DEVELOPMENT OF A PUBLIC TRANSPORT COST MODEL

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INTRODUCTION

The Durban Metropolitan Council, in cooperation with the National Department of Transport and the Kwa-Zulu Natal Department of Transport has embarked on a project to restructure Durban's Public Transport System (Department of Transport, 1999).

This project has nine tasks in all. These include the collection of origin-destination for all existing public transport users, stated and revealed preference studies for the existing and proposed public transport modes, the identification of a high priority public transport network consisting of key nodes and corridors and the development of a public transport network based on least cost and acceptable levels of service.

This paper deals with the work done for Task 2 of this project, referred to as "Public Transport Mode Assessment Study for Durban" (Department of Transport, 1999). This task served to produce a base set of costs whereby the cost of public transport strategies, proposals and scenarios could be estimated and compared.

The paper contains:

- A set of references from the Moving South Africa that provided guidance in respect of the components to be considered in the project.
- A brief description of the Fundamental Restructuring Project requirements and current National initiatives that give further direction to the Mode Assessment task.
- A description of the components that make up the cost of a public transport service and how these are structured.
- A description of the studies done to gather the input into the costing model.
- The structure of the public transport cost model and the assumptions made in developing the costs of the public transport scenarios.
- A discussion of the impact of different vehicle types, passenger volume, route distance and service frequency on the comparative cost of the different public transport scenarios.
- A set of conclusions.

MOVING SOUTH AFRICA

Moving South Africa (1999) includes the following comments on urban passenger transport strategies relevant to the achievement of its vision by 2020:

- "*The core of the public transport system will be a network of high volume high frequency corridors in which public transport will be given priority*".
- "*…. public transport provision must be planned and regulated at the local level, with local control over stable funding sources for both operation and infrastructure, detailed research into*

local customer needs and close cooperation with local land use planning and other relevant local function".

- *"…. where they do not undermine the volumes required for a sustainable optimal mode in a corridor, alternative services will be priced significantly higher*" to differentiate services.
- "*Creating corridors and focusing investment and resources on them is the key component of the urban passenger strategy since dispersed land use is the biggest driver of poor public transport performance*".
- *"…. is based on the premise that government, operators and customers can do more to improve productivity*".
- "*…. in the medium to long term, sustainability across all modes should be greatly enhanced by the move to a corridor based system with optimized modal deployment and improved utilization level*".

From these few comments it would appear that the government intends to:

- Ensure that an appropriate level of public transport service is offered in the urban areas.
- This service will be structured on a network of corridors.
- To reduce cost/passenger, densification will occur along these corridors.
- Modes, other than the optimum mode, will only be permitted if these do not make the cost/passenger unsustainable.

As such it is essential that an understanding be developed of the costs of delivering public transport services and how the costs of the different modes are affected by passenger volume, distance and service quality.

FUNDAMENTAL RESTRUCTURING PROJECT REQUIREMENTS AND CURRENT NATIONAL INITIATIVES

The Fundamental Restructuring Project, as the name implies, involves fundamental restructuring and rationalising of the public transport system in Durban. It is therefore more than likely that some of the recommendations of the Project could be controversial for some of the stakeholders. A fundamental requirement therefore of the economic mode assessment model was that it be as accurate, realistic and robust as possible to be able to stand up under scrutiny. This meant that not only must the existing modes be examined and modeled realistically, but also that mode alternatives that are currently not used in operations in Durban, such as light rail transit and bi-articulated bus be included in the model**.**

Furthermore, the model must include scenarios which are likely to be realised in the implementation stages of the Project. This means that the cost implications of the current recapitilisation of the minibus taxi industry initiative of the National DOT and rail concessioning had to be assessed and included.

PUBLIC TRANSPORT COSTS

The cost of public transport services includes capital and operating cost components.

In the case of capital costs, these are annualized by considering the analysis period, life of the investment, the ruling interest rate and the residual value of the investment at the end of analysis period. It might also be appropriate to take account of:

- The opportunity cost saved by delaying investments

- The impact of differential inflation between South Africa and countries from which public transport components are to be acquired in the future.

The following capital costs can be included in estimating the cost public transport services:

- The cost of the vehicle; including the cost of one or more refurbishments/overhauls during it's life or the analysis period.
- The cost of the way; which would include railways and roadways (more specifically high occupancy vehicle lanes (HOV) lanes).
- The cost of terminals, bus termini and minibus ranking facilities at the beginning and end of routes.
- The cost of stations and stops
- The cost of depots, where vehicles can be stored, maintained and/or overhauled.

