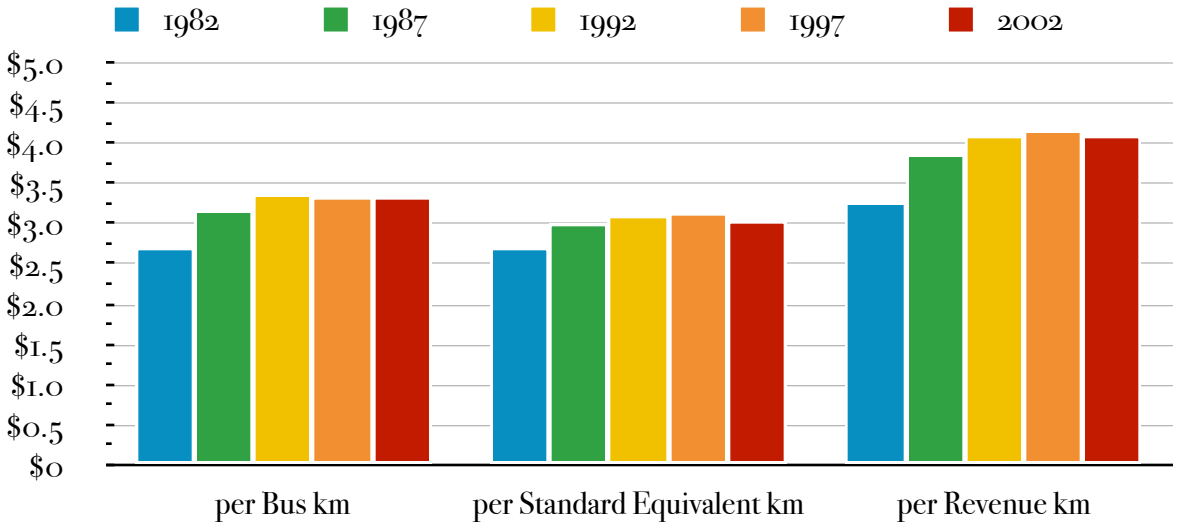
Annual Operating Cost per:	1982	1987	1992	1997	2002
Revenue Hour, 2002 CAD	66.26	89.53	101.62	104.89	105.31
2002 USD	US$ 42.20	US$ 57.03	US$ 64.73	US$ 66.81	US$ 67.08
Index (1982 = 100)	*100*	*135*	*153*	*158*	*159*

The decline in annual revenue passengers from 1984 to 1998 was only part of the challenge facing OC Transpo management during this period. Inflation-adjusted "supply-side" unit operating costs rose sharply from 1982 (a fact ignored by Kain (1992)). This upward trend was stabilized after 1992 but the "price" of doing so included a 24-day strike at the end of 1996.

Readers are again reminded that conversion from Canadian to U.S. dollars does not incorporate adjustment for differences in wage levels between the two countries.

9) Operating Cost per Vehicle-km

Inflation-Adjusted Annual Operating Cost (2002 CDN)



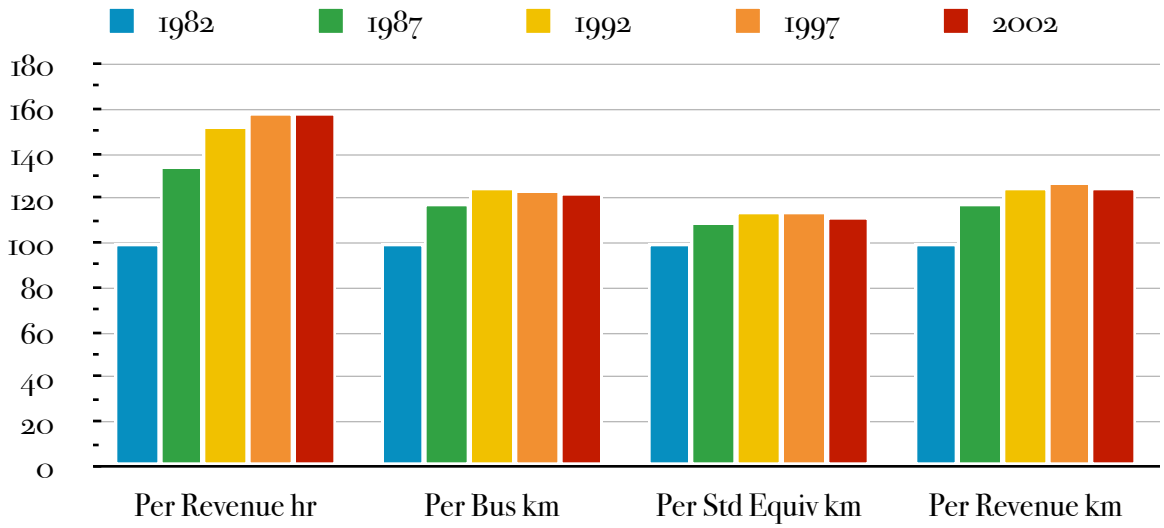
Annual Operating Cost per:	1982	1987	1992	1997	2002
Bus km, 2002 CAD	2.71	3.18	3.38	3.34	3.33
Bus mi, 2002 USD	US$ 2.78	US$ 3.27	US$ 3.47	US$ 3.44	US$ 3.42
Index (1982 = 100)	*100*	*118*	*125*	*124*	*123*
Standard equivalent km, 2002 CAD	2.72	3.00	3.10	3.13	3.05
Standard equivalent mi, 2002 USD	US$ 2.80	US$ 3.08	US$ 3.18	US$ 3.21	US$ 3.14
Index (1982 = 100)	*100*	*110*	*114*	*115*	*112*
Revenue km, 2002 CAD	3.27	3.86	4.09	4.16	4.10
Revenue mi, 2002 USD	US$ 3.35	US$ 3.97	US$ 4.20	US$ 4.27	US$ 4.21
Index (1982 = 100)	*100*	*118*	*125*	*127*	*125*

The lower rate of change in the “standard equivalent km” indicator from 1982 to 1992, relative to “bus km,” reflects increased usage of articulated buses.

Trends - Cost Efficiency:

Inflation-adjusted annual operating cost per vehicle-hour and per vehicle- km

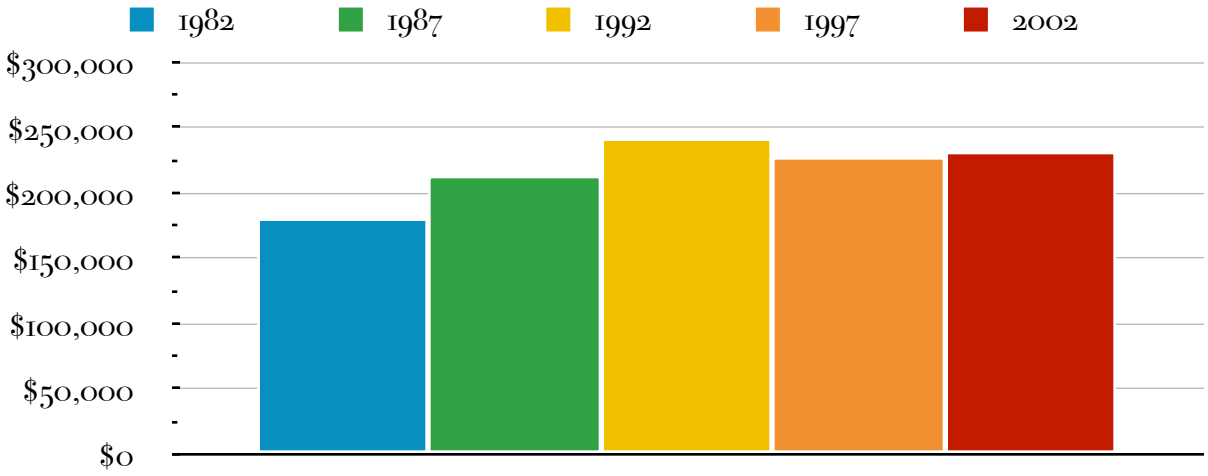
(1982 = 100)



The upward trend in OC Transpo “supply-side” unit operating costs from 1982 to 1992, adjusted for inflation, is obvious. This trend reflects factors in addition to labor cost escalation, as documented below.

10) Operating Cost per Scheduled Peak-Period Bus

Inflation-Adjusted Annual Operating Cost per Scheduled Peak-Period Bus (2002 CAD)

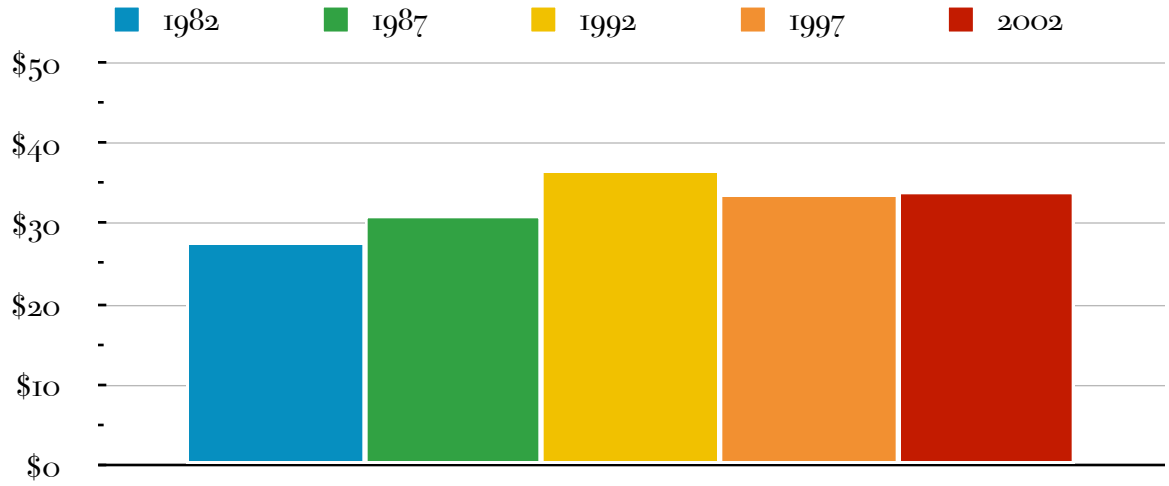


Operating Cost per Peak Bus	1982	1987	1992	1997	2002
2002 CAD	180,865	213,447	242,768	228,139	231,795
2002 USD	US$ 115,201	US$ 135,953	US$ 154,630	US$ 145,312	US$ 147,640
Index (1982 = 100)	*100*	*118*	*134*	*126*	*128*

The principal factor which determines bus transit system fixed costs ("overhead") is vehicle fleet size. This in turn establishes factors such as operating base and maintenance facility size. Operating cost per scheduled peak-period bus is commonly interpreted as an indicator of overhead costs. Among the factors contributing to the large real increase from 1982 to 1992 were "infrastructure" (i.e. transitway) management and maintenance costs "new" to OC Transpo.

11) Labor Cost: Operator Cost per Platform Hour

Inflation-Adjusted Annual Operator (Driver) Cost per Platform Hour (2002 CAD)



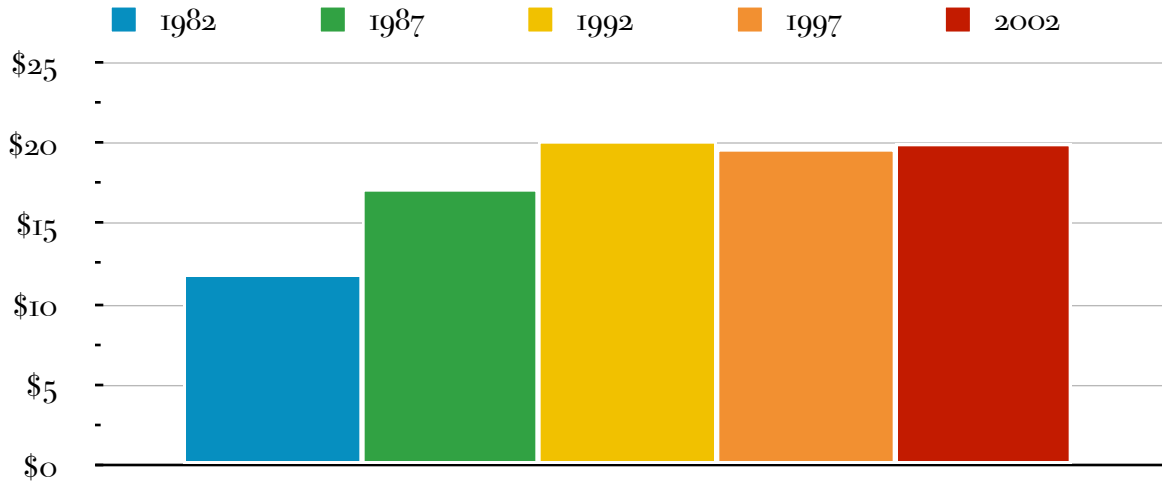
Operator Cost per Platform Hour	1982	1987	1992	1997	2002
2002 CAD	27.81	31.00	36.66	33.75	34.17
2002 USD	US$ 17.71	US$ 19.74	US$ 23.35	US$ 21.50	US$ 21.76
Index (1982 = 100)	*100*	*111*	*132*	*121*	*123*

"Platform hours" include vehicle operator (driver) time aboard vehicles. This includes revenue service, "layovers" at line terminals, and "deadheading:" operation of vehicles from and to garages ("pull-out" and "pull-in"), and non-revenue operation of vehicles between terminals.

Inflation-adjusted labor costs increased significantly from 1982 to 2002. From 1982 to 1992, consecutive annual real (inflation-adjusted) increases averaged about 3 percent. Annual increases from 1987 to 1992 averaged about 3.5 percent. OC Transpo managed to slow this trend, and held the long-term increase to an "annual percentage rate" of about one percent. However, the "price" of doing so included the 1996 strike noted above.

12) Overhead: Semi-Fixed Cost per Platform Hour

Inflation-Adjusted Annual Semi-Fixed Cost per Platform Hour (2002 CAD)



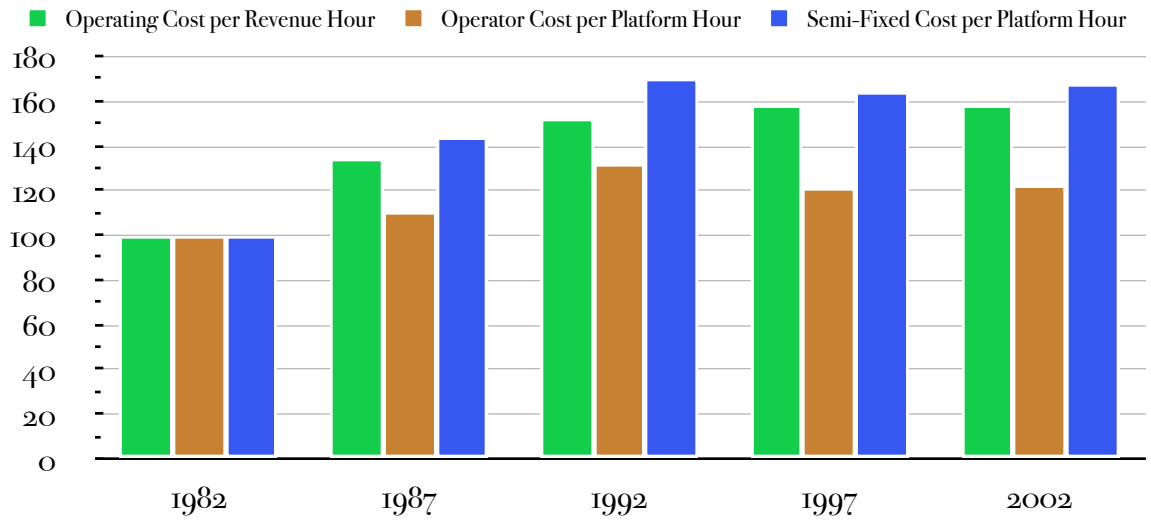
Semi-Fixed Cost per Platform Hour	1982	1987	1992	1997	2002
2002 CAD	11.92	17.21	20.24	19.71	20.05
2002 USD	US$ 7.59	US$ 10.96	US$ 12.89	US$ 12.55	US$ 12.77
Index (1982 = 100)	*100*	*144*	*170*	*165*	*168*
Ratio of Semi-fixed Cost to Total Operator Cost (per Platform Hour)	0.20	0.25	0.25	0.25	0.26

The large percentage increase in real semi-fixed ("overhead") costs from 1982 to 1992 reflects, in part, infrastructure (transitway) costs new to the undertaking. The "annual average" rate of increase from 1982 to 1987 was about four percent, but this trend did not continue after 1987. The ratio of "overhead" to operator (driver) cost increased during the early years of transitway operation but remained stable after 1987.

Trends - Operating Cost per Revenue Hour,

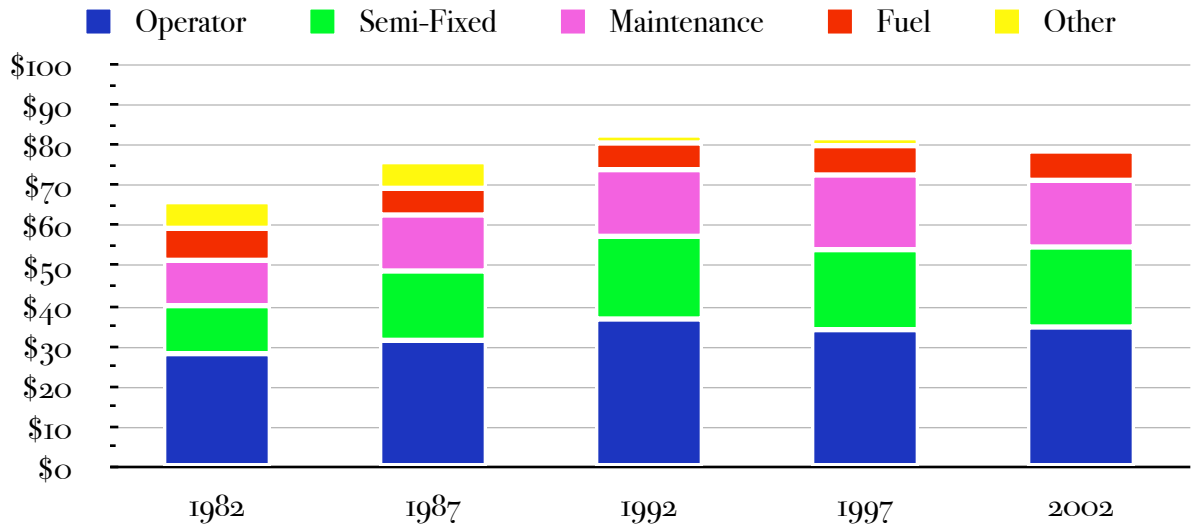
Operator Cost per Platform Hour and Semi-Fixed Cost per Platform Hour

(1982 = 100)



The long-term increase in real operating cost per revenue hour occurred at an average "annual percentage rate" of about 2.5 percent. As noted about, the long-term increase in real operator cost per platform hour occurred at an average annual rate of about one percent.

