

ENERGY FOR ROAD PASSENGER TRANSPORTATION - THE BUS SECTOR

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Abstract :- This paper examines the Energy demand for transportation in Sri Lanka and the Energy consumed in the provision of road based passenger transportation in particular. The bus sector which caters for over 80% of the passenger traffic in Sri Lanka is the subject of a detailed study. The publicly owned and the privately owned bus systems which together compose the bus sector are studied in terms of a time series analysis of Energy consumption in a decade of operations. On this basis, a fuel efficiency index is developed to assess the relative fuel efficiency of the two alternate modes provided for public road passenger transportation in the country.

INTRODUCTION

Road transportation is highly dependant on supplies of imported oil and this dependance is unlikely to be either easily or quickly altered.

In the transport Energy scene in Sri Lanka, it is the demand for petroleum which is used to provide the Energy required for moving vehicles, that we need to look at, in considering the Energy demand for transportation. Table 1 depicts the demand for transportation fuel and its major components, auto diesel and petrol in 1988.

At present, road and rail transportation account for around 50% of the total petroleum products sold in Sri Lanka, of which, road based transportation which alone consumes 95.95% of the demand for auto diesel is a major user of imported oil. In table 2, the demand for auto diesel in road based transportation is further disaggregated to isolate the bus sector as a user of this large component of transportation fuel.

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| | | Gallons in % Millions | |
|------------|----------------------------------------------------------------------------------------|--------------------------|--------|
| (a) Auto | <u>Road based</u> | | |
| | <u>Diesel</u> | | |
| | <u>Transportation</u> | | |
| | Predominantly diesel consuming vehicles; buses/coaches, lorries, tractors, diesel cars | 127.9 | 95.95 |
| | <u>Track based</u> | | |
| | <u>Transportation</u> | | |
| | Rail | 5.4 | 4.05 |
| Total | | 133.3 | 100.00 |
| (b) Petrol | <u>Petrol consuming vehicles</u> | | |
| | Motor coaches, cars, Motor cycles | 48.3 | |

Table 1 - Energy Demand for Transportation 1988

| | | Auto diesel in Gallons % | |
|-----------------------------------------|-------------------------------------------------|-----------------------------|-------|
| Predominantly diesel consuming vehicles | | | |
| Buses : | Transport Board and Privately operated vehicles | 51.04 | 39.9 |
| Others : | Coaches, lorries, tractors, private cars | 76.86 | 60.1 |
| Total | | 127.90 | 100.0 |

Table 2 - Energy Demand for Road based Transportation 1988

ENERGY DEMAND

The bus service in Sri Lanka is more than just a mode of transportation. It constitut-

Table 3 - FUEL DEMAND IN ROAD PASSENGER TRANSPORTATION-BUS SECTOR - SRI LANKA TRANSPORT BOARD (SLTB)

| Productivity measure | Item | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|----------------------|------------------------------------|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Input | Fleet | 7254 | 7531 | 7725 | 7453 | 7686 | 8005 | 7335 | 7212 | 7245 | 6996 |
| Input | Fuel Bill (Rs. million) | 258.4 | 558.1 | 809 | 806.6 | 907.04 | 944.74 | 881.46 | 864.24 | 855.08 | 785.81 |
| Input | Diesel Fuel consumed | | | | | | | | | | |
| Output | (million gallon) | 25.09 | 34.1 | 29.96 | 29.87 | 27.85 | 25.54 | 23.83 | 23.36 | 23.12 | 21.24 |
| Output | km operated (million) | 482 | 517 | 494 | 482 | 457 | 417 | 390 | 375 | 371 | 333 |
| Output | km per gallon | 19.21 | 15.2 | 16.49 | 16.14 | 16.41 | 16.34 | 16.36 | 16.1 | 16.1 | 15.7 |
| Output | km per Litre | 4.2 | 3.4 | 3.7 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 |
| Output | Passenger kilometres (million) | 22,186.0 | 23,701 | 18,481 | 18,721 | 16,885 | 15,964 | 15,249 | 15,149 | 15,974 | 15,413 |
| Energy Efficiency | Passenger/ km per gallon of diesel | 884.3 | 729.3 | 616.7 | 626.7 | 606.3 | 625.1 | 639.9 | 648.5 | 690.9 | 725.7 |
| - do - | Passenger/ km per Litre | 196.5 | 162.1 | 137.1 | 139.3 | 134.7 | 138.9 | 142.2 | 144.1 | 153.5 | 161.3 |