The operating costs can include:

- The cost of energy or fuel
- The operating costs of the vehicles which include operating staff costs, management costs, offices rentals, insurance, overheads, licenses, marketing, vehicle maintenance, etc. These costs can be apportioned as either cost/vehicle-km or cost/vehicle/year or both.
- The annual operating, staff and maintenance costs of the railway and roadway.
- The annual operating, staff and maintenance costs of termini, ranks, stations and stops. (It is possible that income can be derived at these from rentals from shops and offices.)
- The annual operating cost of the depot. (In the study it was not possible to obtain separate values for this cost; and instead were included as part of the vehicle operating cost.)

DATA COLLECTION

The data collected for the study is discussed for each mode separately.

Train

The capital costs for the train were obtained from the report on the major refurbishment of the existing 5M to 10M (SARCC, 1998) and from the tenders received for the supply of 9M trains (Potgieter, 1999). Costs for track and stations were derived from the Inanda Study (De Leuw Cather et al, 1998). Costs for depots were derived from the MSc thesis by Simmer (1997). Operating costs for 5M and 10M trains were derived from an apportionment of the 1998/99 Metrorail budget for the Durban region to which were added major overhaul costs obtained from SARCC (revised to meet overhaul frequencies proposed by SARCC (1998)) and the cost of energy. Staffing and overhead costs were revised to approximate costs applicable to operations under concessioning. Operating costs for the proposed 9M trains were derived from costs for the 8M trains operating in Cape Town .The operating costs were apportioned to cost/vehicle-km, cost/vehicle/year, cost/track km/year and cost/station/ year. Train operating speeds and acceleration/deceleration rates were derived from schedules and from information supplied by SARCC.

Light Rail Transit (LRT)

Data for LRT could only be obtained from one source. The fact that new track, a new depot and a new control centre (estimated at R50 million) would be required, and that the vehicles are relatively expensive (at least with respect to capacity) produced one-way travel costs that were almost an order of magnitude higher than the costs of other modes. It is possible that competitive bidding could bring the price down. But it is doubted whether this would be sufficient to make the mode competitive on cost.

Bus

The capital cost for standard buses were obtained from published prices and interviews with bus company representatives. The cost for the 35-seater midibus, as estimated by Government in its recapitalisation project was increased by 30 % on the basis of discussions with the industry. (Current rumours of the tender prices that were received suggest that this was a reasonable assumption). The costs for the articulated and bi-articulated buses were based on local chassis costs and others received from Volvo in Brazil (Arrivabene,1999) and body costs in South Africa. The capital cost for HOV lanes were developed for the study. Lane capacity was estimated at 300 standard buses/hour/lane (based on 7 second headway and 60% green/cycle ratio). Terminal costs were based on the costs of planned minibus ranks and literature on bus bay/peak hour bus ratio (DOT,1981). The cost of bus stops was considered to either be too small to be included in the costs if located along existing roads or included in the cost of HOV lanes if located along them. Depot costs were again based on the work done by Simmer (1997).

Operating costs were obtained from 3 bus companies. The costs were rationalised to take into account the changes in overheads and staffing costs that can be expected from operating under tender conditions. These costs were apportioned among cost/bus-km and cost/bus/year. Vehicle operating speeds and acceleration rates were obtained from an analysis of tachographs for 720 km of travel by Durban Transport buses in and out of peak, on and off freeways and in different parts of the city.

Minibus

It was assumed that legislation would preclude the continued operation of the existing form of minibuses; being replaced by those intended through the Government's recapitalisation programme. The capital costs estimated by Government appeared reasonable and were adopted. Minibus operating speeds and acceleration and deceleration rates were derived from following minibus taxis over 69 km. Further information on operating costs was obtained from interviews with six minibus operators and augmented by earlier studies (Pather,1996). The costs of the HOV facility came from the study done as mentioned earlier. The lane capacity was based on a short study indicating a headway of 3 seconds. Using a green/cycle ratio of 60 % this would result in a lane capacity of 700 minibuses/hr. Taxi rank costs are based on a survey of four ranks planned in Durban recently. The cost of stops was handled in the same way as for buses. No depot costs were applied in the mode as it was assumed that vehicles would be stored on the properties of drivers/operators. The operating costs were obtained from a comparison between existing practice and the values given in the recapitalisation project. The operating costs used in estimates for the recapitalisation programme were increased to allow for the minibus services to be run by a company/cooperative and management costs were added.