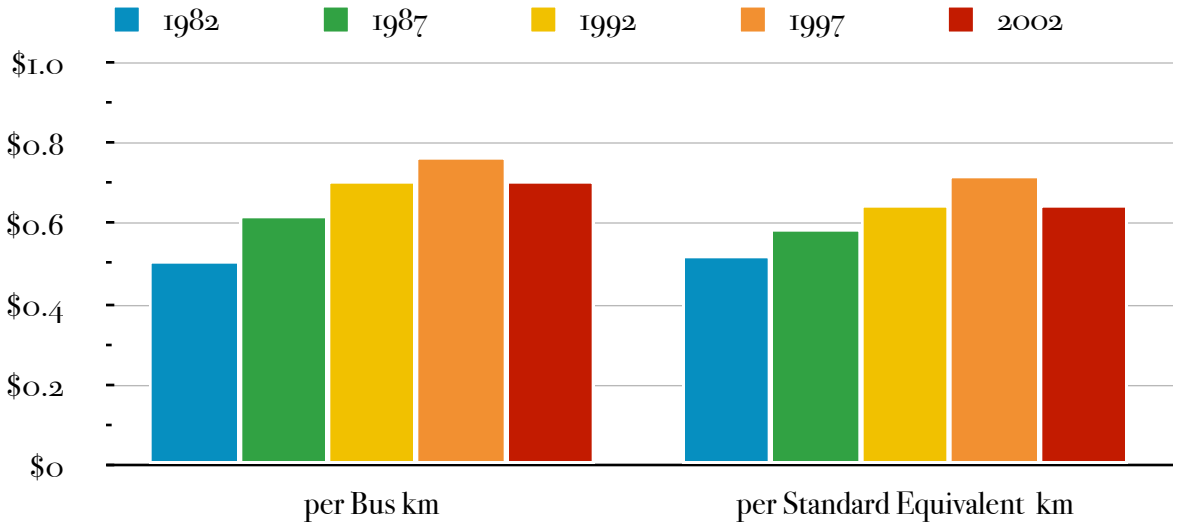
Components of Annual Operating Cost per Platform Hour (2002 CAD)



The majority of the supply-side unit operating cost increase experienced by OC Transpo from 1982 to 2002 reflects factors other than increases in real unit labor (operator) costs. The chart above illustrates major components of operating cost per platform hour. Although operator (driver) cost accounts for the largest discrete share for any given year, the “Semi-Fixed Cost” and “Maintenance Cost” components experienced relatively larger increases from 1982.

13) Maintenance Cost: Annual Maintenance Cost per km

Annual Service and Maintenance Cost (2002 CDN)



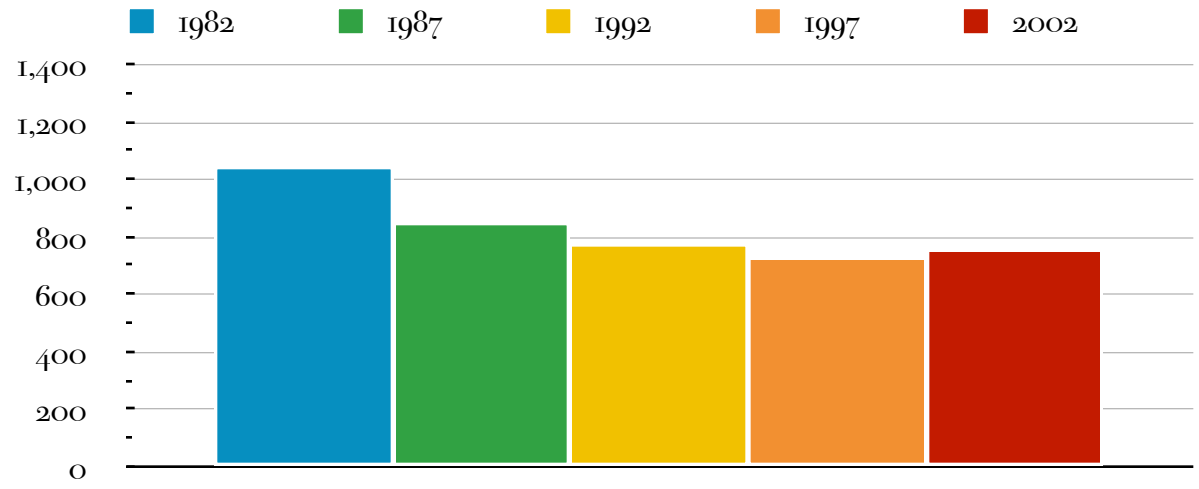
Annual Maintenance Cost	1982	1987	1992	1997	2002
per Bus km, 2002 CAD	0.51	0.62	0.71	0.77	0.71
per Bus mi, 2002 USD	US$ 0.53	US$ 0.64	US$ 0.73	US$ 0.80	US$ 0.73
Index (1982 = 100)	*100*	*121*	*138*	*150*	*137*
per Std Equ km, 2002 CAD	0.52	0.59	0.65	0.72	0.65
per Bus mi, 2002 USD	US$ 0.53	US$ 0.60	US$ 0.67	US$ 0.74	US$ 0.67
Index (1982 = 100)	*100*	*113*	*126*	*140*	*125*

Unit service and maintenance cost increased sharply from 1982 although accounting for relative vehicle size mitigates this trend. The “average annual” rate of increase in real maintenance cost per bus-km from 1982 to 1997 was about 2.7 percent, or about 2.3 percent accounting for relative vehicle size.

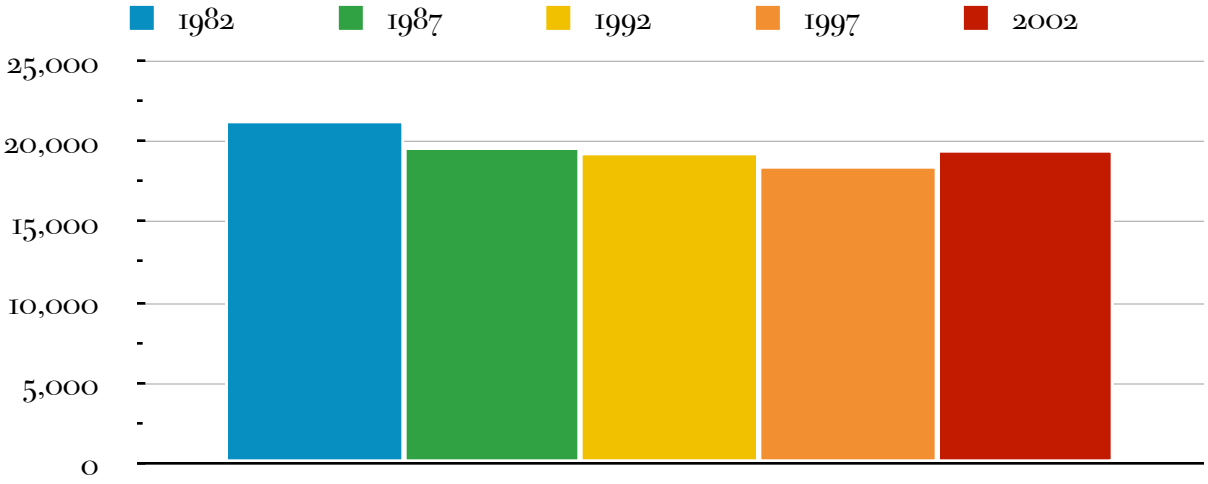
The undertaking has not explained this unfavorable trend but has evidently brought it under control.

14) Annual Revenue Hours and Vehicle-km per Employee

Annual Revenue Service Hours (RSH) per Employee



Annual Revenue Vehicle-km per Employee

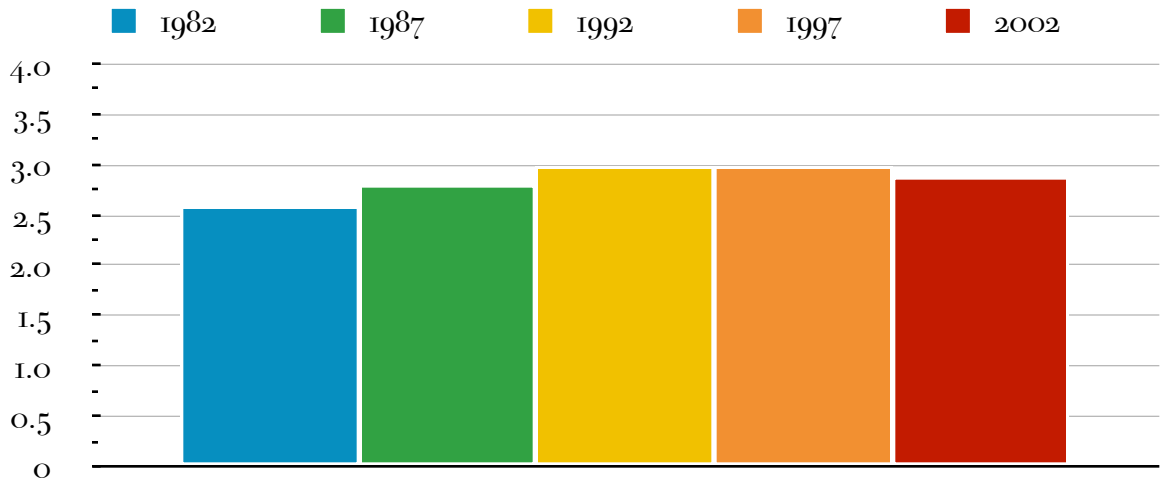


	1982	1987	1992	1997	2002
Revenue Hours per Employee	1,050	852	777	733	761
Index (1982 = 100)	*100*	*81*	*74*	*70*	*72*
Revenue km per Employee	21,300	19,750	19,297	18,493	19,562
Revenue mi per Employee	13,206	12,245	11,964	11,466	12,128
Index (1982 = 100)	*100*	*93*	*91*	*87*	*92*

The “productivity measures” indicators in the chart and table above reflect the efficiency with which management utilizes labor. The negative trends coincided with opening of successive transitway segments. Accounting for relative vehicle size (i.e. for increased use of articulated buses after 1982) would mitigate to some degree the trends evident above.

15) Employees per Peak Vehicle, Annual Average

Employees per Scheduled Peak Vehicle, Annual Average

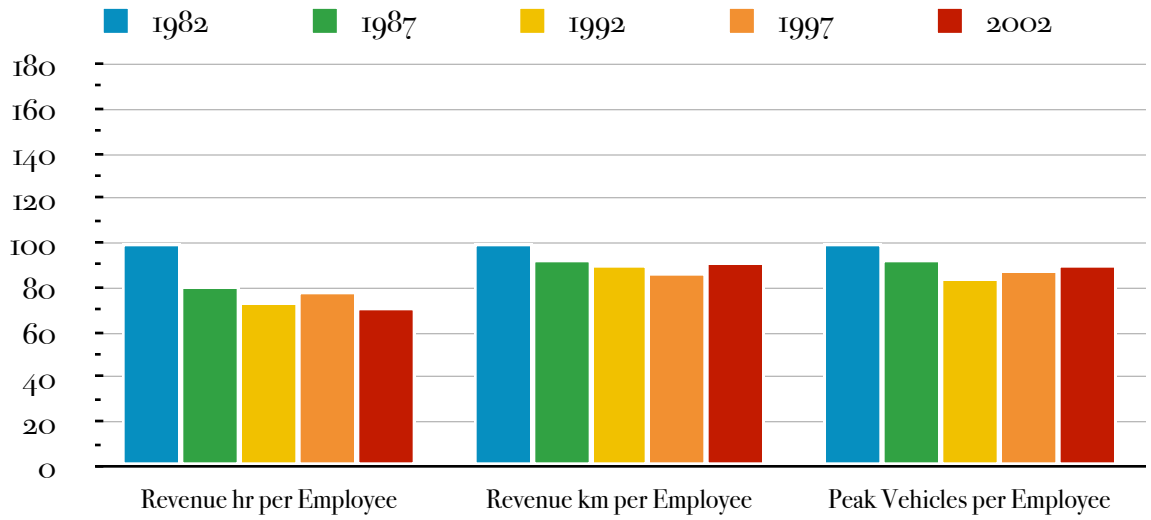


	1982	1987	1992	1997	2002
Employees per Peak Scheduled Vehicle	2.6	2.8	3.0	3.0	2.9
Index (1982 = 100)	100	108	117	114	111
1 / Index (1982 = 100)	*100*	*93*	*85*	*88*	*90*

An increase in the number of "employees per peak scheduled vehicle" represents a decrease in productivity: if the number of employees required per "production unit" grows larger, productivity per employee grows smaller.

Trends - Staff (employee) Productivity, Supply-side

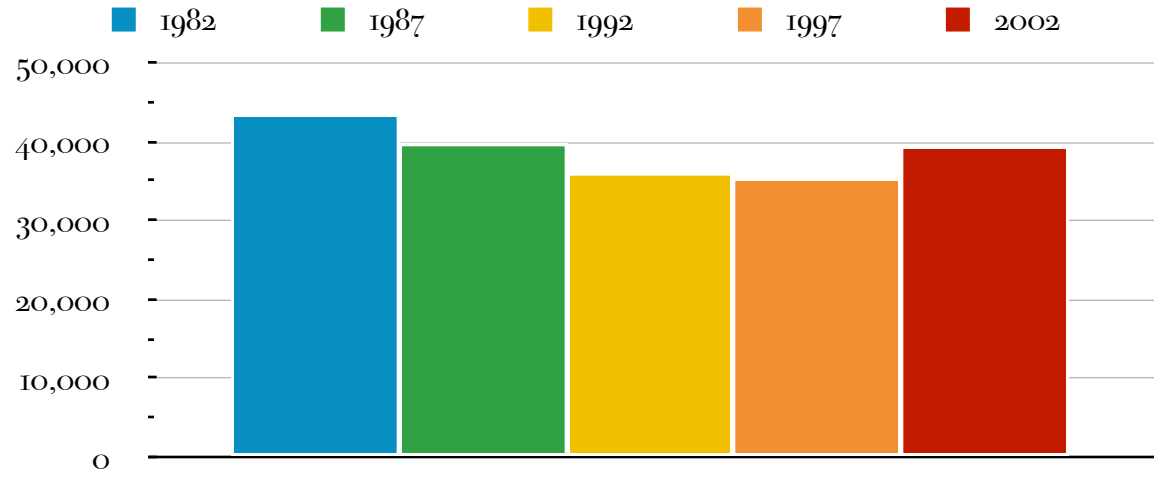
(1982 = 100)



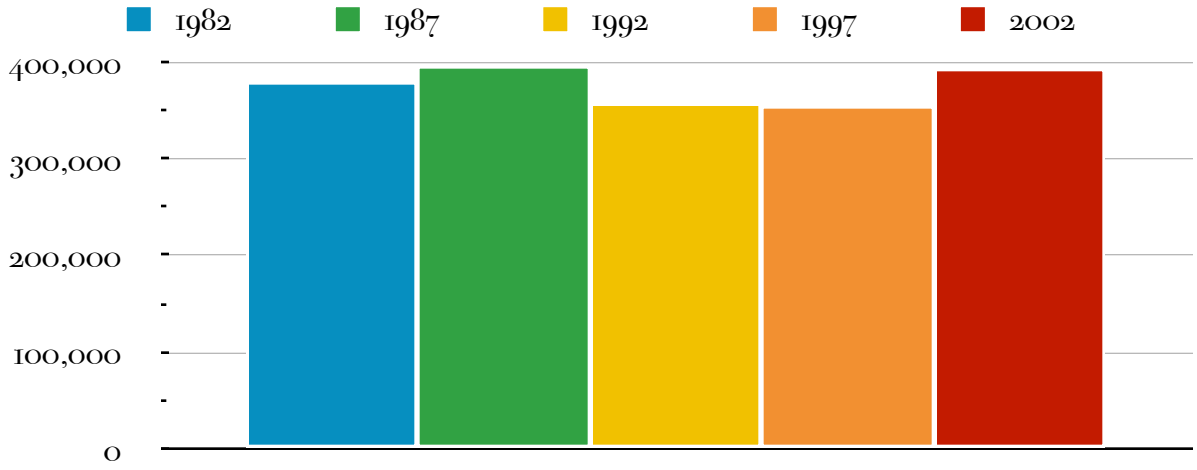
The long-term negative trends are evident, but some degree of stabilization or reversal is visible from the early to mid 1990s.