Energy Efficiency 1979 - 1988 : Average Passenger km per gallon of fuel consumed - 677.4
 Average Passenger km per litre of fuel consumed - 150.5

Source : SLTB

es. an essential part of the economic and social fabric of the nation. Buses cater to more than 80% of the total passenger traffic in Sri Lanka.

The bus sector which accounts for 40% of the total demand for auto diesel in road based transportation consists of publicly and privately owned bus systems. Data relating to the fuel demand of the publicly owned bus system operated by the Sri Lanka Transport Board (SLTB) is well documented. On the other hand, information relating to the operation of the privately owned bus system is very sparse and is available only in respect of the number of buses issued with route permits for operating regular passenger services. Parameters necessary for the assessment of the fuel demand of this system have therefore to be estimated in determining the relative fuel demand, there being a high correlation between the fuel demand and the kilometre operated.

ANALYSIS OF FUEL DEMAND 1989 - 1988

Publicly owned bus system - (SLTB)

1980 appears as the high water mark of SLTB's operations, its scale of operations having been 517 million km in that year. Thereafter, the scale of operations have steadily declined to reach 333 million km in 1988. The fuel demand of this sector can be assessed to have been around 34.1 million gallons of diesel in 1980 as shown in table 3. With the decrease in the scale of operations as described, the gallonage consumed can be estimated to have declined to around 21.2 million by 1988 (table 3). However, considering the more stable rate of consumption achieved during the period 1985 - 1988 at a little over 23 million gallons/annum, it may be safe to assume the fuel demand in 1990 to be around 23.5 million/gallons for a scale of operations of around 375 million km per year with a possible restoration of stability in the country (table 3).

Privately Owned Bus System (PB)

The fleet of the privately owned bus system has steadily increased from 4,234 buses in 1980 to a height of 14,391 by 1987 and thereafter, it has declined to 13,708 in 1988. This information is well documented. In estimating the parameters of operation of this fleet of vehicles, in order to assess the fuel demand relative to this system, its scale of operations

has been estimated in two different scenarios on the basis of the following assumptions.

Fleet Availability

Scenario 1 : Ranges from 70% in 1979 to around 65% in 1988.

The upper range is based on the Ameer Report (1982) which represents more or less the first attempt to estimate the operating indicators in respect of the private bus system. It records fleet availability at less than 75%. In the present estimation it is assumed that fleet availability could decline to around 65% on account of the ageing of the private bus fleet and the distortions in the operating environment due to the civil disturbances in the country, which affect the number of buses in operation in a given day.

Scenario 2 : Ranges from around 66% in 1979 to 80% in 1988.

The upper range is based on the findings of the Sri Lanka Transport Sector Planning Study (TSPS) 1986, Vol; 3, where bus availability is taken as 80% for the latter part of the time series which is considered somewhat optimistic.

Kilometre Operated per Vehicle per Day

Scenario 1 : 175 km in 1979 to 205 by 1988.

The estimation is based on the findings of the Ameer Report (1982) and TSPS (1986) Vol: 3.

Scenario 2 : 200 km in 1979 to 205 by 1988.

The km operated per vehicle per day is taken at around 205 km per day based on TSPS (1986) Vol: 3.

Number of Bus Days

Scenario 1 : 300 days per annum.

Scenario 2 : 365 days per annum.

This is based on TSPS (1986) Vol: 3 which is considered optimistic.

Vehicle Capacity

Scenario 1 : 23.4 in 1979 to 24 in 1988.