The cost components are summarised in Table 1.

TABLE 1: SUMMARY OF THE COSTS OF PUBLIC TRANSPORT COMPONENTS

	11-coach up 5M	11-coach 10M	5-coach up 5M	12-coach 9M	3-coach LRT	Midibus	Standard bus	Articulated bus	Minibus
Travel speed CBD/Commercial in peak (km/h)	40	40	40	40	25	25	25	25	25
Travel speed Arterial in peak (km/h)	45	45	45	45	45	45	45	45	50
Travel speed Freeway in peak (km/h)	50	50	50	50	50	50	50	50	70
Travel speed Residential in peak (km/h)	55	55	55	55	30	30	30	30	60
Travel speed CBD/Commercial off-peak (km/h)	40	40	40	40	25	25	25	25	25
Travel speed Arterial off-peak (km/h)	45	45	45	45	45	50	50	50	50
Travel speed Freeway off-peak(km/h)	50	50	50	50	50	50	50	50	80
Travel speed Residential off-peak (km/h)	55	55	55	55	30	30	30	30	60
Vehicle capacity (standing allowed)	2085	2085	921	3050	660	35	90	170	18
Vehicle capacity (standing is not allowed)	1390	1390	614	2030	510	35	65	105	18
Vehicle capacity	2085	2085	921	3050	510	35	65	105	18
Passenger handling time(sec/passenger)	0	0	0	0	0	8.5	8.5	8.5	21
Vehicle Stopped Time/stop (sec)	20	20	20	20	20	0	0	0	0
Time spent to turn vehicle(min)	8	8	6	9	3.5	1	1	1	0
Cost per vehicle or train(Rm)	7.84	15.68	3.53	78	36	0.22	0.6	1.05	0.106
Cost of refurbishment/vehcle/train(Rm)	7.86	7.86	3.77	10	7.2	0	0.15	0.0273	0
Time to refurbishment(years)	7	7	7	12	7.5	7	10	6	5
Life after refurbishment(years)	7	7	7	12	7.5	0	8	6	0
Number of refurbishments per vehicle	2	2	2	3	3	0	1	2	0
Residual Value (%)	10	10	10	10	10	15	15	15	15
Capacity per lane (Veh/h)	20	20	20	20	50	500	300	250	600
Cost of way (Rm/lane-km)	6.5	0	0	0	9.75	1.045	1.045	1.045	1.045
Life of way(years)	40	40	40	40	30	20	20	20	20
Cost land(R/km/lane) CBD/Commercial	0.875	0	0	0	0.875	0.875	0.875	0.875	0.875
Cost land(R/km/lane) Inner section	0.23	0	0	0	0.23	0.23	0.23	0.23	0.23
Cost land(R/km/lane) Outer section	0.23	0	0	0	0.23	0.23	0.23	0.23	0.23
Cost land(R/km/lane) Residential	0.105	0	0	0	0.105	0.105	0.105	0.105	0.105
Cost of Terminal(Rm/10000 peak hour pass.)	2.025	0	0	0	0.67	0	0	0	0
Cost of Terminals(Rm/peak hour vehicle)						0.0545	0.1170	0.2300	.0090
Minimum cost of station/stop(Rm)	0	0	0	0	0	0	0	0	1
Life of terminals(years)	30	30	30	30	30	30	30	30	20
Cost of stops(Rm/stop)	4.89	0	0	0	1.62	0	0	0	0
Life of stops(years)	30	30	30	30	30	10	10	10	10
Cost of depot	6.6	0	0	0	80	43	118	182	0
Life of depot(years)	30	30	30	30	20	30	30	30	20
OPERATING COSTS									
Energy consumption(Mjoules/veh.km)	87.1	77.4	42.7	123.2	118.8	0	0	0	0
Fuel Consumption(l/100km)	0	0	0	0	0	22	40	67	14
Cost of energy(R/Mjoule) (peak)	0.042	0.042	0.042	0.042	0.042	0	0	0	0
Cost of energy(R/Mjoule) (off-peak)	0.055	0.055	0.055	0.055	0.055	0	0	0	0
(Other)Cost/veh.km(R/vehicle.km)	9.61	9.61	7.95	11	24.63	0.63	1.35	2.2	0.042
Cost/vehicle/year(R/vehicle/year)	1.11	1.11	0.91	1.24	4.065	0.078	0.138	0.201	0.062
Cost/lane.km/annum(R/lane.km/year)	0.06	0.06	0.06	0.06	0	0.046	0.046	0.046	0.046
Cost/terminal/annum (Rm)	0.67	0.67	0.67	0.67	0	0	0	0	0
Cost/station or stop/annum (Rm)	0.67	0.67	0.67	0.67	0	0	0	0	0

STRUCTURE OF THE MODEL

Figure 1 shows the structure of the spreadsheet model.