16) Annual Passengers and Passenger-km per Employee

Annual Revenue Passengers ("Riders") per Employee



Annual Passenger-km ("Rider km") per Employee

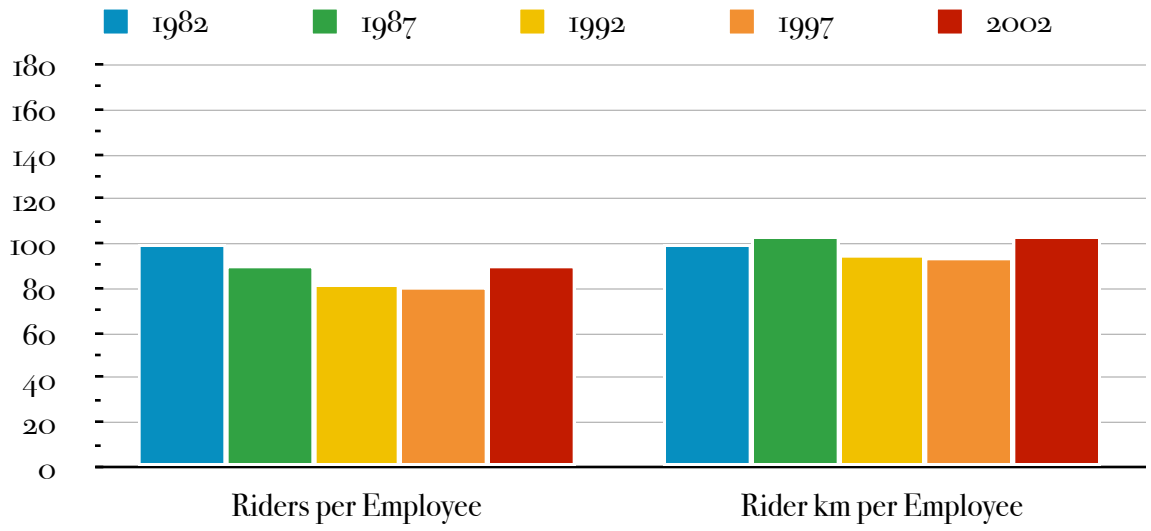


	1982	1987	1992	1997	2002
Riders per Employee	43,728	39,708	35,989	35,591	39,419
Index (1982 = 100)	*100*	*91*	*82*	*81*	*90*
Rider km per Employee	380,434	397,080	359,890	355,910	394,190
Rider mi per Employee	235,869	246,190	223,132	220,664	244,398
Index (1982 = 100)	*100*	*104*	*95*	*94*	*104*

Annual passenger-km (rider km) per staff member (employee) is the fundamental indicator of public transport staff productivity. This indicator displayed some degree of volatility from 1982 to 2002 but no long-term declining trend. In turn, this fact reflects increases in the average distance traveled per passenger ("rider km per rider") and management's success in avoiding declines in service effectiveness over the long term (below).

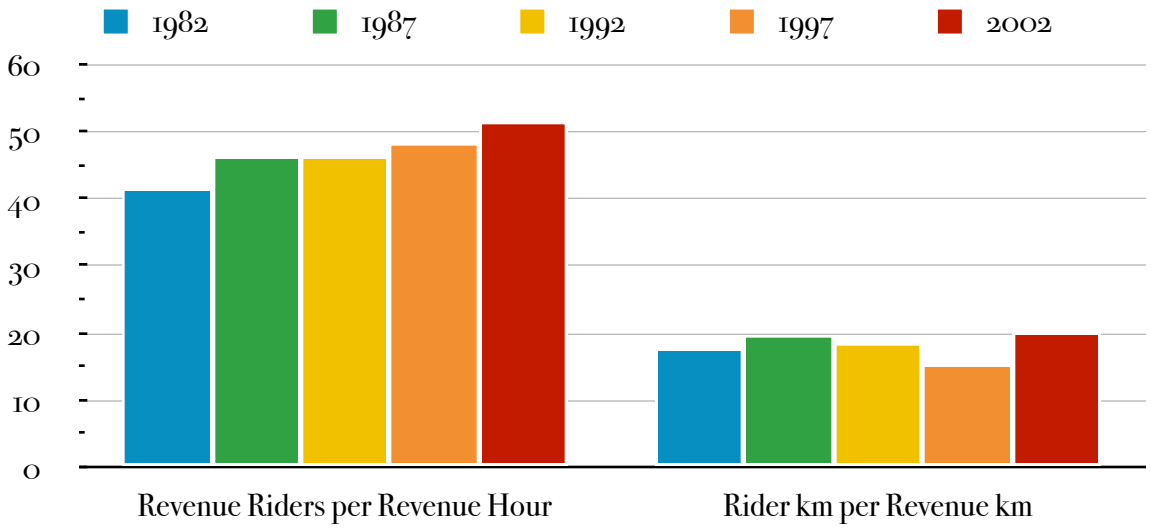
Trends - Staff (employee) Productivity, Consumption-side

(1982 = 100)



The decline in annual passengers per employee was not mirrored by changes in the number of annual passenger-km per employee. As documented in the following section, mangement was able to improve service effectiveness.

17) Service Effectiveness: Consumption per Unit of Supply

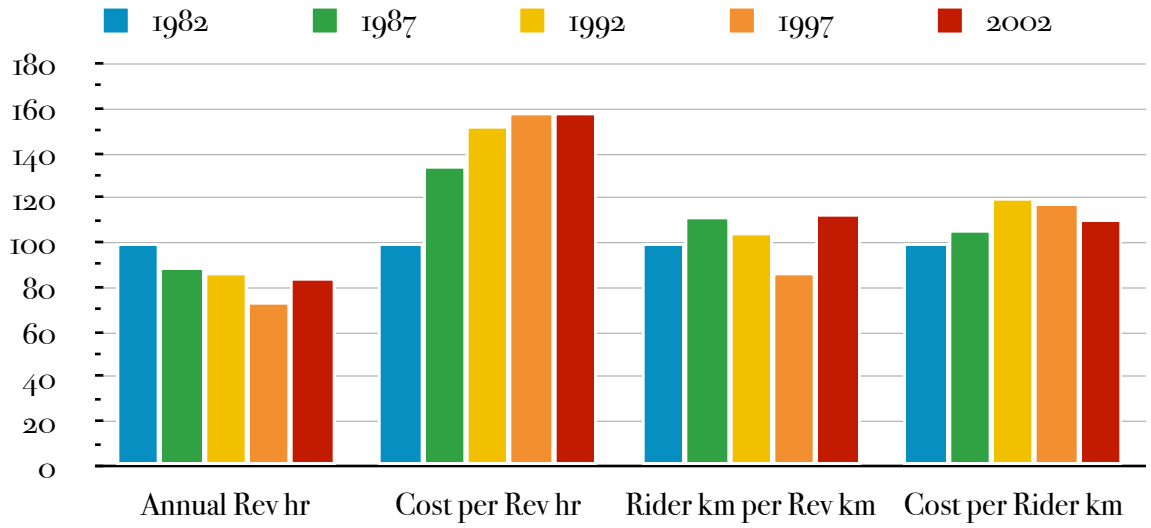


	1982	1987	1992	1997	2002
Revenue Riders per Revenue Hour	41.7	46.6	46.3	48.5	51.8
Index (1982 = 100)	*100*	*112*	*111*	*116*	*124*
Rider km per Revenue km	17.84	20.01	18.65	15.49	20.15
Index (1982 = 100)	*100*	*112*	*105*	*87*	*113*

A logical management response to decreasing ridership is to make changes (e.g. route consolidations schedule changes) that increase service efficiency - the amount of service consumed per unit of supply. OC Transpo managed to increase service productivity in terms of revenue riders (linked trips) per revenue hour (revenue service hour, or RSH). The undertaking also held the ratio of passenger-km to revenue vehicle-km relatively stable. By doing so, OC

Transpo held “consumption-side” unit cost escalation below the levels of “supply-side” unit cost escalation experienced during this period.

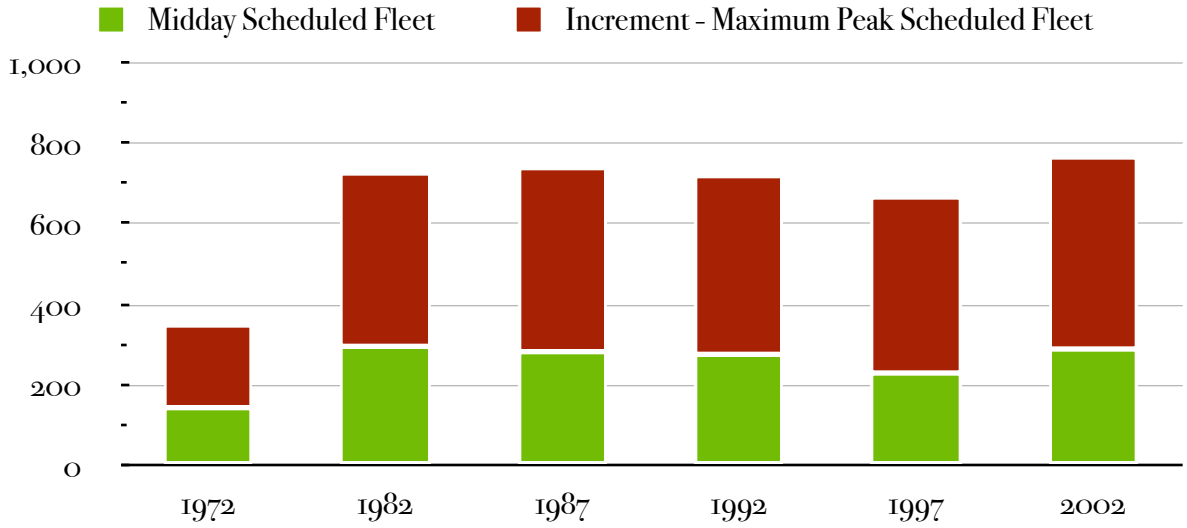
Trends - Service Supply, Cost Efficiency, Service Effectiveness and Cost Effectiveness (1982 = 100)



Adjustment for increased use of articulated vehicles would mitigate the apparent decrease in annual revenue hours (RSH) from 1982 to 1997.

OC Transpo managed to avoid a large long-term decrease in cost effectiveness from 1982 to 2002, despite unfavorable trends in ridership and cost efficiency - and significant decreases in productivity, outlined below.

18) "Peak-to-Base" Ratio



On the chart above, the label "Increment - Maximum Peak Scheduled Fleet" refers to the difference between "Maximum Peak Scheduled Fleet" and "Midday Scheduled Fleet" (see table). 1972 data were included above to provide historic reference.

Adjustment for increased use of articulated vehicles would magnify the apparent increase from 1972 in fleet size and the number of buses scheduled.

	1972	1982	1987	1992	1997	2002
Total Active Fleet	368	780	824	831	793	915
Index (1982 = 100)	*47*	*100*	*106*	*107*	*102*	*117*
Maximum Peak Scheduled Fleet	349	718	729	717	663	761
Index (1982 = 100)	*49*	*100*	*102*	*100*	*92*	*106*
Midday Scheduled Fleet	141	289	275	272	227	284
Index (1982 = 100)	*49*	*100*	*95*	*94*	*79*	*98*

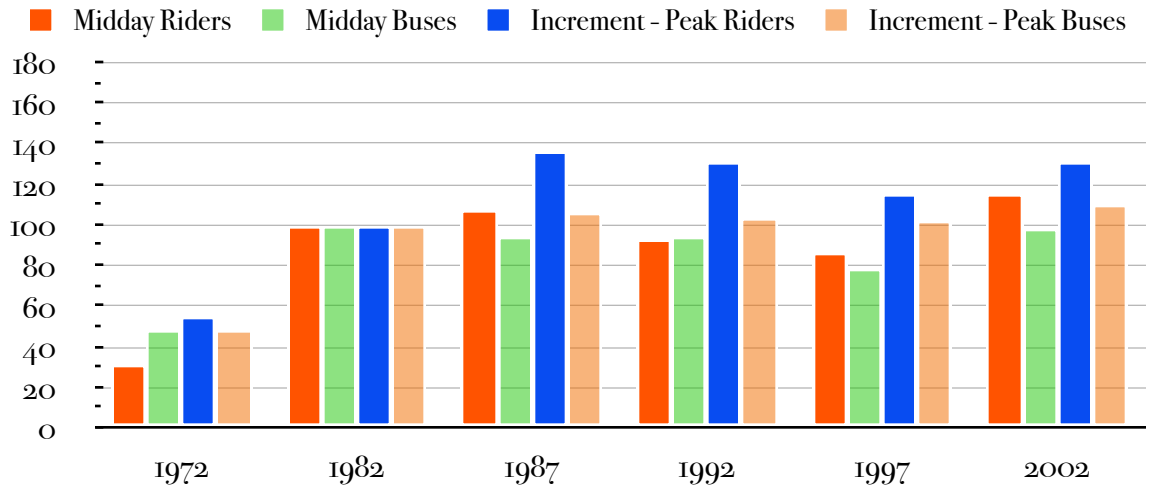
	1972	1982	1987	1992	1997	2002
Peak : Off-peak Scheduled Bus Ratio	2.475	2.484	2.651	2.636	2.921	2.680

The principal factor which determines bus transit system fixed ("overhead") costs is vehicle fleet size. This in turn establishes factors such as operating base and maintenance facility size. The ratio of buses scheduled for peak service to buses scheduled for midday ("off-peak" or "base") service is an important indicator of traffic patterns and cost efficiency. In general, a high "peak-to-base ratio" indicates that a relatively large share of total weekday traffic is carried during peak periods. Some of the vehicles, staff and facilities required for peak-period traffic are not needed at other times. Consequently, a high "peak-to-base" ratio also suggests relatively lower levels of cost efficiency than would occur if peak-hour was relatively less dominant. In the U.S., a "peak-to-base ratio" approaching 2.00 is considered "high." A high peak-to-base ratio is a historic characteristic of Ottawa transit services.

Trends - Midday Scheduled Buses and Passengers;

Peak-Period Passengers and Buses Added for Peak Schedules

(1982 = 100)



On the chart above, “Increment - Peak Riders” refers to the difference between “ Weekday Peak Period Riders (a.m. & p.m)” and “ Weekday Riders.” “Increment - Peak Buses” refers to the difference between “Maximum Peak Scheduled Fleet” and “Midday Scheduled Fleet.” 1972 data were included to provide historic reference.

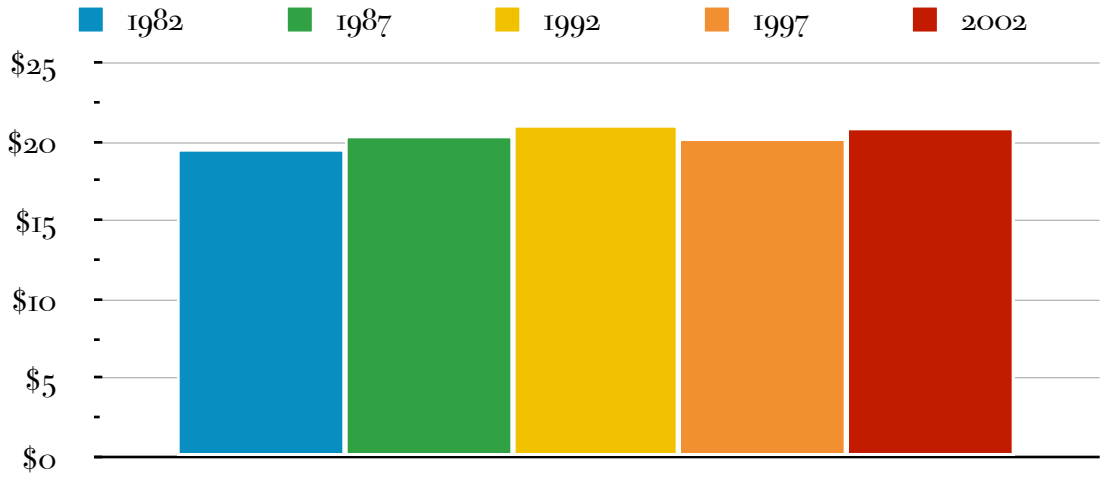
The increment of peak-period passengers increased significantly from 1982, continuing a trend visible from 1972 (at a somewhat lower rate than during 1972-1982). Midday ridership continued to increase after 1982, but at a much lower rate than during 1972-1982. Both indicators declined to 1997 but increased thereafter; the trends confirm that midday ridership increased at a higher rate during 1997-2002.

Adjustment for relative vehicle size (i.e. increased use of articulated vehicles after 1982) would magnify the apparent increase from 1972 in “Midday Buses” and “Increment - Peak Buses.” The authors believe that, if so adjusted, changes in “Midday Buses” would closely mirror changes in “Midday Riders.” The increase in the “Peak Rider” increment during 1982-1987 appears large enough to exceed the change in the “Peak Bus” increment, adjusted for relative vehicle size, although to what extent is not clear.

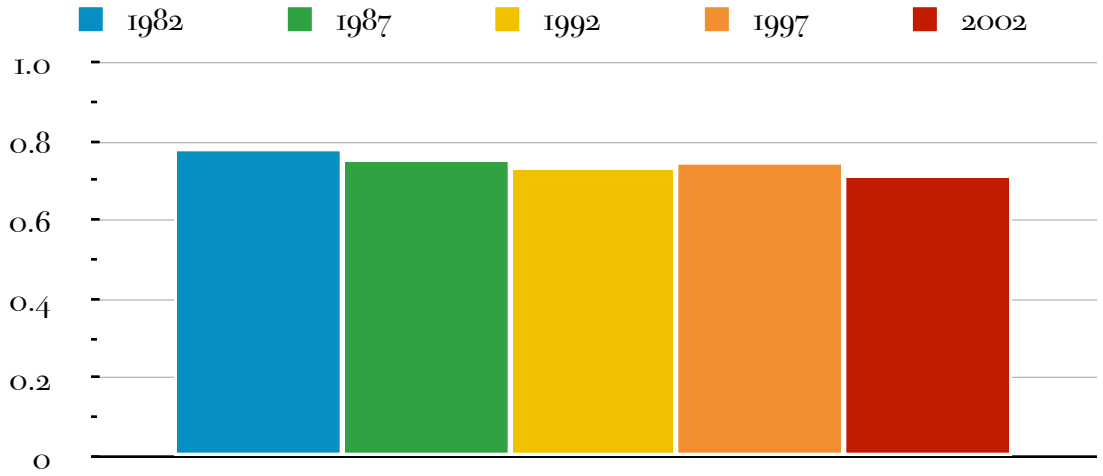
The number of “Midday Buses” operated by OC Transpo decreased significantly from 1982 to 1997 while the “Peak Bus” increment remained quite stable. This was reflected by a significant increase in the undertaking’s “peak-to-base ratio,” which in turn implies significant upward pressure on “overhead” cost per unit of service.