Table 4 - FUEL DEMAND IN ROAD PASSENGER TRANSPORTATION - (PRIVATE BUSES) SCENARIO 1

| Productivity Measure | Item | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|----------------------|----------------------------------------|--------|--------|--------|--------|--------|--------|--------|---------|--------|
| | | 1576 | 4234 | 6564 | 9001 | 9756 | 10316 | 11001 | 12896 | 14391 |
| Input | Fleet | | | | | | | | | |
| Input | Fuel Bill (Rs. million) | 26.40 | 118.56 | 339.56 | 465 | 607.80 | 703.18 | 716.87 | 840.27 | 937.74 |
| Input | Fuel Demand (million gallon) | 2.6 | 6.9 | 12.6 | 17.2 | 18.6 | 19.14 | 19.46 | 22.7 | 25.35 |
| Output | kilometre operated (million km/Gallon) | 57.9 | 155.6 | 282.6 | 387.5 | 419.9 | 431.4 | 439.8 | 515.5 | 575.3 |
| Output | km/Litre | 22.3 | 22.6 | 22.43 | 22.53 | 22.58 | 22.54 | 22.60 | 22.71 | 22.6 |
| Output | Passenger km (million) | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Energy Efficiency | Passenger km per gallon consumed | 1084.0 | 2912 | 6104 | 8370.2 | 9069.8 | 9215 | 9393.4 | 11001.5 | 11288 |
| - do - | Passenger/km per Litre consumed | 416.9 | 422 | 484.4 | 486.6 | 487.6 | 481.5 | 482.7 | 485.1 | 487.7 |
| | | 92.6 | 93.8 | 107.6 | 108.1 | 108.4 | 107.0 | 107.3 | 107.8 | 107.7 |

Energy Efficiency Measures - 1979 - 1989 : Average Passenger km per gallon of diesel consumed - 486.7
 Average Passenger km per Litre of diesel consumed - 108.2

Source : Transport Studies & Planning Centre

Table 5 - FUEL DEMAND IN ROAD PASSENGER TRANSPORTATION - (PRIVATE BUSES) SCENARIO 2

| Productivity Measure | Item | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | |
|----------------------|----------------------------------|------------------------------------------------------------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--|
| Input | Fleet [1] | 1576 | 4234 | 6564 | 9001 | 9756 | 10316 | 11001 | 12896 | 14391 | 13708 | |
| Input | Fuel Bill (Rs. million) | 28.73 | 128 | 387.6 | 543 | 900.8 | 1002.5 | 1072.5 | 1156 | 1154 | 1102 | |
| In Put | Fuel Demand (million gallons) | 2.8 | 7.5 | 14.4 | 19.8 | 27.6 | 27 | 28.9 | 31.3 | 31.2 | 29.8 | |
| Output | kilometre operated (million) | 63 | 168 | 323 | 445 | 623 | 617 | 658 | 709 | 708 | 676 | |
| Output | km/Gallon | 22.5 | 22.4 | 22.4 | 22.4 | 22.5 | 22.8 | 22.8 | 22.7 | 22.7 | 22.7 | |
| Output | km/Litre | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | |
| Out Put | Passenger[2] | 1,100 | 2,600 | 6,900 | 9,500 | 13,300 | 13,700 | 14,060 | 15,134 | 15,124 | 14,445 | |
| Energy Efficiency | Passenger/km per gallon consumed | 393.8 | 346.7 | 479.2 | 479.8 | 481.9 | 507.4 | 486.5 | 483.5 | 484.7 | 484.7 | |
| - do - | Passenger/km per Litre consumed | 87.5 | 77 | 106.5 | 106.6 | 106.7 | 112.8 | 108.1 | 107.4 | 107.7 | 107.7 | |
| Energy Efficiency | 1979 - 1988 | Average Passenger km per Gallon of diesel consumed - 480.5 | | | | | | | | | | |
| | | Average Passenger km per Litre of diesel consumed - 106.8 | | | | | | | | | | |

Source : [1] Transport Studies & Planning Centre

[2] 1979 - 1985 : Transport Statistics, Sri Lanka (1988), Transport Studies & Planning Centre