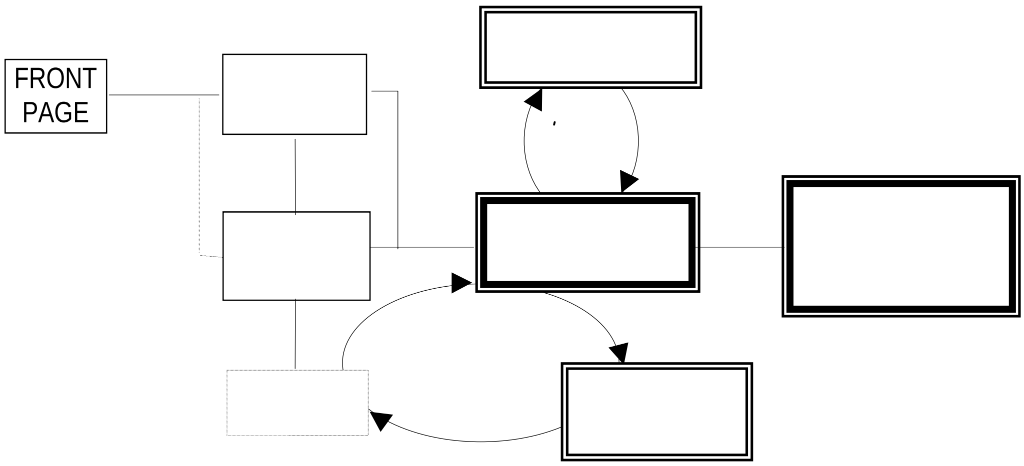

FIGURE 1: STRUCTURE OF THE MODEL

From this it can be seen that it has six major modules; namely:

- The situation sheet in which the description of the service to be provided is input in terms of parameters such as number of people to be served, peaking distribution, length of route, minimum service frequency and the economic parameters.
- The set of sheets that contain the information on each public transport scenario; such as speed and acceleration rates, vehicle capacity, lane capacity, capital costs of the components, operating costs and energy and fuel consumption.
- The calculation sheet, the engine room of the model, in which the cost is calculated for the public transport service for 20 different public transport scenarios. The total cost is calculated as the sum of the annualised cost of all the capital costs and the annual operating costs . This information is converted into cost/one-way trip, cost per space offered and cost/pass-km. The model also calculates the amount of energy/fuel used and the one-way travel time.
- The summary sheet fits all the salient inputs and outputs of the calculation sheet onto one page, for easy comparison between modes.
- The sensitivity sheet can be used to determine the effect of changes in the values of seven input parameters on seven output parameters; (e.g. the effect on the cost/one-way trip of increasing the capital cost by 20%).
- The context sheet calculates the cost per one-way trip over a range of daily and peak hour one-way passenger volumes. The output is also shown graphically.

ASSUMPTIONS MADE IN THE APPLICATION OF THE MODEL

Any model is a simplification of the real world. Furthermore, certain operating changes are expected to occur as public transport is restructured. A number of assumptions had to be made to simplify the model and to reflect the anticipated changes in public transport operating environment. These included the following:

- Since it is unlikely that significant new rail track would be constructed, no capital cost needs to be allocated for train infrastructure; track, stations and depots. .
- On the other hand, it was assumed that for high volumes of road-based vehicles, an HOV would be needed. This would require construction and traffic management equipment and even land acquisition. It was assumed that no cost would be included if the road vehicle volume was less than ¼ of lane capacity, the cost of 1 lane would be included if the vehicle volume was between

¼ and ½ of lane capacity, the cost of 2 lanes would be included if the volume was between ½ and 1 lane capacity. It was also considered that it would be inappropriate to have road based corridors with more than one lane in the peak direction. As such it would be more appropriate for corridors where demand exceeds one-lane of road-based vehicle capacity (i.e. more than 27 000 one-way passenger trips in the peak hour) to be served by trains.