19) Operator (Driver) Pay Rates and Productivity Indicators

Inflation-Adjusted Top Operator (Driver) Pay Rate, 2002 CAD



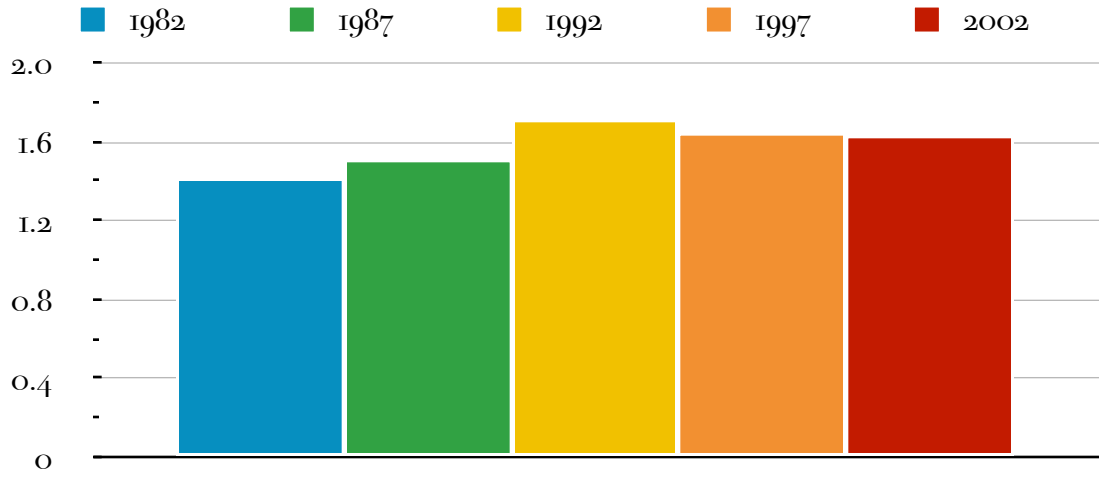
Platform Hours per (Operator) Pay Hour



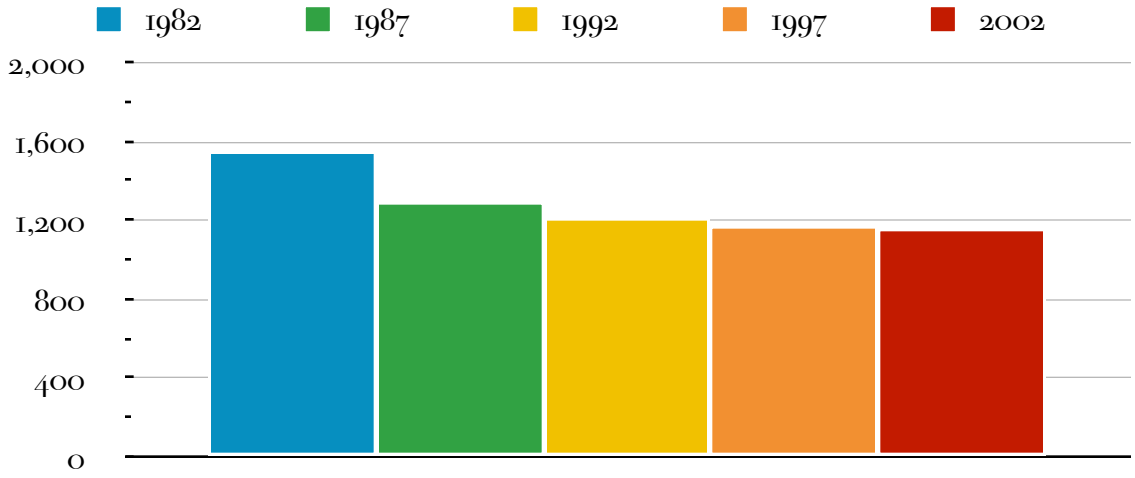
Ratio of

"Operator (Driver) Cost per Platform Hour"

to "Top Operator Pay Rate"



Annual Revenue Hours per Operator (Driver)



	1982	1987	1992	1997	2002
Top Operator Pay Rate, 2002 CAD	19.63	20.49	21.06	20.24	20.89
2002 USD	US$ 12.50	US$ 13.05	US$ 13.42	US$ 12.89	US$ 13.31
Index (1982 = 100)	*100*	*104*	*107*	*103*	*106*
Platform Hours per Pay Hour	0.785	0.759	0.739	0.747	0.719
Index (1982 = 100)	*100*	*97*	*94*	*95*	*92*
Ratio of Operator Cost per Platform Hour to Top Operator Pay Rate	1.42	1.51	1.71	1.65	1.64
Index (1982 = 100)	*100*	*106*	*120*	*116*	*115*
Revenue Hours per Operator	1,551	1,300	1,219	1,173	1,166
Index (1982 = 100)	*100*	*84*	*79*	*76*	*75*

In real (inflation-adjusted) terms, the top wage rate paid to transit operators (drivers) by OC Transpo remained remarkably stable 1982 to 2002. (This was also true during 1972-1982 (*Canadian Transit Handbook* 1985); the same source states that the number of strikes during the decade 1973-1982 in the Canadian transit industry exceeded the total number during 1900-1972.) However, the number of "platform hours per pay hour" declined gradually, perhaps reflecting changes in work rules favorable to employees. The increasing trend of "Ratio of Operator Cost per Platform Hour to Top Operator Pay Rate" suggests relative increases in fringe-benefit costs - and might also reflect relative decreases in the efficiency of labor utilization by management. The decline in the number of revenue hours per operator might reflect work rule changes favorable to labor - or less-efficient utilization of labor by management.

Trends - Operator (Driver) Pay Rate and Productivity Indicators:

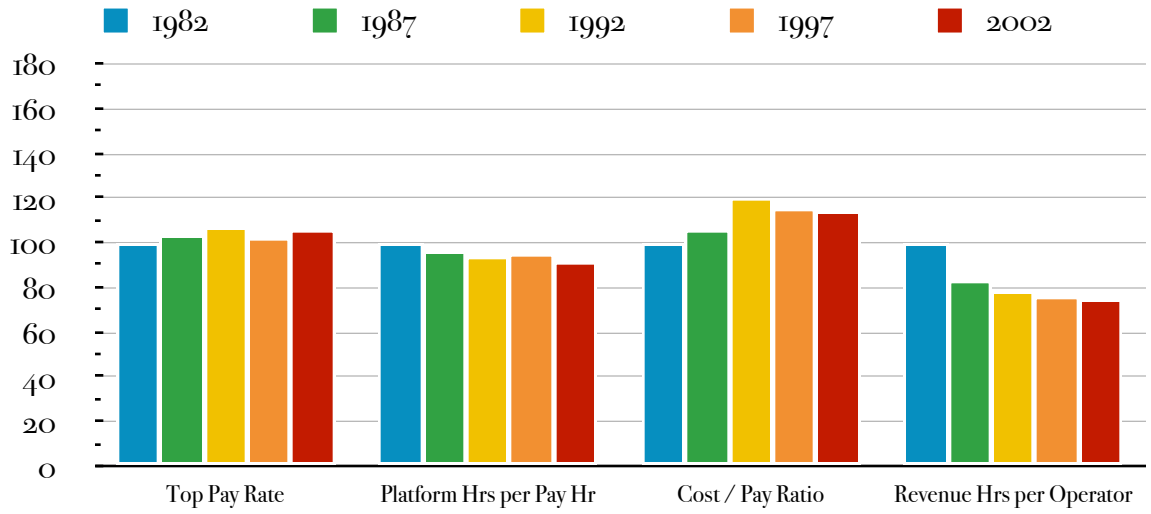
--Inflation-Adjusted Top Operator (Driver) Pay Rate

--Platform Hours per (Operator) Pay Hour

--Ratio of Operator Cost per Platform Hour to Top Operator Pay Rate

--Annual Revenue Hours per Operator (Driver)

(1982 = 100)



OC Transpo labor costs have remained stable in terms of real operator (driver) pay rates. Moreover, the apparent declines in labor productivity cannot be attributed to the workforce itself. In other words, "blame" for the unfavorable trends apparent above cannot be attributed to OC Transpo staff members.

The authors believe that:

1) the marginal decline in "platform hours per pay hour" reflects work rule changes favorable to labor; such changes would tend to compensate for the low rate of increase in "real" pay rates.

2) the primary underlying trend leading to increases in the "Cost / Pay Ratio" (i.e. the "Ratio of Operator Cost per Platform Hour to Top Operator Pay Rate") is increased real expenditures for fringe benefits.

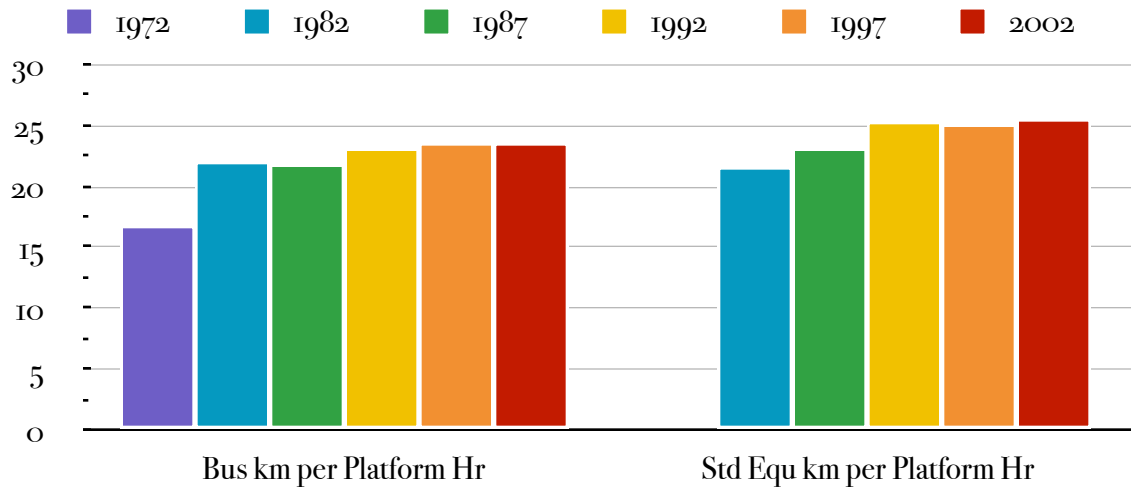
3) the primary underlying trend leading to decreased "Revenue Hours per Operator" was decreased efficiency of labor utilization by management.

The authors emphasize that 3) above is not necessarily the fault of management.

The authors are not aware of any evidence suggesting that OC Transpo operators (drivers) - or managers - were less dedicated at 2002 than at 1982. However, the trends documented below suggest underlying "structural" or "inherent" inefficiencies associated with expansion of the transitway network.

20) Utilization of Labor: "Speed Made Good"

Vehicle km per Platform Hour ("Speed Made Good")



	1972	1982	1987	1992	1997	2002
Speed Made Good (Bus km per Platform Hour)	16.79	22.10	21.94	23.28	23.61	23.57
Bus mi per Platform Hour	10.41	13.70	13.60	14.50	14.64	14.61
Index (1982 = 100)	*76*	*100*	*99*	*105*	*107*	*107*
Std Equ km per Platform Hour	N/A	21.77	23.17	25.35	25.23	25.71
Std Equ mi per Platform Hour		13.50	14.37	15.72	15.64	15.94

	1972	1982	1987	1992	1997	2002
Index (1982 = 100)		*100*	*106*	*116*	*116*	*118*

The ratio of vehicle km per platform hour (labeled “Speed Made Good” by OC Transpo) indicates the relative efficiency of labor utilization by management. The underlying “causal factors” reflect service-planning issues. This indicator reflects operating “speed” (e.g. commercial speed) to some degree but the relationship is relatively weak.

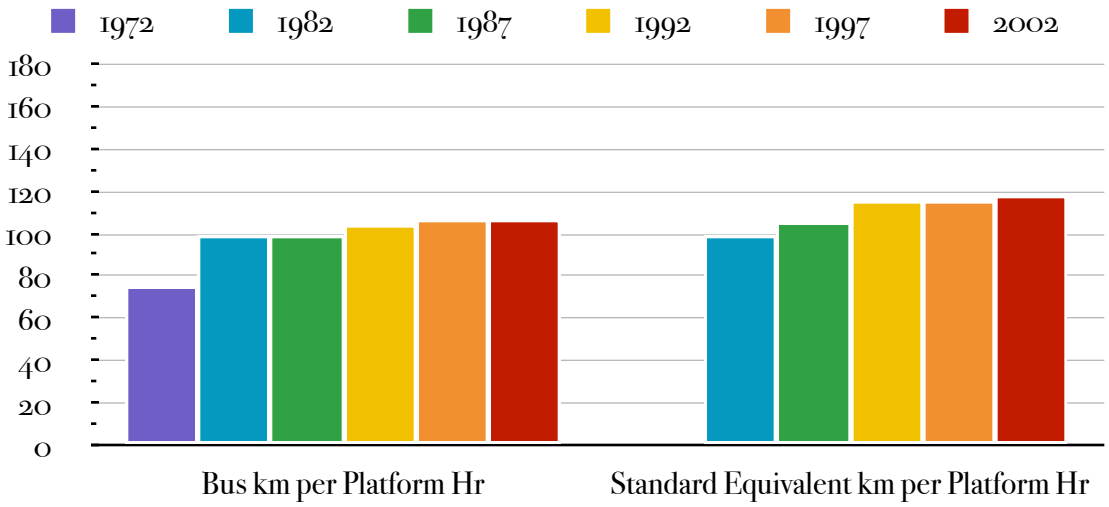
Prior to the start of transitway construction, OC Transpo anticipated that “higher speed” facilitated by transitways would lead to “lower costs.” This was based on alternatives-analysis results during early planning stages, and might be described today as “a theory that was not tested.” Despite visible increases in commercial (passenger) speed, the transitways did not facilitate large increases in bus km per platform hour. In other words, the undertaking was not able to substantially increase the efficiency of labor utilization as the transitway network expanded.

The 1972-1982 increase in bus km per platform hour coincides with the expansion of OC Transpo service to suburban areas. The authors believe this change reflects characteristics “typical” of suburban services, e.g. less-frequent stops and higher operating speed than purely “urban” services.

In theory, transitway development reduced the negative impacts of increasing street traffic congestion on OC Transpo operations; the slight upward trend in bus km per platform hour during 1982-2002 might have reversed without the transitways. The authors believe this to be true but lack supporting data.

Trends - Bus km per Platform Hour; Standard Equivalent km per Platform Hour

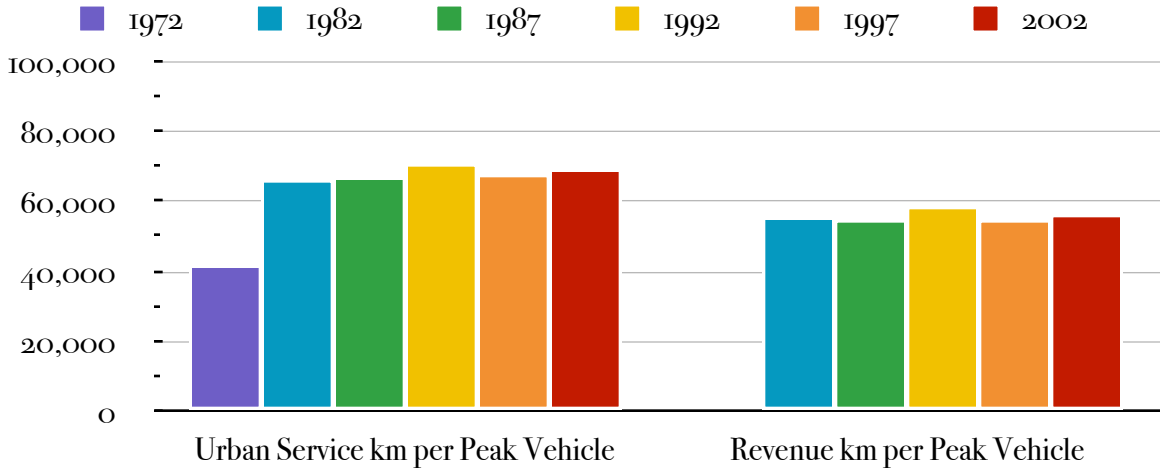
(1982 = 100)



The authors calculated “standard equivalent km per platform hour” to demonstrate the one significant (i.e. positive change greater than 10 percent; clear upward trend; identifiable causal relationship) productivity gain associated with the period of transitway development. Adjustment for relative vehicle size in this manner demonstrates an increase in “capacity” (seat-km or place-km) per platform hour. This was not sufficient to offset other factors underlying the increase in real unit operating cost (e.g. per revenue service hour and standard equivalent km).

20) Utilization of Vehicles: Annual km per Peak Vehicle

Annual km per Maximum Peak Scheduled Vehicle



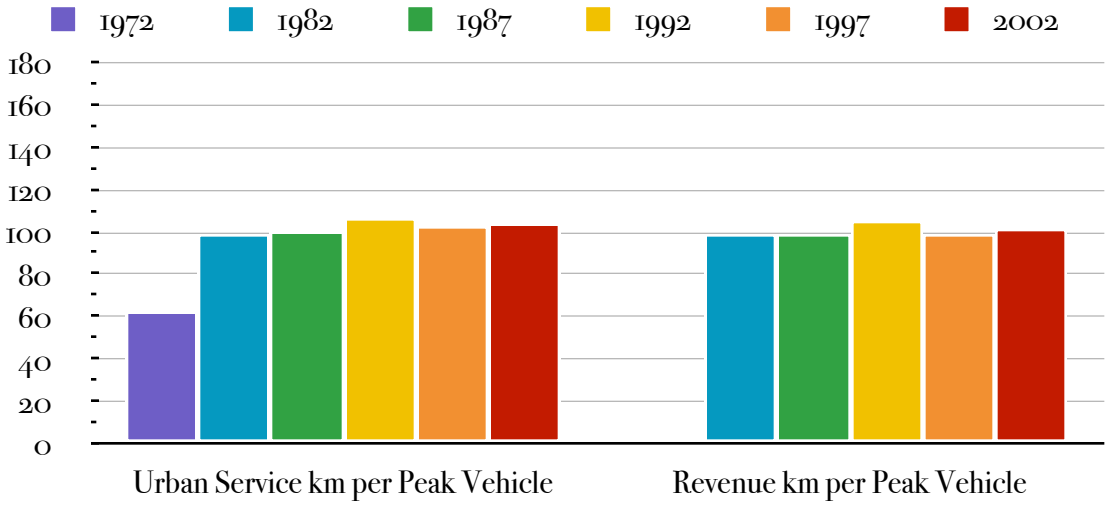
	1972	1982	1987	1992	1997	2002
Urban Service Bus km per Maximum Peak Scheduled Vehicle	42,132	66,391	66,860	71,022	68,154	69,480
Urban Service Bus mi per Peak Vehicle	26,122	41,163	41,453	44,034	42,255	43,077
Index (1982 = 100)	*63*	*100*	*101*	*107*	*103*	*105*
Revenue km per Maximum Peak Scheduled Vehicle	N/A	55,386	55,294	58,805	54,839	56,578
Revenue mi per Peak Vehicle		34,339	34,282	36,459	34,000	35,078
Index (1982 = 100)		*100*	*100*	*106*	*99*	*102*

The ratio of annual vehicle km to the maximum number of vehicles scheduled for peak-period service is an indicator of the relative efficiency of resource (vehicle fleet) utilization by management. The efficiency of resource utilization influences resource requirements; in other words, for a given level of peak-period service, a larger number of vehicle-km per "peak bus" implies a smaller number of buses required to operate this service. As above, the underlying "causal factors" reflect service-planning issues.