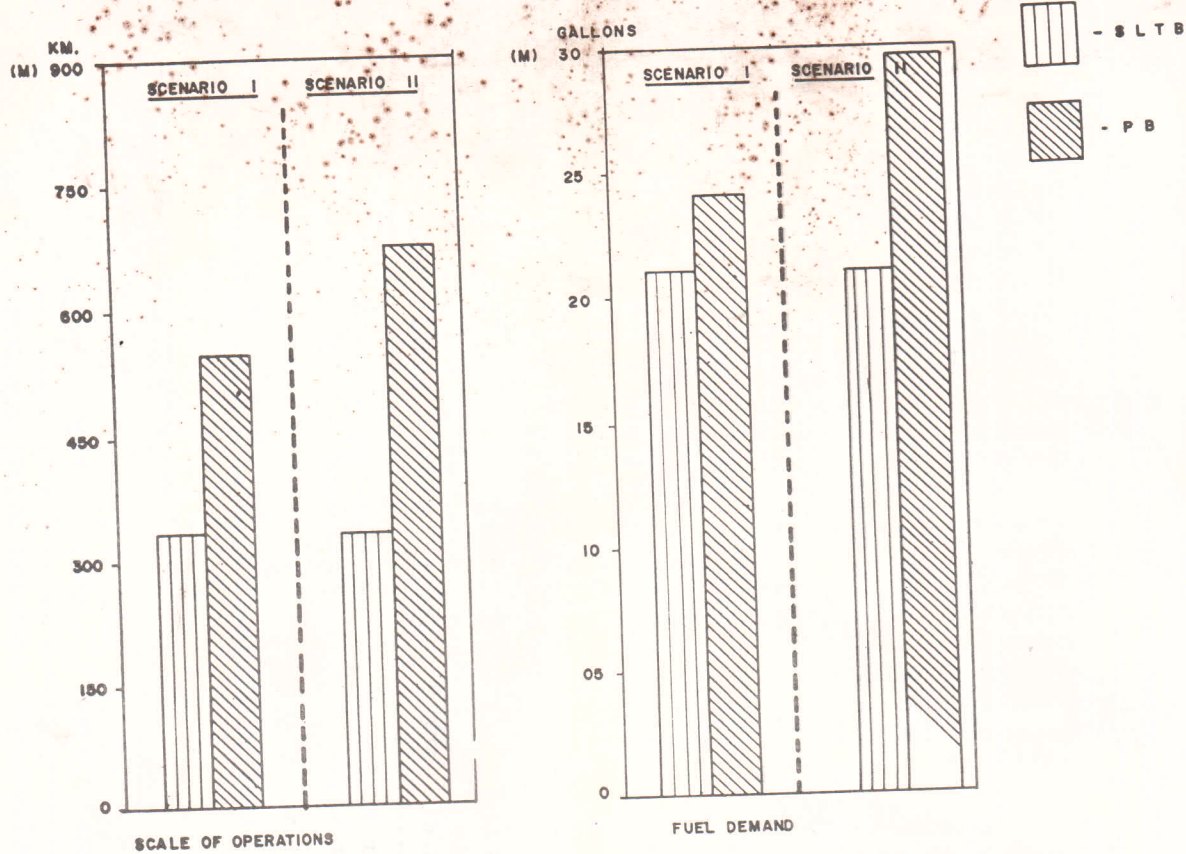
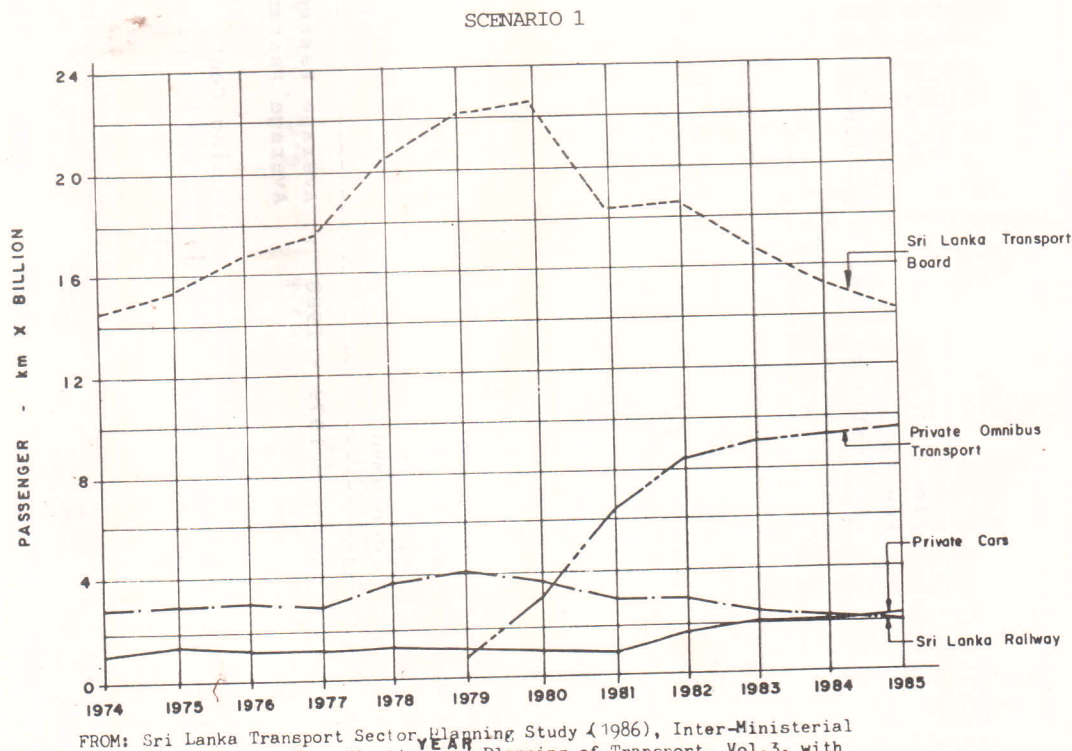