- The 5M2a fleet needs to be upgraded. As such it cannot be considered as one to the train modes.
- Since the upgrading of the 5M2a train fleet to 10M would take 20 years it can be assumed that the average of the costs of the two train types should be used for vehicle capital and operating costs.
- Trains would be operating under concessioning. This would reduce the cost of staff and overhead costs. (The assumptions produced a saving in one-way trip cost of the order of 7%).
- Buses would be operating under tender conditions, As such overhead and staff costs presently found in municipal, para-statal and even large bus undertakings would be reduced.
- Minibuses and (midibuses operated by former minibus taxi operators) would be required to operate as a company or co-operative; as such a management cost would be incurred and driver salaries would become closer to those of the formal transport industry.
- The model takes the capital costs into account as "interest and redemption"; i.e. the model assumes that funds are borrowed to fund an investment and then paid back at the ruling interest rate over the life of the investment. The inclusion of both "interest and redemption" and "depreciation" is considered to be double counting in the case of the cost model, even though it might be an allowable deduction (not cost) for tax purposes.
- The study also examined alternative financing arrangements which could reduce the cost of capital investments. These seemed to always be related to maximising the tax deductions in either one or more countries. While this might provide an operator with a competitive edge over another, in the situation where subsidies are paid to transport operators, the saving in tax is negated by the loss in revenue to fund the subsidy.
- A minimum service frequency of two vehicles in each hour of the three-hour peak period and one vehicle in the remainder of the day. (The model can estimate costs for other minimum vehicle frequencies.)
- Public transport services would be provided over a 17-hour day (as provided by the train services at present) rather that the 14-hour day (as provided by bus services at present).
- Standing is acceptable for an in-vehicle time of less than 30 minutes. This means that for distances longer than (some value between 20 and 30 km) the capacity of vehicles is significantly reduced.
- The model only studies a corridor and not a network. Some marginal cost savings can be achieved by network operation rather than corridor operation. These savings would be related mainly to the off-peak operational costs; since the peak hour defines the capital expenditure and the peak period defines the operating patterns along corridors along which services are provided.

APPLICATION OF THE MODEL

The model can be applied to determine the cost of a providing public transport service for a range of public transport modes. This can be used to test a number of policies and concepts. In this paper, five policies will be considered:

- The concept of the optimum mode, in terms of cost
- The effect of densification on affordability
- The effect of travel distance on affordability
- The potential for parallel public transport services
- The impact of improving service frequency on cost and optimum mode

Optimum mode

Moving South Africa refers to the "optimum" mode. There are many possible criteria that can be used to define "optimum" but cost is probably the most important. The other is whether the mode has the capacity to cope with the passengers along the corridor. This study can provide the required input to determine the cost of modes. Cost in this case is considered as the cost/one-way trip. When comparing modes in search of the optimum mode, three aspects affect their cost; namely passenger volume, distance and quality of service (e.g. minimum vehicle frequency).

The effect of passenger volume on cost

Table 2 shows the cost/one-way trip for a range of daily one-way passenger trips between 1000 and 100 000 for 8 mode scenarios; namely 11-coach upgraded 5M, 11-coach 10M, 5-coach upgraded 5M, 12-coach 9M; midibus, standard bus, articulated bus and minibus. In terms of cost, a mode can be considered as "optimum" if it is the lowest cost mode or its cost is within 20% of that of the lowest cost mode.

TABLE 2: COST FOR ONE-WAY 20KM

	?M/11	10M/11	?M/5	9M/12	Recap35R	Std B	Artic	Recap18R
1000	52.05	60.91	36.07	84.46	**3.72**	**4.14**	5.78	**3.93**
2000	26.03	30.46	18.03	42.23	**3.60**	**3.63**	5.09	**3.58**
5000	10.41	12.18	7.21	16.89	**3.53**	**3.57**	4.45	**3.31**
10000	5.21	6.09	4.77	8.45	**3.51**	**3.57**	4.36	**3.79**
12000	4.34	5.08	3.98	7.04	**3.51**	**3.51**	4.31	**3.65**
14000	**3.72**	4.35	4.22	6.03	**3.51**	**3.52**	4.40	**3.56**
16000	**3.92**	4.66	**3.70**	5.28	**3.87**	**3.51**	4.36	**3.49**
18000	**3.49**	4.14	**3.62**	4.69	**3.81**	**3.83**	4.33	**3.44**
20000	**3.14**	**3.73**	**3.56**	4.22	3.78	**3.79**	4.36	**3.76**
40000	**2.64**	3.24	**2.87**	3.68	3.77	**3.78**	4.43	3.58
60000	**2.49**	3.08	**2.74**	3.17	3.66	3.66	4.47	3.52
80000	**2.16**	2.68	2.65	3.18	3.69	3.69	4.42	3.49
100000	**2.17**	2.71	**2.56**	2.98	3.70	3.63	4.45	3.48