The authors calculated the number of annual “Urban Service Bus km” and “Revenue km” per “Maximum Peak Scheduled Vehicle;” the indicators reported by OC Transpo are based on total km, revenue km, and active fleet size. Although annual km per peak bus increased substantially during 1972-1982, no significant change was associated with opening of successive transitway segments. Adjustment for relative vehicle size (i.e.. increased use of articulated buses from 1982) would reveal some degree of increase.

Trends - Annual Urban Service km and Annual Revenue km per Maximum Peak Scheduled Vehicle

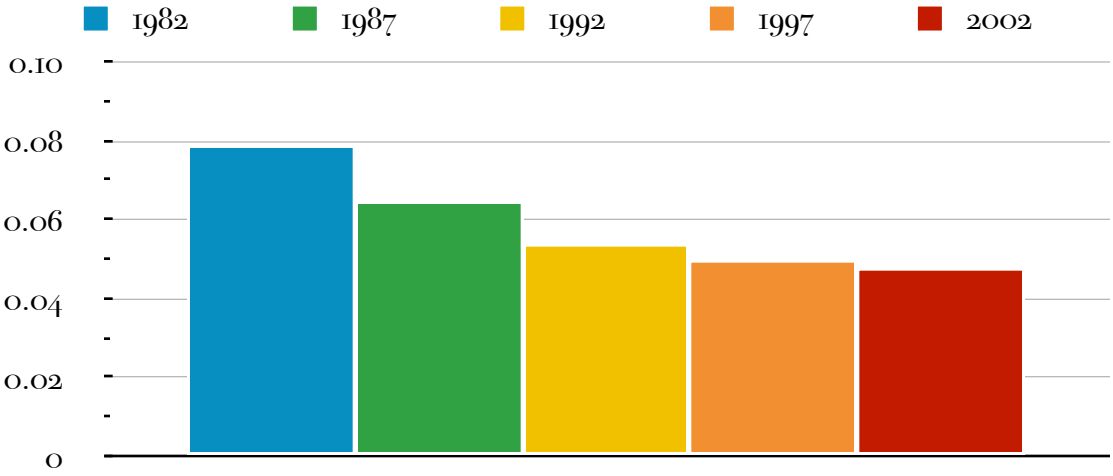
(1982 = 100)



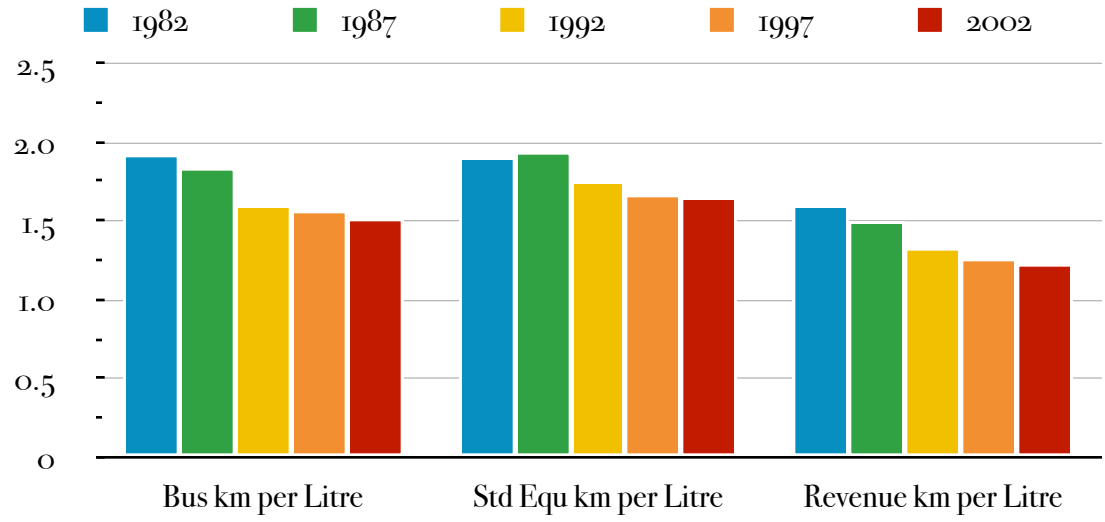
Prior to the start of transitway construction, OC Transpo anticipated that increases in annual km per vehicle would permit operation of service with a smaller fleet size. This, as above, was based on alternatives analysis results during early planning stages - and might be described today as “another theory that was not tested.”

21) Energy Efficiency: Fuel Consumption per Hour and km

Revenue Service Hours per Litre



Vehicle km per Litre

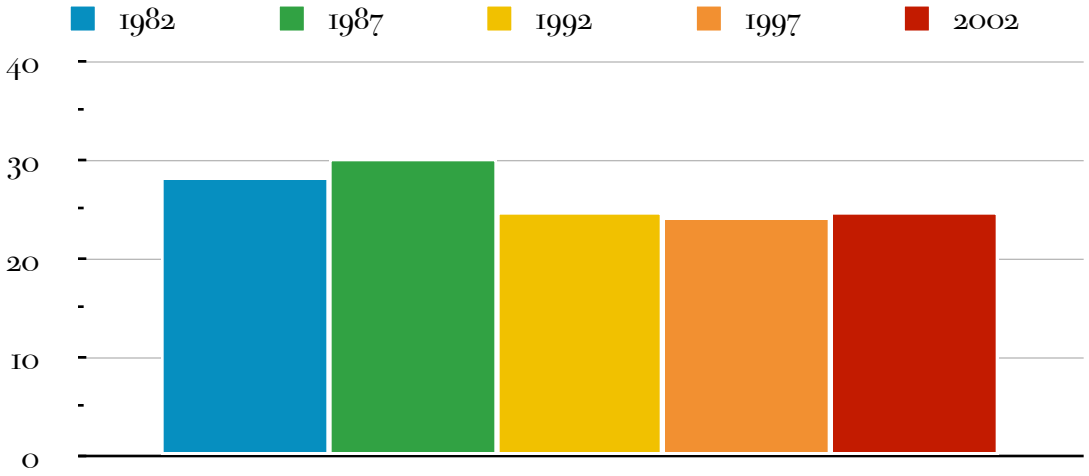


	1982	1987	1992	1997	2002
Revenue Hours per Litre	0.079	0.065	0.054	0.050	0.048
Revenue Hours per U.S.-gallon	0.298	0.248	0.203	0.189	0.181
Index (1982 = 100)	*100*	*83*	*68*	*64*	*61*
Litres per Revenue Hour	12.7	15.3	18.7	20.0	20.9
U.S.-gallons per Revenue Hour	3.4	4.0	4.9	5.3	5.5
Bus km per Litre	1.93	1.84	1.61	1.57	1.52
Bus mi per U.S.-gallon	4.53	4.32	3.78	3.68	3.57
Index (1982 = 100)	*100*	*95*	*83*	*81*	*79*
Standard Equivalent km per Litre	1.91	1.95	1.76	1.68	1.65
Standard Equivalent mi per U.S.-gallon	4.49	4.58	4.13	3.94	3.87
Index (1982 = 100)	*100*	*102*	*92*	*88*	*86*
Revenue km per Litre	1.60	1.51	1.34	1.26	1.23
Revenue mi per U.S.-gallon	3.75	3.54	3.14	2.96	2.89
Index (1982 = 100)	*100*	*94*	*84*	*79*	*77*

Labor accounts for the major share of transit bus operating cost per revenue service hour. However, the sharp increase in OC Transpo fuel consumption per RSH, associated with transitway development, had an obvious upward influence on unit operating costs. This trend was slowed during 1992-2002 but not reversed. At 2002, OC Transpo's fuel economy in terms of revenue km / L had fallen nearly 40 percent below 2.0 revenue km/L (4.0 mi per U.S.-gallon), a figure used typically for planning purposes.

22) Fuel Consumption per Passenger-km

Passenger-km per Litre

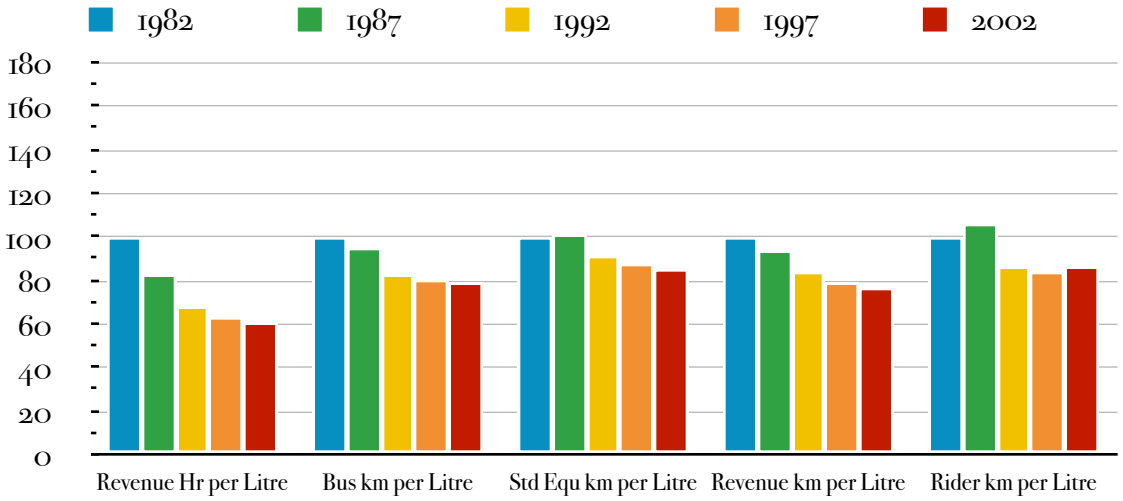


	1982	1987	1992	1997	2002
Rider km per Litre	28.5	30.3	24.8	24.3	24.9
Rider mi per U.S.-gallon	66.9	71.1	58.2	57.0	58.4
Index (1982 = 100)	*100*	*106*	*87*	*85*	*87*

Fuel efficiency in terms of pass-km/L increased to 1987 despite declining ridership, reflecting OC Transpo's success at improving service effectiveness. The undertaking was not able to avoid a long-term decline in "consumption-side" fuel economy, but the trend from 1992 to 2002 was static.

Trends - Fuel (Energy) Efficiency and Economy

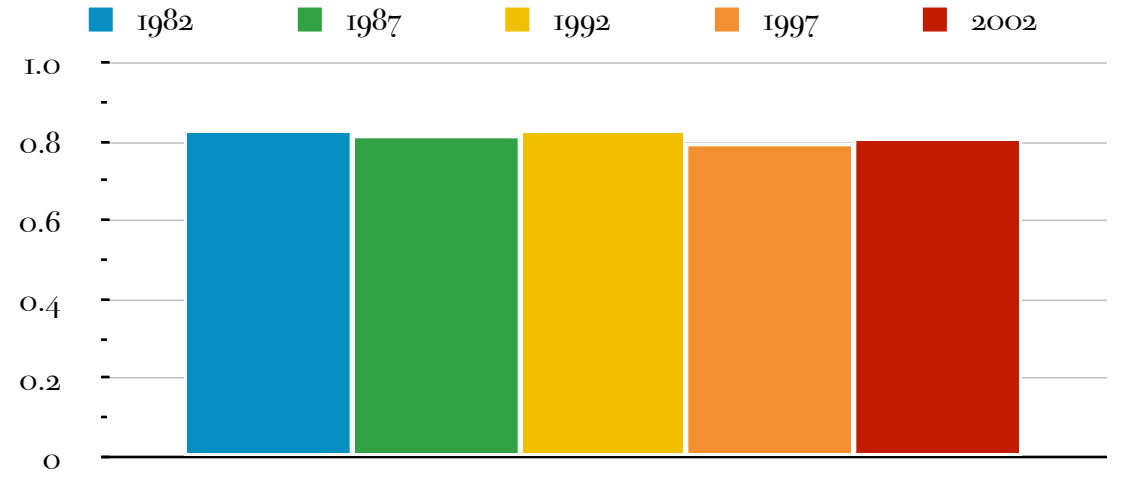
(1982 = 100)



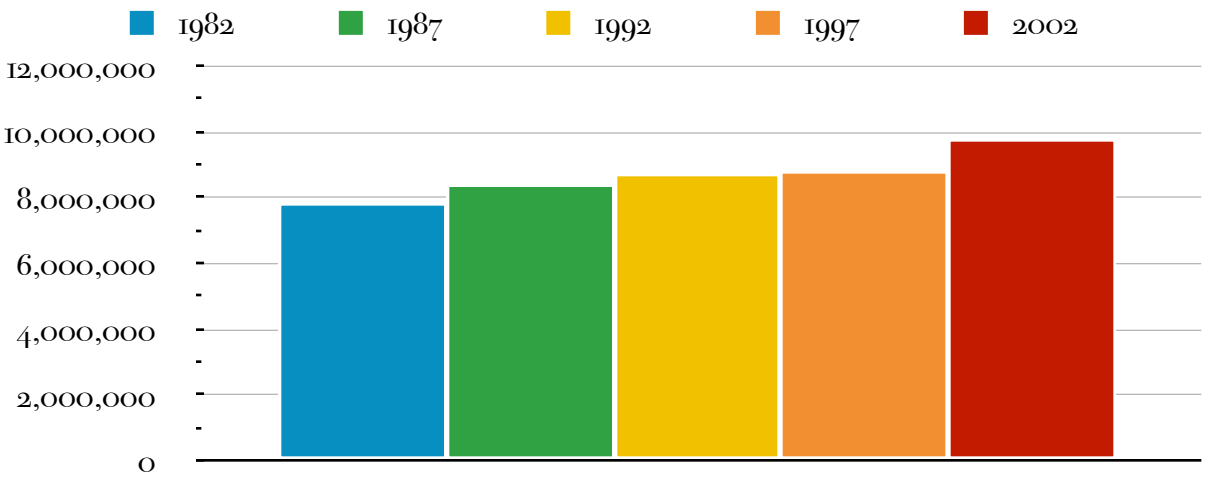
The authors believe the trends illustrated above reflect (in order of significance) increases in non-revenue ("deadhead" km), increased energy consumption as the result of higher "cruise speed" between stops (Sims and Miller 1982), and increased use of articulated buses.

23) "Deadheading:" Revenue and Non-Revenue Vehicle-km

Revenue km per Vehicle km



Non-revenue Urban Service km

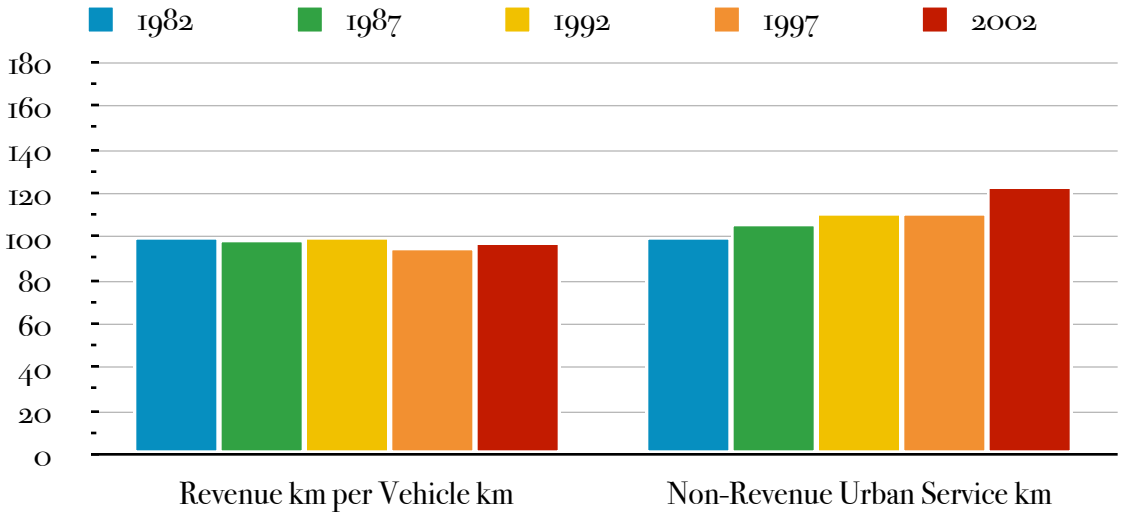


	1982	1987	1992	1997	2002
Revenue km per Vehicle km	0.83	0.82	0.83	0.80	0.81
Index (1982 = 100)	*100*	*99*	*100*	*96*	*98*
Non-Revenue Urban Service km	7,902,000	8,432,000	8,760,000	8,828,000	9,818,000
Non-revenue mi	4,899,000	5,228,000	5,431,000	5,473,000	6,087,000
Index (1982 = 100)	*100*	*107*	*111*	*112*	*124*

“Deadheading” is a term used in Canadian and U.S. transit jargon to describe non-revenue operation of vehicles. This includes operation from the garage to the location where revenue service begins, return to the garage from the point where revenue service ends, and non-revenue operation between terminals.