Fig 1 - Bus Sector
Scale of Operations and Fuel Demand - 1988



FROM: Sri Lanka Transport Sector Planning Study (1986), Inter-Ministerial Committee for Co-ordination and Planning of Transport, Vol.3, with re-estimate of passenger km, private Omnibus transport.

Fig 2 - Bus, Rail and Car Travel Passenger km (1974 - 1985)

SOURCE: PRIVATE OMNIBUS TRANSPORT: DOT AND CONSULTANTS ESTIMATES.
 OTHER: DERIVED FROM GOVERNMENT STATISTICS AND ESTIMATES.
 FROM: Sri Lanka Transport Sector Planning Study (1986),
 Inter-Ministerial Committee for Co-ordination and
 Planning of Transport, Vol. 3.

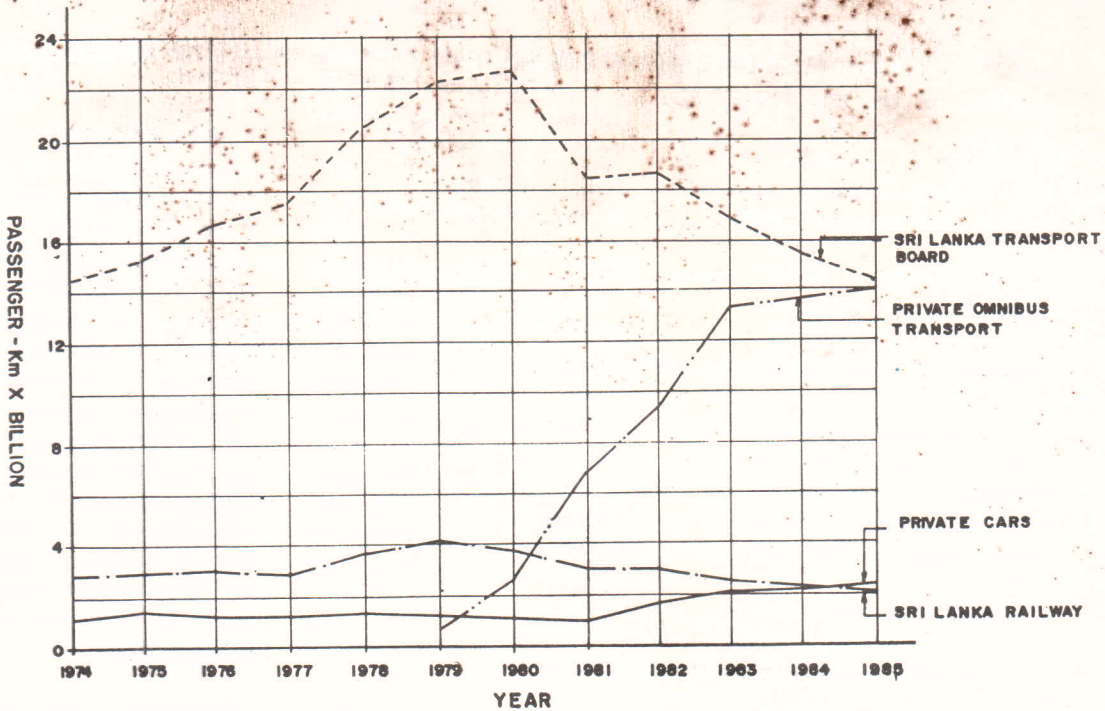


Fig 3- Bus, Rail and Car Travel Passenger km (1974 - 1985)