From this table it can be seen that for a trip length of 20 km and for a minimum service frequency of two vehicles in each of the three peak hours and one vehicle/hour for the remainder of the day:

- Road-based modes are less costly than rail-based modes for low volumes. This is to be expected in view of the need for greater passenger volumes by the rail based modes to achieve economies of scale.
- It is also obvious that above the 1000 one-way passengers/day the cost/one-way trip for road-based modes is fairly constant indicating that the economies of scale have been reached
- Rail becomes optimum above 10 000 one-way passengers/day and road-based modes cease to be optimum above 20 000 one-way passengers/day.
- It is also obvious that the 9M train is not an optimum mode regardless of passenger volume. A policy decision will need to be taken in respect of the upgrading of the train fleet in South Africa beyond simply refurbishing the 5M to 10M standards, since these upgraded trains cannot be expected to last forever. So while the 9M is never less expensive than the upgraded 5M train it is within 10% of the lowest cost road mode or less expensive above 40 000 one-way passengers/day. It might be advantageous for the transport authorities to develop a long term replacement policy and begin to introduce the 9m train on those routes where it is most cost competitive.
- Also shown in the table are the proposed upper capacity limits to road based vehicles.

Effect of distance

One would expect that the effect of distance on cost would be linear. However at between 20 and 30 km the passenger capacity of vehicles that permit standing are reduced since one of the quality of service standards assumed in the model is that standing will not be permitted for in-vehicle times longer than 30 minutes. This affects each mode differently; e.g. minibus and midibus capacity is unaltered, bus capacity reduces from 90m to 65 and the 11-coach 10M train reduces from 2085 to 1390 passengers. As such the point at which trains become relatively less costly than road-based vehicles increases to about 40 000 one-way passengers/day. This is shown graphically in Figure 2a.