Trends - Revenue and Non-Revenue Vehicle km

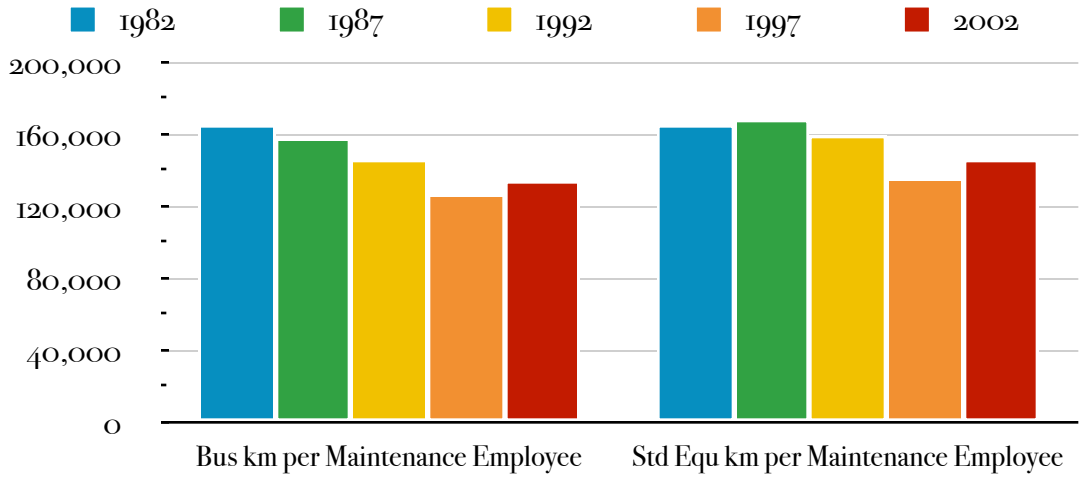
(1982 = 100)



The ratio of revenue km to vehicle km remained relatively static during 1982-2002. However, this indicator did not reflect a significant increase in the absolute number of “non-revenue urban service km.” The “annual average” rate of increase was about one percent. However, the authors estimate that the absolute increase, nearly 2 million km, accounted for more than (2002 CAD) 6 million (2002 USD 4 million) in annual operating cost at 2002.

24) Annual Vehicle-km Per Maintenance Employee

Annual Vehicle km per Maintenance Employee

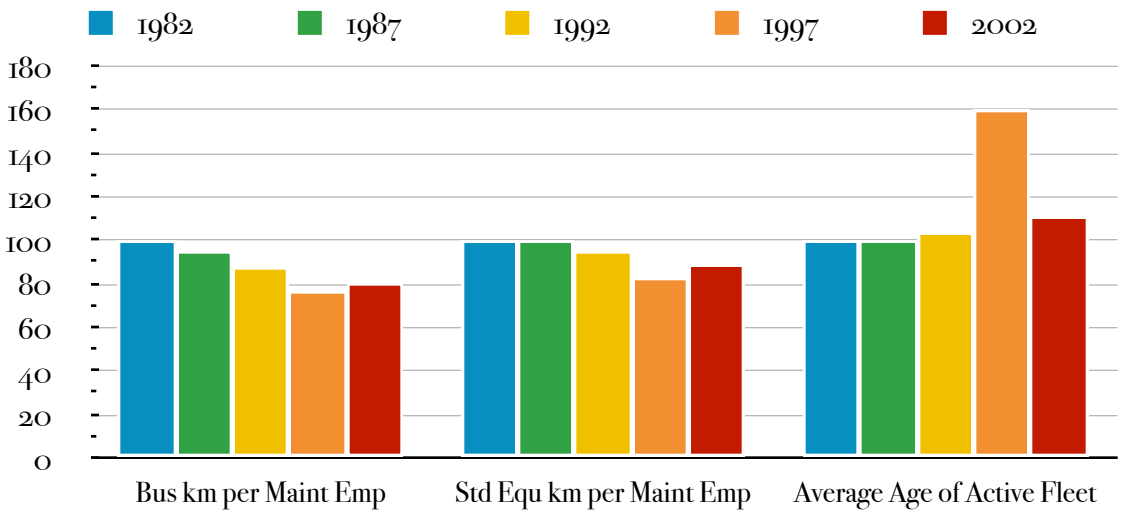


	1982	1987	1992	1997	2002
Bus km per Maintenance Employee	166,000	158,000	146,000	128,000	135,000
Bus mi per Maintenance Employee	103,000	98,000	91,000	79,000	84,000
Index (1982 = 100)	*100*	*95*	*88*	*77*	*81*
Standard Equivalent km per Maintenance Employee	166,000	169,000	160,000	137,000	147,000
Std Equ mi per Maintenance Employee	103,000	104,000	99,000	85,000	91,000
Index (1982 = 100)	*100*	*101*	*96*	*83*	*89*
Average Age of Active Fleet	8.55	8.57	8.9	13.7	9.6
Index (1982 = 100)	*100*	*100*	*104*	*160*	*112*

Changes in the number of vehicle km per maintenance employee reflect changes in the average age of the active fleet to some extent. Adjustment for relative vehicle size (e.g. using "standard equivalent km") moderates the decline to 1997 in vehicle km per maintenance employee.

Trends - Vehicle-km per Maintenance Employee and Average Age of Active Fleet

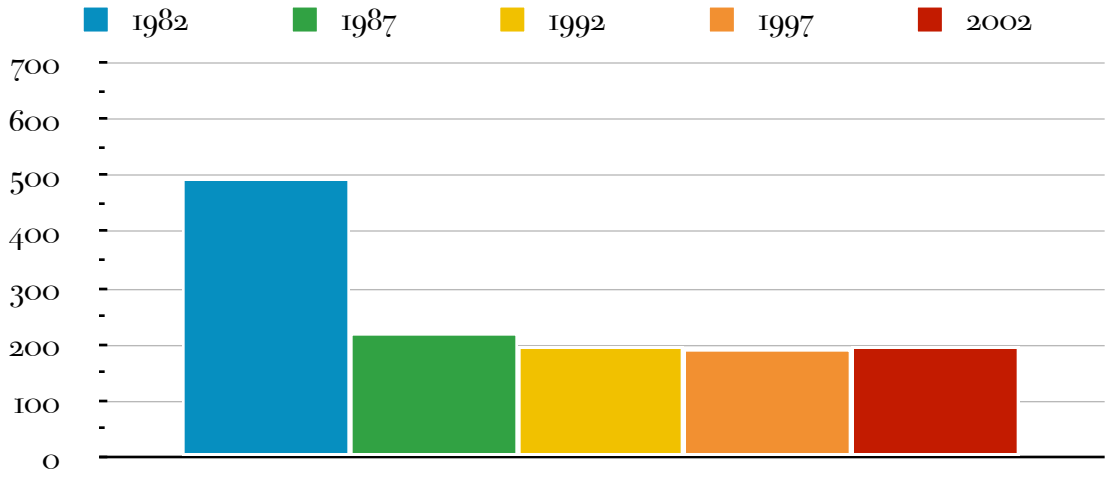
(1982 = 100)



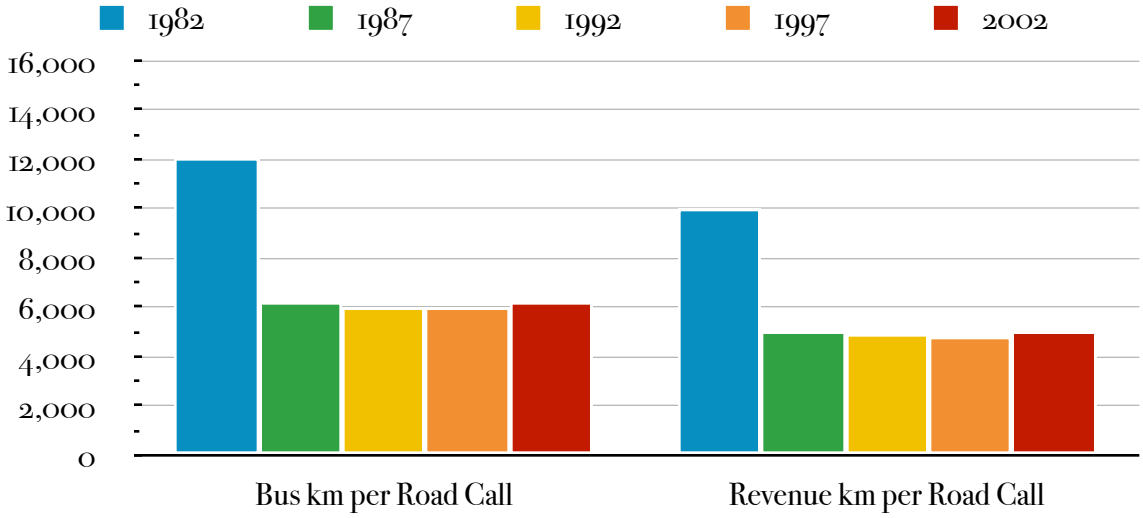
Maintenance productivity declined significantly during 1982-1987, when the average active fleet age was relatively stable. The sharp “spike” in average fleet age during the late 1990s coincided with a discernible acceleration of the negative trend in productivity; the causal relationship should be obvious.

25) Service Hours and km per Road Call

Revenue Service Hours per Road Call



Vehicle km per Road Call



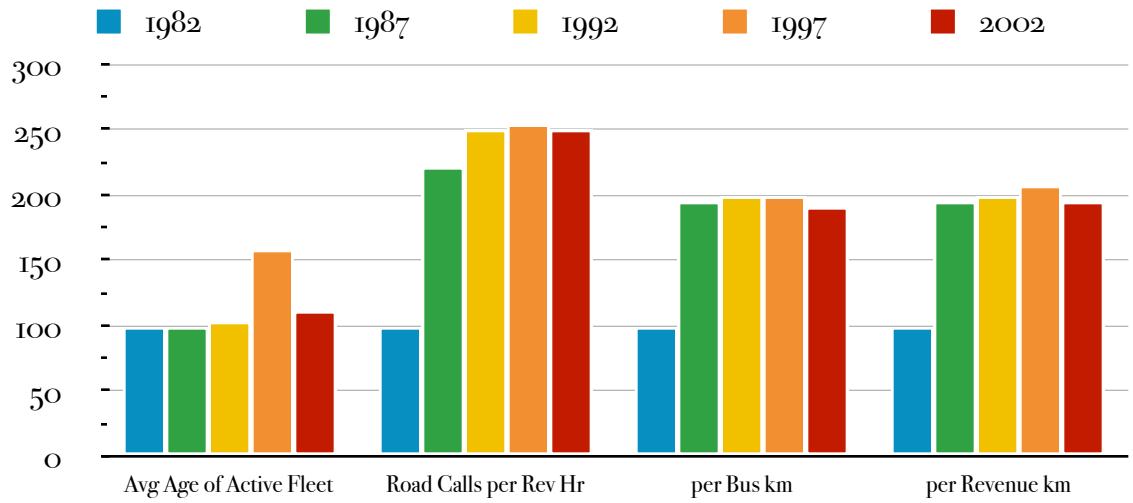
	1982	1987	1992	1997	2002
Revenue Hours per Road Call	495	221	200	193	199
Index (1982 = 100)	*100*	*45*	*40*	*39*	*40*
Bus km per Road Call	12,128	6,227	6,018	6,057	6,291
Bus mi per Road Call	7,519	3,861	3,731	3,755	3,900
Index (1982 = 100)	*100*	*51*	*50*	*50*	*52*
Revenue km per Road Call	10,066	5,106	4,995	4,846	5,096
Revenue mi per Road Call	6,241	3,166	3,097	3,004	3,159
Index (1982 = 100)	*100*	*51*	*50*	*48*	*51*
Average Age of Active Fleet	8.55	8.57	8.9	13.7	9.6
Index (1982 = 100)	*100*	*100*	*104*	*160*	*112*
Bus Service and Maintenance Employees	287	308	349	353	393
Index (1982 = 100)	*100*	*107*	*122*	*123*	*137*

The indicators in the charts and table above imply a sharp increase in the incidence of road calls from the early 1980s - which in turn implies a sharp increase in the incidence of road failures. Moreover, the incidence of road calls stabilized at a much higher rate during 1987 - 2002. This implies in turn that OC Transpo service disruptions became - and remained - much more common after 1982 than during the undertaking's initial decade of operation.

The questions are obvious: Did the increased incidence of reported road calls reflect actual, sustained increases in the rates of OC Transpo service disruptions and road failures? Or, did this rather abrupt change occur as the result of other factor(s), e.g. changes in work rules?

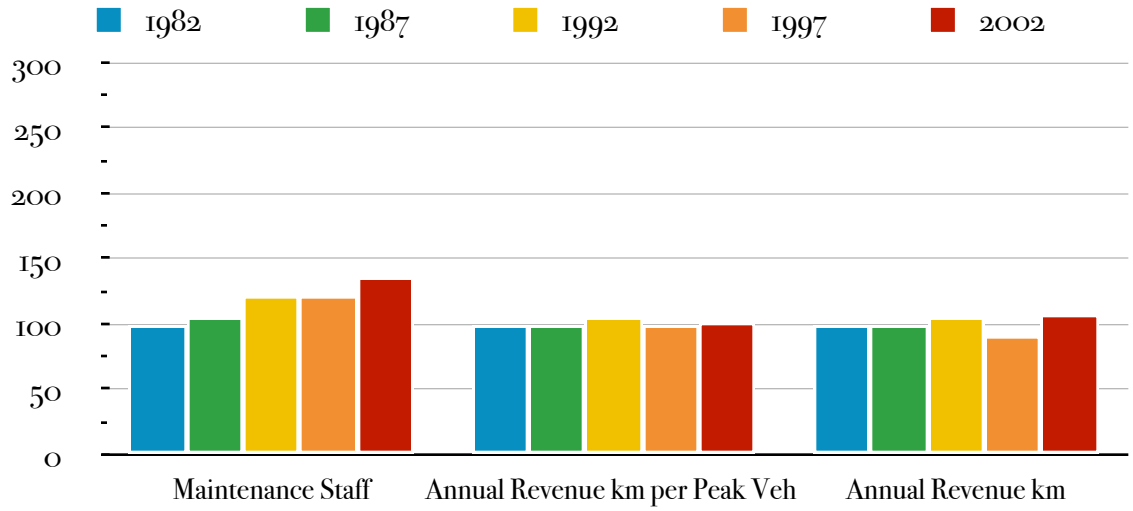
Trends - Average Age of Active Fleet and Incidence of Road Calls

(1982 = 100)



Trends - Maintenance Staff Level, Annual Revenue km and Annual Revenue km per Maximum Peak Scheduled Vehicle

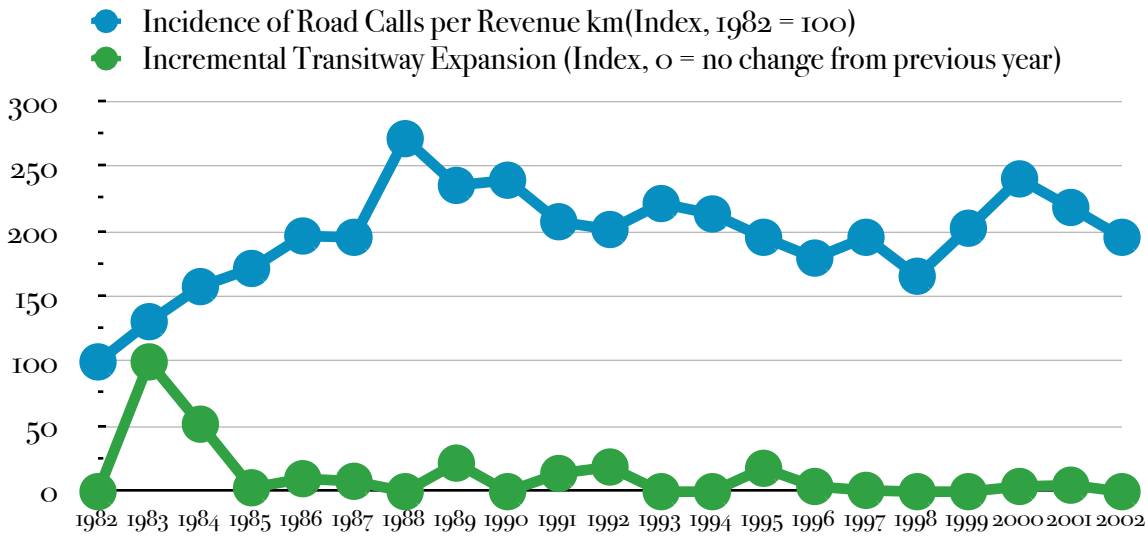
(1982 = 100)



With the exception of the two charts above (and two below), all charts in this paper showing changes in index statistics ("Trends") were prepared with a common scale to facilitate comparisons. The index range used elsewhere in this paper was not sufficient above because of the large relative increase in road calls (and was not sufficient below for the large relative increase in traffic accidents per passenger and per passenger-km).

The first chart above includes reciprocal indexes of "Revenue Hours per Road Call," "Bus km per Road Call" and "Revenue km per Road Call" in order to display changes in the incidence of road calls. The sharp increase in the incidence of road calls was not accompanied by significant changes in average age of active fleet. In fact, the "spike" in average fleet age at 1997 was accompanied by only a small increase in the incidence of road calls per revenue km. Moreover, the significant increase in maintenance staff levels was not accompanied by significant increases in vehicle utilization ("Annual Revenue km per Peak Vehicle"), nor by an absolute increase in annual service levels ("Annual Revenue km").

Trends - Incidence of Road Calls per Revenue km and Total Transitway km In Service



As before, the "Index of Incremental Transitway Expansion" in the chart above shows year to year changes in transitway system length.

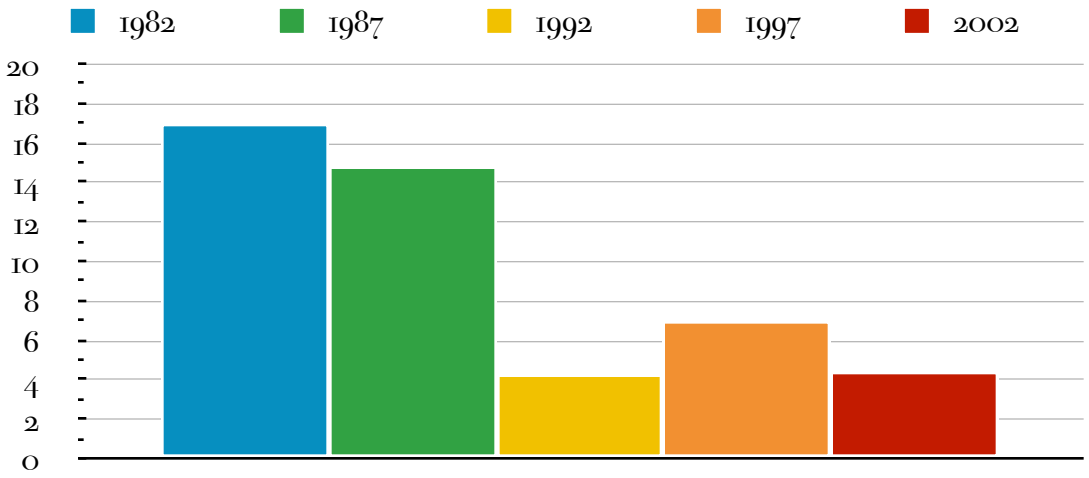
A change in work rules leading to an increased incidence of road calls (e.g. requiring operators to make calls for certain events that did not require road calls previously) should result in an

abrupt increase from one year to the next, standing out from “background” trends. Except for the incremental change to 1988 (when the absolute number of road calls reached a sharp peak), no such change is evident. The increasing trend in the incidence of road calls during 1982-1990 overlaps the period when the incidence of customer communications, and by inference the incidence of customer complaints, increased sharply.