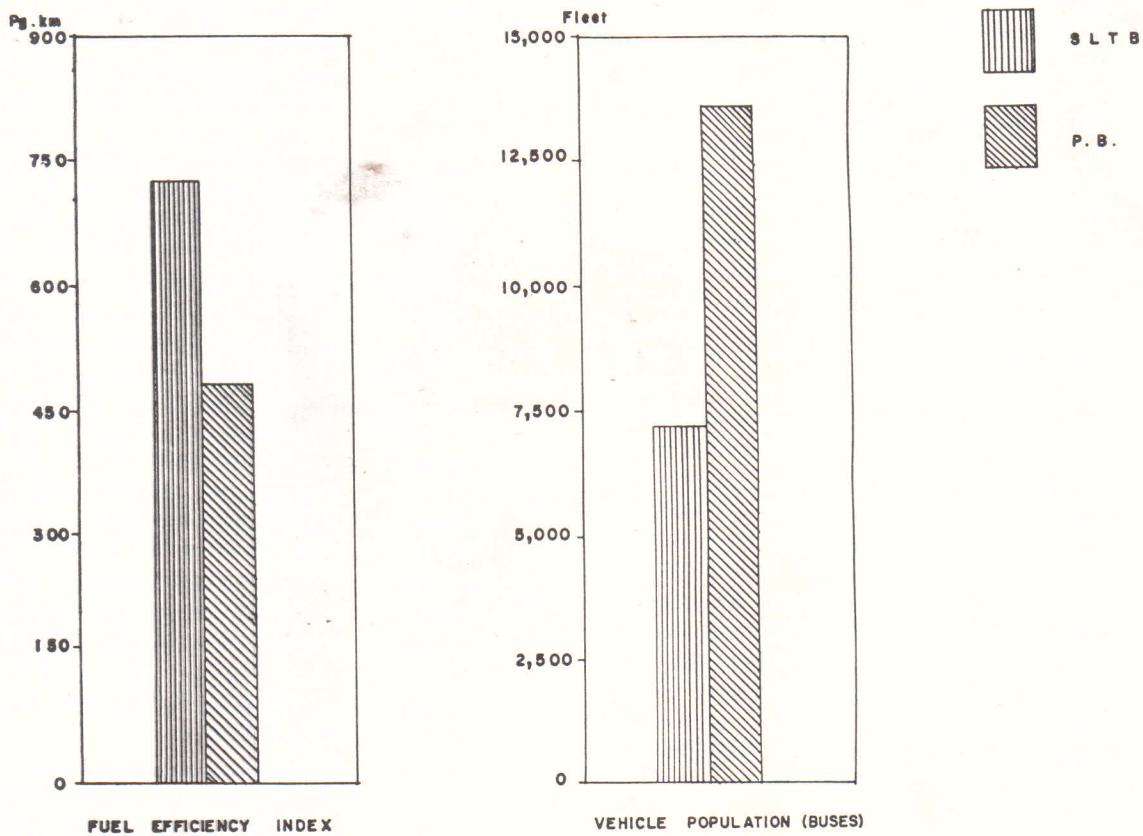


Fig 4 - Bus Sector
 Fuel Efficiency Index and Vehicle Population (Buses)
 1988

This assumption is based on the Ameer Report (1982) and the TSPS (1986) Vol: 3.

Scenario 2 : 24 seats

Average capacity is assumed to be 24 seats from 1981 onwards on the basis of TSPS (1986) Vol: 3.

Load Factor

Scenario 1 : 80% in 1979 to 89% in 1988.

The load factor which represents the percentage utilized of the capacity provided, has been deemed to range from 80% in 1979 to 89% in 1988. The assumption is based on the findings of the Ameer Report (1982) and TSPS (1986) Vol: 3.

Scenario 2 : 89%

This is based on TSPS (1986) Vol: 3.

Scale of Operations and Fuel Demand

Scenario 1

The scale of operations of the privately owned bus system is seen to have steadily increased from around 57.9 million km in 1979 to an estimated 575.3 million km by 1987 and thereafter suffered a slight decline to an estimated 548 million km in 1989 as shown in table 2. The fuel demand for this scale of operation is estimated to have ranged from 2.6 million gallons in 1979 to 25.35 million gallons by 1988. In the year 1990 a fuel demand of 24.25 million gallons of diesoline could be a likely consumption level (Table 4).

Scenario 2

In scenario 2, the scale of operations of the privately owned bus system is seen to have risen from around 63 million in 1979 to an estimated 708 million km by 1987 and declined to 676 million in 1989 as shown in table 5.

The fuel demand for this scale of operations could be estimated to have ranged from around 2.8 million gallons in 1979 to 30 million gallons by 1988. For the year, 1990 the fuel demand of around 31.3 million gallons of diesoline could be the likely consumption level in anticipation of a restoration of stability in the country. (table 5).

The scale of operations and the comparative Energy demand of the publicly owned (SLTB) and