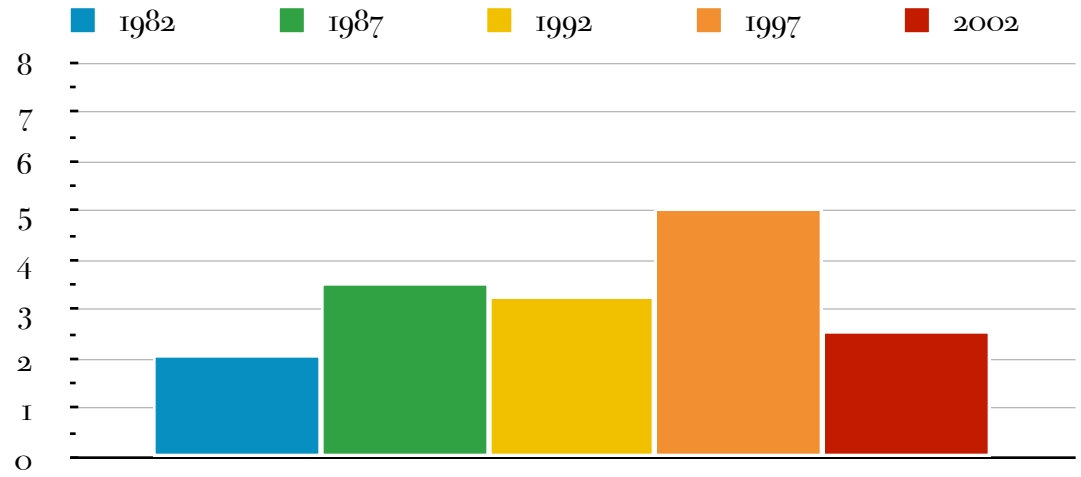
Available data suggest - but do not establish - that OC Transpo experienced an increased incidence of service disruptions and road failures from 1982, coinciding with the initial period of transitway operation. Moreover, anecdotal reports suggest the association of high maintenance costs with operation of motorbuses in a manner that mimics typical (U.S.) “light rail” service patterns: relatively high cruise speeds (e.g. 70-90 km/h (45-55 mph)) and frequent acceleration cycles (e.g. stops spaced every 2-3 km (1-2 mi)). Additional research is clearly indicated.

26) Safety

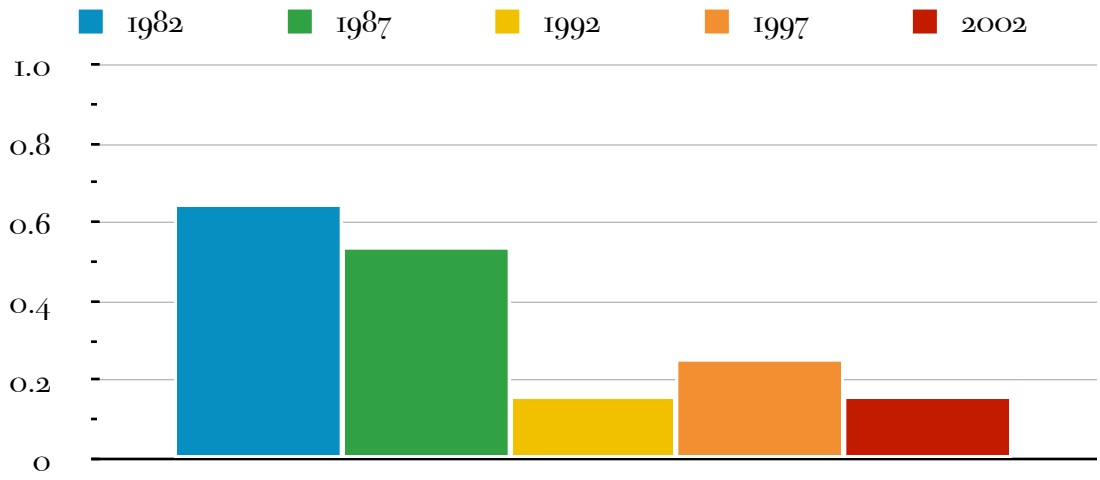
Traffic Accidents per Million Bus km



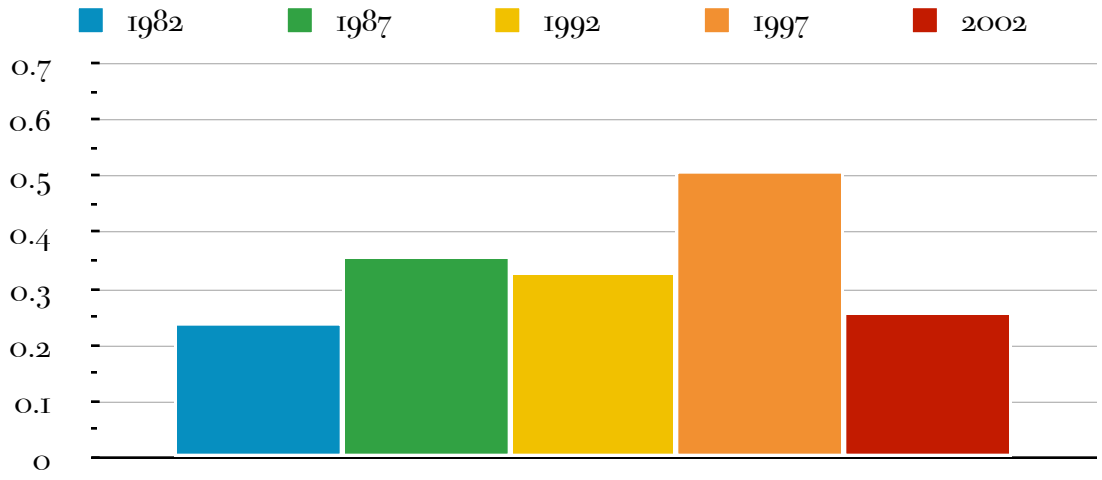
Traffic Accidents per Million Passengers



Traffic Accidents per Operator (driver)



Traffic Accidents per Million Passenger-km



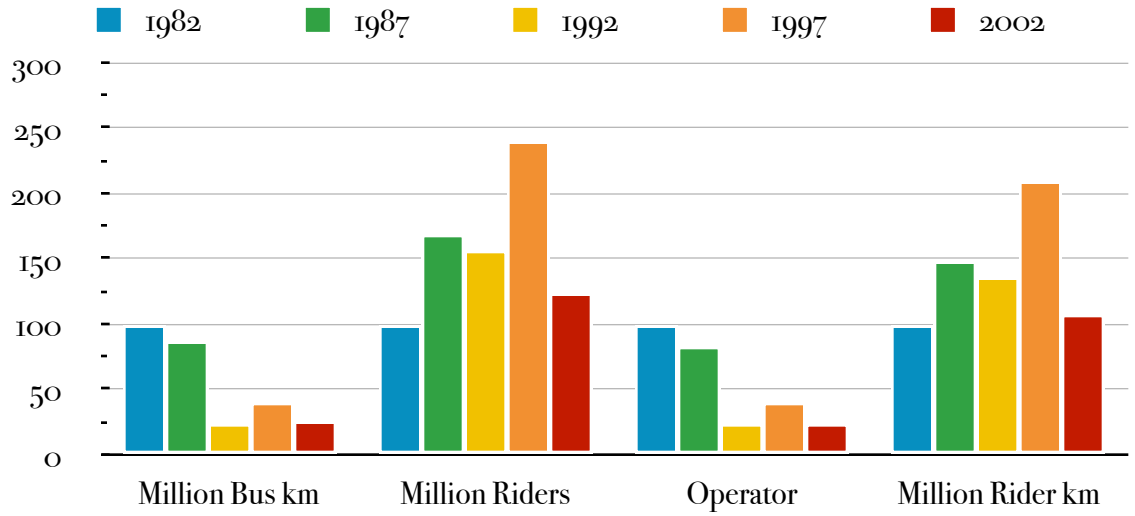
	1982	1987	1992	1997	2002
Traffic Accidents per Million Bus km	17.0	14.8	4.3	7.0	4.5
per Million Bus mi	27.4	23.9	6.9	11.3	7.3
Index (1982 = 100)	*100*	*87*	*25*	*41*	*26*
Traffic Accidents per Million Riders	2.11	3.58	3.31	5.09	2.62
Index (1982 = 100)	*100*	*170*	*157*	*241*	*124*
Traffic Accidents per Operator (driver)	0.65	0.54	0.16	0.26	0.16
Index (1982 = 100)	*100*	*83*	*25*	*40*	*25*
Traffic Accidents per Million Rider km	0.24	0.36	0.33	0.51	0.26
per Million Rider mi	0.4	0.6	0.5	0.8	0.4
Index (1982 = 100)	*100*	*148*	*136*	*210*	*108*

The first three safety indicators in the table above are those published by OC Transpo. Two showed an overall declining trend during 1982-1997. The trend of increasing average travel distance per passenger suggested that the rate of traffic accidents per passenger-km did not

increase to the same degree as the rate per passenger. The authors added this safety indicator accordingly.

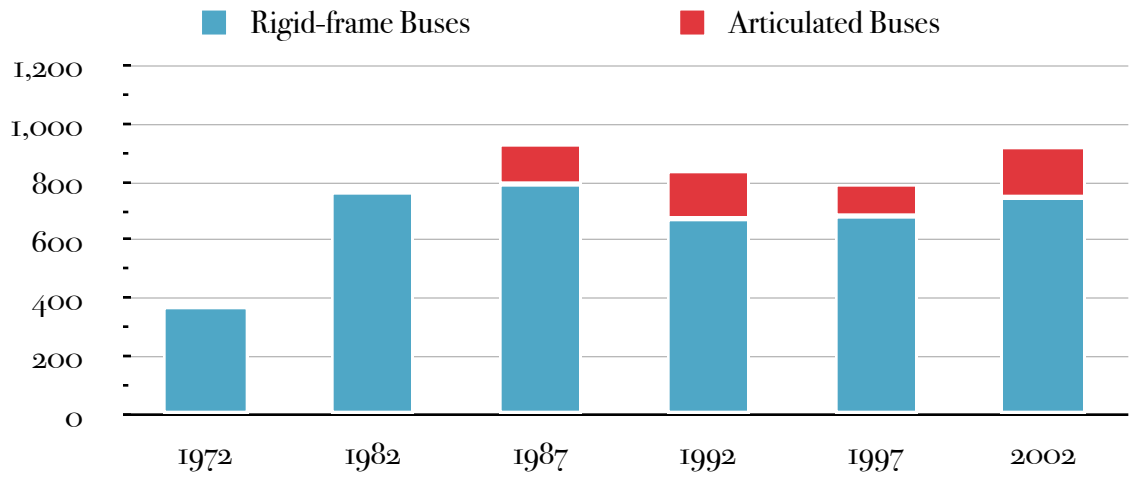
Trends - Safety Indicators - Traffic Accidents per:

(1982 = 100)



27) Standard and Articulated Buses

OC Transpo Active Fleet Size



	1982	1987	1992	1997	2002
Articulated Buses	21	134	161	114	171
Percentage of Total Active Fleet	*2.7*	*16.3*	*19.4*	*14.4*	*18.7*
Ratio of Standard Equivalent km : Bus km	*0.99*	*1.06*	*1.09*	*1.07*	*1.09*

OC Transpo's use of articulated buses is relevant *per se* to analysis of productivity and efficiency. Moreover, certain common planning assumptions related to bus rapid transit services using articulated vehicles are not consistent with actual operating experience - and one common planning assumption clashes with the laws of physics.

The authors note that the statistic published by OC Transpo, "Standard Equivalent km," is based on the relative size of vehicles in the active fleet - and does not directly reflect the relative share of revenue km operated by articulated buses. Personal observations at 1992 and 2000 suggest that the share of OC Transpo peak-period service operated by articulated buses was reduced during this interval.

Articulated buses utilize operator (driver) labor more efficiently than standard buses because of larger vehicle size, and so achieve greater productivity. However, articulated buses cost more to operate; various cost elements include greater fuel consumption and higher maintenance costs (UMTA 1982, UMTA 1984). Net result: articulated buses cost about 25 percent more to operate per revenue service hour (RSH) than standard buses. Early planning studies often assume equivalent operating cost per RSH for standard and articulated buses, but this does not reflect results from actual service.

The relevance of research by the U.S. Urban Mass Transportation Administration from the early 1980s to the current generation of articulated buses has been questioned. However, the comparison of interest is not between today's articulated vehicles and those built 25 years ago, but between contemporary articulated and standard vehicles. For this purpose, the UMTA findings remain relevant. Despite design improvements over the past 20 years, operation of articulated buses still costs more per RSH than operation of standard buses - simply because articulated buses are larger, heavier vehicles with greater passenger capacity. Comparative specifications suggest that recent articulated buses might have greater mass per unit of length than earlier vehicles, as the result increased durability and increased power. This in turn would lead to rela-

tively greater fuel consumption per RSH by comparison with today's standard buses. The difference in operating cost per RSH might be greater than the 25 percent found by UMTA.

A common planning assumption is that bus operating cost per RSH does not vary with operating speed. This is not correct. Given an increase in revenue km per RSH, fuel accounts for a relatively larger share of operating cost per RSH even if fuel economy (km/L, or mpg) does not change. This occurs simply as a consequence of the increased number of km per RSH. Fuel accounts for a relatively small share of total operating cost per RSH, but this "small share" is not "fixed" and positive changes exert upward pressure on unit operating costs.

The estimated 25-percent greater operating cost per RSH of articulated buses assumes service characteristics typical of buses in mixed traffic. It does not incorporate "BRT" service characteristics that might lead to a larger cost difference per RSH. Operation of articulated motorbuses in a manner that "mimics" the service characteristics of light rail vehicles may lead to unit operating costs 30-40 percent greater than "baseline" levels (per RSH), which reflect 1) standard buses and 2) service patterns "typical" of buses in mixed traffic. Additional research is indicated to quantify the cost elements of articulated bus operation in actual service - with specific emphasis on "BRT" service characteristics.

28) Summary

Canada's National Capital region houses about 1.1 million people. OC Transpo currently serves nearly 60 percent of this population, and carries nearly 85 percent of the region's transit ridership. The transitway network operated by OC Transpo has a system length of 46.3 km (28.7 mi). About half of the region's 400,000 weekday passengers travel over some part of the transitway system, although reported "transitway" ridership includes a significant share of passengers who do not travel over transitway segments away from the Ottawa CBD.

The Urban Transit Area (UTA) population served by OC Transpo increased by more than 28 percent from 1982 to 1997. Taking vehicle size into account, the undertaking increased annual service ("standard equivalent km") by 17 percent through 1992, essentially matching the UTA population increase (18 percent). However, ridership fell after 1984, and this overall trend was not reversed until 1998.

The 1984-1998 ridership decline is unfortunate, but less troubling than several negative trends evident during the same period: decreasing labor productivity and efficiency of labor utilization,

increasing maintenance costs and apparent incidence of road failures, and decreasing fuel economy.

Operating cost per revenue hour increased at a "real" rate of about 2.5 percent per year during 1982-2002. In other words, unit operating cost escalated at an average annual rate 2.5 percent greater than the economy-wide rate of price escalation in Canada. The authors estimate that the net effect of real increases in pay rates, work rule changes favorable to labor and real increases in fringe benefits was an average annual (real) unit operating cost increase of about one percent. Therefore, roughly 40 percent of the cost impacts estimated above may be attributed to "increased labor costs." The remainder - that is, the majority of the real unit cost escalation experienced during 1982-2002 - must be attributed to other factors.

The overall cost impact was substantial. The difference between inflation-adjusted operating cost per revenue service hour at 1982 and 2002 is (2002 CAD) $39.05. If this difference did not exist - that is, had OC Transpo managed to avoid real increases in unit operating cost - total operating cost for 2002 would have fallen $65 million (2002 USD 24 million) below the amount actually reported. Cumulative total operating cost for 1982-2002 would have fallen $1,360 million (2002 USD 865 million) below the "actual" sum.

The various negative trends suggest "inherent" or "structural" inefficiencies associated with Ottawa's transitway program. Additional research is clearly indicated to determine underlying causes and identify potential counter-strategies.

Returning to ridership indicators: the number of weekday peak-period passengers (a.m. and p.m.) carried by OC Transpo almost doubled from 1972 to 1982. It then increased to 1985 (by roughly 20 percent), then remained relatively static (at slightly below 190,000) to 1989. A change in methodology might account for some of the decline implied by statistics post-1990, but a clear downward trend was apparent by 1993. This indicator increased by more than 23 percent (155,000-190,000) from 1997 to 2002.

The number of weekday midday passengers carried by OC Transpo more than trebled from 1972 to 1982. It then increased to 1985 (by roughly ten percent) and then remained relatively static (at about 95,000). The change described above might account for some of the decline implied post-1990. This indicator fluctuated around 80,000 per weekday to 1999, then increased by nearly 28 percent (to 102,000) at 2002.

The increase in the number of weekday evening passengers 1972-1982 was even more dramatic than the midday increase. This indicator fell from 1983 to 1985 (by nearly 23 percent, to

27,000) then remained relatively static. A clear upward trend emerged following the “strike year” (1996). This indicator increased by nearly 35 percent (to 40,000) from 1997 to 2002.

Saturday ridership nearly doubled from 1972 to 1982, fell from 1983 to 1986, then remained relatively static (at about 145,000) through 1989. A very sharp drop of 33 percent during a single year (97,000, at 1990) does not coincide with implementation of APC. Following a period of volatility, this indicator increased by 34 percent (to nearly 148,000) from 1997 to 2002.

Sunday ridership also nearly doubled from 1972 to 1982, but subsequent trends were different. Excepting the peaks during 1984-1986 and 1990-1991 (which might reflect changes in motor fuel prices), Sunday ridership remained quite stable (within the range 40,000-44,000) to 1992. Following implementation of APC and the 1996 strike, reported Sunday ridership increased by nearly 45 percent (to 87,000) from 1997 to 2002.

The average distance traveled per revenue passenger increased as successive transitway segments were opened. For this reason, changes in annual travel (passenger-km) did not mirror the trend in revenue riders. Annual passenger-km increased to 1984, remained relatively static to 1990 (at about 800 million pass-km per year), then declined to 1996 (by about 20 percent, to less than 650 million pass-km). Thereafter, annual passenger-km increased by nearly 34 percent, to nearly 870 million at 2002.

Changes in employment levels and distribution explain part of the 1984-1998 ridership decline reported by OC Transpo. UTA employment increased by more than 38 percent from 1981 to 1997 - significantly outstripping the rate of population increase. (This trend also suggests an increase in the number of employees who travelled between residences outside the UTA - e.g. in Quebec - and jobs within.) During the same period, central area employment grew by 21 percent. In other words, employment throughout the UTA grew by more than 100,000 but less than 14 percent of this growth, fewer than 15,000 new jobs, occurred within the central area. In addition, available data suggest that central area employment declined slightly (by less than 2 percent) from 1991 to 1996. As noted above, weekday peak period riders and annual passenger-km declined during this period.

Increases in real fares might explain part of the 1984-1998 ridership decline, but the relationship is not clear. Real fare per passenger increased by 16 percent from 1982 to 1987, but fare per km remained stable because the average travel distance per passenger grew longer. During this interval, weekday ridership increased by 12 percent, Saturday ridership declined slightly and Sunday ridership grew by eight percent. The trends from 1987 to 1992 are intriguing: continued increase in real fare per passenger, significant increase in real fare per km, and declines

in weekday and Saturday ridership - but not Sunday ridership. Moreover, at 1992, weekday ridership had declined from 1984 but was still slightly above the 1982 level - despite fares per passenger 31 percent higher and fare per km was 14 percent higher than at 1982. Sunday ridership increased by 10 percent during 1982-1992 but Saturday ridership fell by nearly 25 percent. Increases in real fares might explain part of the decline in ridership per capita from the early 1980s but other factors (e.g. changes in employment locations) were evident; additional research is indicated.

An extensive body of research makes clear that consumers assign considerable disutility to transfers between vehicles. However, the actual influence of this preference for “one-seat” service is less clear. Kain (1992) suggested that most of the ridership decline during 1984-1988 was the result of increased transfer activity; this was disputed by the (then-) General Manager of OC Transpo, John A. Bonsall. No obvious correlation between the number of transfers per revenue passenger and various indicators of ridership per capita is visible above (“Ridership Trends”). The OC Transpo transfer rate increased by 20 percent during 1972-1982 while per-capita ridership increased dramatically; the authors note that high transfer rates are characteristic of Canadian and U.S. cities (e.g. Montréal, New York, San Francisco, Toronto) where transit attracts “European levels” of ridership. The OC Transpo transfer rate continued to increase through 1987 and stabilized thereafter, while per-capita ridership indicators continued to change significantly. The authors do not doubt the existence of a “transfer penalty” effect *per se*, but believe that its influence is often exaggerated in theory.

The authors again note, with interest, that the rate of OC Transpo customer contacts - and the inferred rate of customer complaints - increased sharply during 1985-1989. This coincided with a sharp increase in “road calls” and the initial period of ridership decline from 1984. Additional research is clearly indicated to quantify the degree of change in customer satisfaction and determine the influence on ridership.

In conclusion, the authors hope that this paper will encourage further analysis of bus rapid transit operating cost issues in the “real world.” The number of urban corridors in Canada and the U.S. with traffic sufficient to justify the investment for rail transit is small compared to the number where traffic levels justify relatively lower investments for improved bus service. The need for further analysis is clear.

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OC Transpo Operating Data - 1982-2002

	1982	1987	1992	1997	2002
Urban Transit Area population	509,600	555,000	603,800	653,700	723,800
Urban Transit Area Employment	282,400 (1981)			390,800	
Central Area Employment	68,140 (1981)	74,847 (1986)	83,300 (1991)	82,600	93,640 (2001)
Transitway Route Length, km	0.0	17.9	32.7	42.3	46.3
Revenue Kilometrage	39,767,000	40,309,000	42,163,000	36,358,000	43,056,000
Urban Service Bus kilometrage	47,669,000	48,741,000	50,923,000	45,186,000	52,874,000
Charter and Sight-seeing kilometrage	334,000	142,000	73,000	47,000	42,000
Total Bus Kilometrage	48,003,000	48,883,000	50,996,000	45,233,000	52,916,000
Standard (40-foot) Equivalent kms	47,665,000	51,909,000	55,678,000	48,393,000	57,774,000
Revenue Hours	1,960,000	1,738,000	1,697,000	1,442,000	1,675,000
Urban Service Platform Hours	2,157,000	2,222,000	2,187,000	1,914,000	2,243,000
Charter and Sight-seeing Hours	32,000	18,000	9,000	4,000	4,000
Total Platform Hours	2,189,000	2,240,000	2,196,000	1,918,000	2,247,000
Annual Unlinked Trips	105,583,000	113,463,000	110,876,000	97,962,000	121,466,000
Annual Linked Trips	81,640,000	81,045,000	78,636,000	69,972,000	86,761,000
Weekday Riders	283,585	318,961	285,072	264,600	335,468

	1982	1987	1992	1997	2002
Weekday Peak Period Riders (a.m. & p.m)	155,924	188,506	171,943	155,407	191,400
Weekday Midday Riders	87,943	95,050	81,949	76,870	101,921
Weekday Evening Riders	34,232	27,016	28,657	29,946	40,692
Saturday Riders	148,977	144,519	113,744	110,171	147,617
Sunday Riders	40,395	43,562	44,623	60,362	87,344
Average Peak Period Trip Length (km)	8.69	9.95	10.0	10.0	10.0
Bus Fuel and Tax Cost (CAD)	9,169,000	10,574,000	12,639,000	12,389,000	17,099,000
Bus Maintenance Cost (CAD)	13,564,000	20,915,000	30,550,000	31,665,000	37,452,000
Operator Costs (CAD)	33,405,000	47,557,000	65,215,000	58,533,000	76,782,000
Total Operating Cost (CAD)	71,260,000	106,568,000	144,915,000	136,766,000	176,396,000
Total Capital, Debentures and Reserves (CAD)	11,021,000	35,007,000	38,328,000	48,870,000	129,571,000
Total Revenue (CAD)	42,692,000	60,952,000	81,513,000	79,818,000	104,215,000
Net OC Transpo Cost (includes capital, CAD)	27,769,000	45,616,000	94,742,000	90,7430,00	N/A
Total OC Transpo Employees	1,867	2,041	2,185	1,966	2,201
Operators	1,264	1.337	1,392	1,229	1,437
Bus Service and Maintenance Employees	287	308	349	353	393
Top Operator Pay Rate (CAD)	10.77	14.03	17.70	18.30	20.89

	1982	1987	1992	1997	2002
Total Fuel (litres)	24,934,000	26,571,000	31,673,000	28,840,000	35,012,000
Road Calls	3,958	7,850	8,474	7,468	8,412
Total Active Fleet	780	824	831	793	915
Articulated Buses	21	134	161	114	171
Maximum Peak Scheduled Fleet	718	729	717	663	761
Midday Scheduled Fleet	289	275	272	227	284
Average Age of Active Fleet	8.55	8.57	8.9	13.7	9.6
Customer Contacts (calls and letters)	6,152	8,625	7,165	7,032	16,047

Note: Total number of "weekday riders" (i.e. "revenue passengers" or "linked trips") and distribution by time period (e.g. "peak period riders") based from 1990 on Automatic Passenger Counting (APC) boarding data for September ("September booking"). Statistics previous to 1990 based on origin-destination survey data from 1985. "Customer Contacts" include Internet (e-mail) messages from 1997.

OC Transpo Performance Measures - 1982-2002

	1982	1987	1992	1997	2002
Bus km per Capita	93.5	87.8	84.3	69.1	73.1
Revenue Riders per Capita	160	146	130	107	120
Peak Riders per Capita	78	87	73	61	67
Off-Peak Riders per Capita	82	59	58	46	52
Revenue Riders per Revenue km	2.05	2.01	1.87	1.92	2.02
Revenue Riders per Revenue Hour	41.7	46.6	46.3	48.5	51.8
Rider km per Revenue km	17.84	20.01	18.65	15.49	20.15

	1982	1987	1992	1997	2002
Transfers per Revenue Rider	0.29	0.40	0.41	0.40	0.40
Ratio of A.M. and P.M. Peak Ridership to Weekday Ridership	N/A	N/A	0.60	0.59	0.57
Revenue km per Bus	50,983	48,919	50,738	45,849	47,056
Bus km per Bus	61,542	59,324	61,367	57,040	57,832
Bus km per Road Call	12,128	6,227	6,018	6,057	6,291
Revenue km per Vehicle km	0.83	0.82	0.83	0.80	0.81
Scheduled Bus per Total Fleet	0.92	0.88	0.86	0.84	0.83
Peak : Off-peak Scheduled Bus Ratio	2.484	2.651	2.636	2.921	2.680
Revenue km per Employee	21,300	19,750	19,297	18,493	19,562
Riders per Employee	43,728	39,708	35,989	35,591	39,419
Speed Made Good (Bus km per Platform Hour)	22.10	21.94	23.28	23.61	23.57
Revenue Hours per Operator	1,551	1,300	1,219	1,173	1,166
Platform Hours per Pay Hour	0.785	0.759	0.739	0.747	0.719
Bus km per Maintenance Employee	166,000	158,000	146,000	128,000	135,000
Operators : Total Employees Ratio	0.68	0.66	0.64	0.63	0.65
Bus km per Litre	1.93	1.84	1.61	1.57	1.52
Rider km per Litre	28.5	30.3	24.8	24.3	24.9
Revenue : Cost Ratio	0.60	0.57	0.56	0.58	0.59
Net Operating Cost per Capita (CAD)	54.49	82.19	116.38	102.79	N/A
Total Net Cost per Capita (CAD)	77.69	145.27	156.91	138.81	N/A
Net Operating Cost per Rider (CAD)	0.34	0.56	0.89	0.96	N/A
Operating Cost per Bus km	1.48	2.18	2.84	3.02	3.33
Operating Cost per Eqv Bus km (CAD)	1.50	2.05	2.60	2.83	3.05
Operating Cost per Revenue km (CAD)	1.79	2.64	3.44	3.76	4.10
Operating Cost per Rider (CAD)	0.873	1.315	1.843	1.955	2.033

	1982	1987	1992	1997	2002
Operating Cost per Rider km (CAD)	0.100	0.132	0.184	0.195	0.203
Operating Cost per Vehicle Hr (CAD)			66.26	71.46	78.64
Average Fare (CAD)	0.499	0.722	1.004	1.113	1.150
Operating Cost per Peak Bus (CAD)	99,248	146,184	204,007	206,284	231,795
Maintenance and Fuel Cost per Bus km (CAD)	0.47	0.64	0.89	0.97	1.03
Operator Cost per Platform Hour (CAD)	15.26	21.23	30.81	30.52	34.17
Ratio of Operator Cost per Platform Hour to Top Operator Pay Rate	1.42	1.51	1.71	1.65	1.64
Semi-fixed Cost per Platform Hr (CAD)	6.54	11.79	17.01	17.82	20.05
Ratio of Semi-fixed Cost to Total Operator Cost (per Platform Hour)	0.20	0.25	0.25	0.25	0.26
Traffic Accidents per Million Bus km	17.0	14.8	4.3	7.0	4.5
Traffic Accidents per Million Riders	2.11	3.58	3.31	5.09	2.62
Traffic Accidents per Operator (driver)	0.65	0.54	0.16	0.26	0.16

Note: Data and performance measures presented in the tables above are those compiled and published by OC Transpo. Headings have been reworded in a few cases for clarity.

OC Transpo Operating Data - Cumulative Totals, 1982-2002

	1982 - 2002
Revenue Hours	34,766,000
Total Operating Cost, 2002 CAD	3,438,790,000

Conversion Factors

Canadian Consumer Price Index (Statistics Canada):

Year	All Items (1992 = 100)
1982	65.3
1987	81.5
1992	100.0
1997	107.6
2002	119.0

2002 exchange rate (”annual average”): 1.57 CAD = 1.00 USD (Bank of Canada).

100 kilometres = 62 miles.

3.785 litres = 1 U.S. gallon.

The similarity between unit costs expressed as CAD per km and USD per mi in the tables above is coincidental. The 2002 “annual average” exchange rate of USD 0.64 per CAD fell very close to the conversion factor: 0.62 miles per km.

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	1982	1987	1992	1997	2002
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Total Bus Kilometrage	48,003,000	48,883,000	50,996,000	45,233,000	52,916,000
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Saturday Riders	148,977	144,519	113,744	110,171	147,617
Sunday Riders	40,395	43,562	44,623	60,362	87,344
Average Peak Period Trip Length (km)	8.69	9.95	10.0	10.0	10.0
Bus Fuel and Tax Cost (CAD)	9,169,000	10,574,000	12,639,000	12,389,000	17,099,000
Bus Maintenance Cost (CAD)	13,564,000	20,915,000	30,550,000	31,665,000	37,452,000
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Operators	1,264	1.337	1,392	1,229	1,437
Bus Service and Maintenance Employees	287	308	349	353	393
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Total Active Fleet	780	824	831	793	915

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Note: Total number of "weekday riders" (i.e. "revenue passengers" or "linked trips") and distribution by time period (e.g. "peak period riders") based from 1990 on Automatic Passenger Counting (APC) boarding data for September ("September booking"). Statistics previous to 1990 based on origin-destination survey data from 1985. "Customer Contacts" include Internet (e-mail) messages from 1997.

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Revenue Riders per Capita	160	146	130	107	120
Peak Riders per Capita	78	87	73	61	67
Off-Peak Riders per Capita	82	59	58	46	52
Revenue Riders per Revenue km	2.05	2.01	1.87	1.92	2.02
Revenue Riders per Revenue Hour	41.7	46.6	46.3	48.5	51.8
Rider km per Revenue km	17.84	20.01	18.65	15.49	20.15
Transfers per Revenue Rider	0.29	0.40	0.41	0.40	0.40
Ratio of A.M. and P.M. Peak Ridership to Weekday Ridership	N/A	N/A	0.60	0.59	0.57

	1982	1987	1992	1997	2002
Revenue km per Bus	50,983	48,919	50,738	45,849	47,056
Bus km per Bus	61,542	59,324	61,367	57,040	57,832
Bus km per Road Call	12,128	6,227	6,018	6,057	6,291
Revenue km per Vehicle km	0.83	0.82	0.83	0.80	0.81
Scheduled Bus per Total Fleet	0.92	0.88	0.86	0.84	0.83
Peak : Off-peak Scheduled Bus Ratio	2.484	2.651	2.636	2.921	2.680
Revenue km per Employee	21,300	19,750	19,297	18,493	19,562
Riders per Employee	43,728	39,708	35,989	35,591	39,419
Speed Made Good (Bus km per Platform Hour)	22.10	21.94	23.28	23.61	23.57
Revenue Hours per Operator	1,551	1,300	1,219	1,173	1,166
Platform Hours per Pay Hour	0.785	0.759	0.739	0.747	0.719
Bus km per Maintenance Employee	166,000	158,000	146,000	128,000	135,000
Operators : Total Employees Ratio	0.68	0.66	0.64	0.63	0.65
Bus km per Litre	1.93	1.84	1.61	1.57	1.52
Rider km per Litre	28.5	30.3	24.8	24.3	24.9
Revenue : Cost Ratio	0.60	0.57	0.56	0.58	0.59
Net Operating Cost per Capita (CAD)	54.49	82.19	116.38	102.79	N/A
Total Net Cost per Capita (CAD)	77.69	145.27	156.91	138.81	N/A
Net Operating Cost per Rider (CAD)	0.34	0.56	0.89	0.96	N/A
Operating Cost per Bus km	1.48	2.18	2.84	3.02	3.33
Operating Cost per Eqv Bus km (CAD)	1.50	2.05	2.60	2.83	3.05
Operating Cost per Revenue km (CAD)	1.79	2.64	3.44	3.76	4.10
Operating Cost per Rider (CAD)	0.873	1.315	1.843	1.955	2.033
Operating Cost per Rider km (CAD)	0.100	0.132	0.184	0.195	0.203
Operating Cost per Vehicle Hr (CAD)			66.26	71.46	78.64
Average Fare (CAD)	0.499	0.722	1.004	1.113	1.150

	1982	1987	1992	1997	2002
Operating Cost per Peak Bus (CAD)	99,248	146,184	204,007	206,284	231,795
Maintenance and Fuel Cost per Bus km (CAD)	0.47	0.64	0.89	0.97	1.03
Operator Cost per Platform Hour (CAD)	15.26	21.23	30.81	30.52	34.17
Ratio of Operator Cost per Platform Hour to Top Operator Pay Rate	1.42	1.51	1.71	1.65	1.64
Semi-fixed Cost per Platform Hr (CAD)	6.54	11.79	17.01	17.82	20.05
Ratio of Semi-fixed Cost to Total Operator Cost (per Platform Hour)	0.20	0.25	0.25	0.25	0.26
Traffic Accidents per Million Bus km	17.0	14.8	4.3	7.0	4.5
Traffic Accidents per Million Riders	2.11	3.58	3.31	5.09	2.62
Traffic Accidents per Operator (driver)	0.65	0.54	0.16	0.26	0.16

Note: Data and performance measures presented in the tables above are those compiled and published by OC Transpo. Headings have been reworded in a few cases for clarity.

OC Transpo Operating Data - Cumulative Totals, 1982-2002

	1982 - 2002
Revenue Hours	34,766,000
Total Operating Cost, 2002 CAD	3,438,790,000

Conversion Factors

Canadian Consumer Price Index (Statistics Canada):

Year	All Items (1992 = 100)
1982	65.3
1987	81.5
1992	100.0
1997	107.6
2002	119.0

2002 exchange rate (”annual average”): 1.57 CAD = 1.00 USD (Bank of Canada).

100 kilometres = 62 miles.

3.785 litres = 1 U.S. gallon.

The similarity between unit costs expressed as CAD per km and USD per mi in the tables above is coincidental. The 2002 “annual average” exchange rate of USD 0.64 per CAD fell very close to the conversion factor 0.62 miles per km.