privately owned (PB) bus system in 1988 are depicted in figure 1.

FUEL EFFICIENCY

The volume of passenger km catered per gallon of diesoline consumed, may be taken as an acceptable measure of fuel efficiency. Passenger km represents the traffic volume carried per gallon of fuel consumed. Based on this measure, the publicly owned buses are seen to be the more fuel efficient system, in averaging a volume of 677.4 million passenger km per gallon of fuel, compared with the estimate for the privately owned bus system. Even in scenario 2, which would be seen to be the more optimistic estimation, the privately owned bus system averages only 480.5 passenger km per gallon of diesoline consumed. Its efficiency level is therefore about 30% - 40% less than that of the publicly owned system (SLTB). (See figures 2 and 3.)

The fuel efficiency index developed for 1988 is shown in figure 4. In the present context in which the SLTB and the private sector (PB) together provide over 80% of the nation's road passenger transportation needs and assuming a continuation of this policy in the future too, it is appropriate to recognise the inherent opportunities for conservation of Energy in the policies applied to the provision of transportation facilities.



Mrs. M.J. Sahabandu is a graduate of the University of Peradeniya, Sri Lanka and obtained her MSc in Transport from the Imperial College of Science and Technology, U.K. in 1982. She joined the Ceylon Transport Board in 1967 and was the Planning Officer and Deputy Secretary to the Board prior to assuming her current position as Manager, Planning and Research and Head of the Division of Planning and Research in the Sri Lanka Central Transport Board. A British Council Scholar, she is a visiting lecturer and an External Examiner of the University of Moratuwa, Sri Lanka. She is the Vice Chairman of the Chartered Institute of Transport, Sri Lanka section.

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