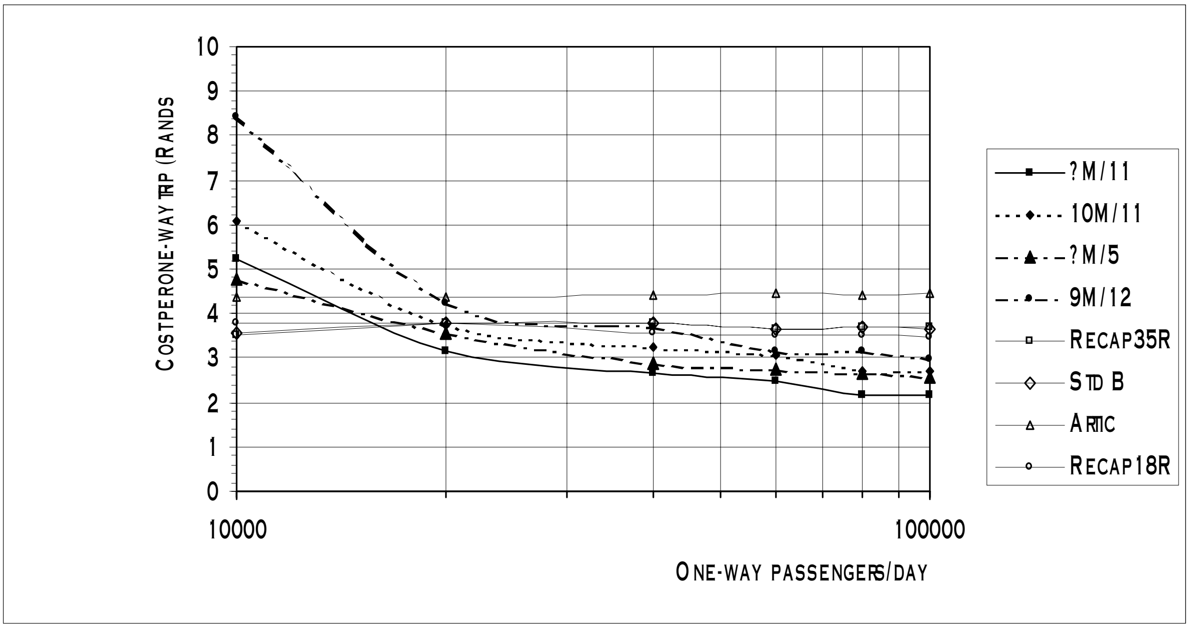

FIGURE 2A: COST/ONE-WAY TRIP FOR 20KM TRIP

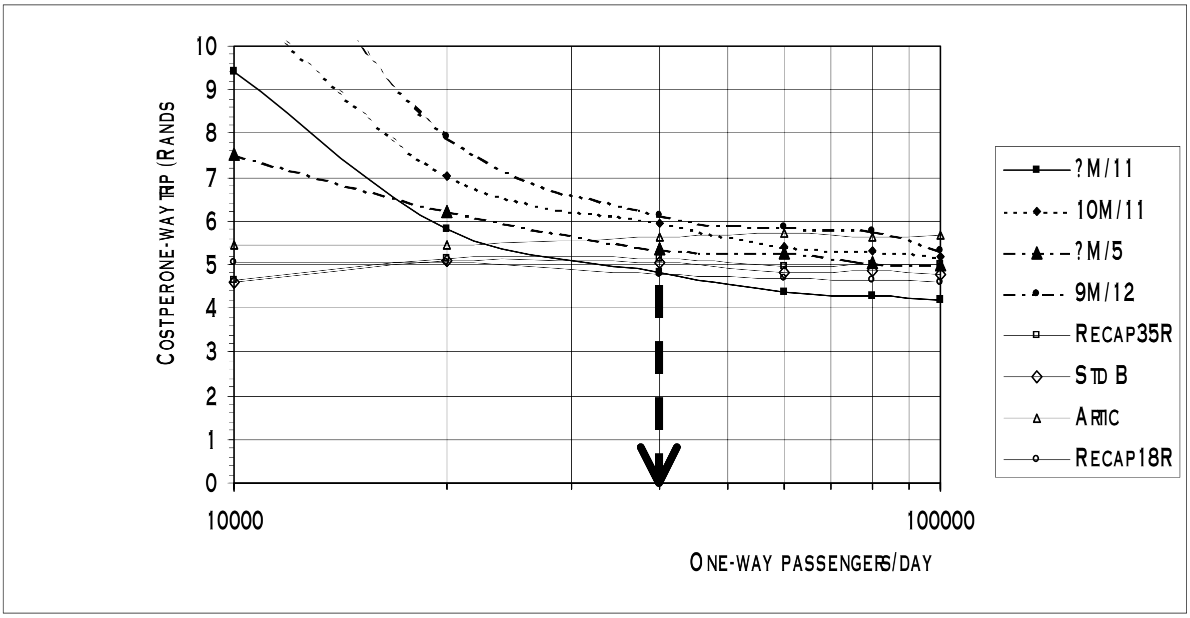

FIGURE 2B: COST/ONE-WAY TRIP FOR 30KM TRIP

Effect of distance and volume on affordability

Figure 3 shows the cost per one-way trip for three sets of one-way passenger volume/day for train and bus.

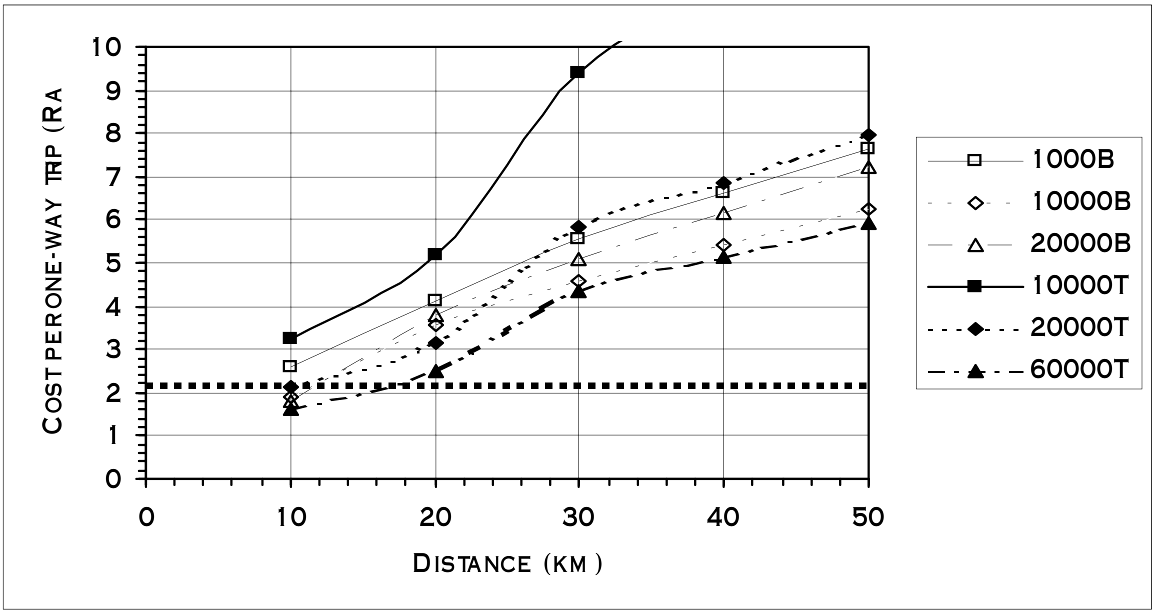

FIGURE 3: EFFECT OF DISTANCE ON AFFORDABILITY

From this figure the following can be seen:

- The higher the volume the lower the cost
- The change in linearity in the range 20 – 30 km
- If one assumes a monthly income of R1000, then the affordable cost without subsidy would be 12 km for corridors carrying at least 10 000 passengers/day

- The longest distance that could be affordable if passengers exceeded 60 000 one-way passengers/day would be 16km

This has implications on the densification policy of Moving South Africa. While it is acknowledged that the settlement policies of the past have created very dispersed cities in South Africa, densification has a limited role to play. Greater efforts should be made to develop an urban system where distances travelled are reduced.

Frequency of service

The third factor affecting the relative cost of public transport modes is the specified minimum vehicle frequency. The effect of this is felt mainly at lower volumes for the larger vehicles. Table 3 shows the ratio of the cost/one-way trip for a minimum frequency of three vehicles in each of the peak three hours and two vehicles in the other hours of the day to the cost/one-way trip for a minimum frequency is two vehicles in each of the peak three hours and one vehicle in the other hours of the day. The volume ranges where the mode is not operating in an optimum volume environment are shown in smaller font to highlight the relevant operating environments where the cost has increased significantly.

TABLE 3: EFFECT OF FREQUENCY ON ONE-WAY TRIP COST

20 km	11-coach	5-coach	Midi	Std A	Artic	Bi-artic	Mini
1000	1.48	1.40	1.07	1.14	1.34	1.51	1.00
5000	1.48	1.40	1.00	1.00	1.02	1.05	1.00
10000	1.48	1.18	1.00	1.00	1.00	1.00	1.00
20000	1.23	1.04	1.00	1.00	1.00	1.00	1.00
40000	1.04	1.01	1.00	1.00	1.00	1.00	1.00
60000	1.02	1.00	1.00	1.00	1.00	1.00	1.00
100000	1.01	1.00	1.00	1.00	1.00	1.00	1.00
30 km							
1000	1.33	1.31	1.09	1.24	1.32	1.59	1.01
5000	1.33	1.18	1.00	1.00	1.02	1.07	1.00
10000	1.18	1.06	1.00	1.00	1.00	1.00	1.00
20000	1.14	1.03	1.00	1.00	1.00	1.00	1.00
40000	1.03	1.00	1.00	1.00	1.00	1.00	1.00
60000	1.01	1.00	1.00	1.00	1.00	1.00	1.00
100000	1.00	1.00	1.00	1.00	1.00	1.00	1.00

CONCLUSIONS

The following conclusions can be drawn from the paper:

- It is possible to determine the optimum mode for a specific route or corridor; as based on cost.
- It is also possible to determine whether permitting competing modes would adversely affect the cost of the "Optimum" mode.
- There is a practical limit to the corridor capacities of road-based public transport modes. However most corridors in South African at present do not have hourly volumes in excess of 25 000 one-way bus passengers in the peak hour.

- For distances longer than say 15 km attempts should be made to concentrate passengers to achieve economies of scale; alternatively the frequency of vehicles will need to be reduced to reduce costs.
- Beyond 20 km it will not be possible to avoid subsidy payments, regardless of the passenger volume that could be aggregated along the corridor (as a result of densification). This suggests that a policy to discourage long distance travel should be investigated.
- Many assumptions have been made which require public debate; e.g.:
    - The rationalisation of the cost of train infrastructure and the costing of HOV lanes for road-based vehicles.
    - The impact of train concessioning, bus tenders and the introduction of the minibus recapitalisation programme.
    - The treatment of capital cost.
    - The lane capacity for HOVs, and the implementation of HOVs in terms of proportion of HOV capacity.
- The focus of this paper has been on the cost of public transport services as the major criterion for the selection of the "optimum" mode. Transport authorities might have other priorities besides cost, such as job creation, image, air pollution, effect of differential inflation on future costs of foreign expenditure; etc.

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DEVELOPMENT OF A PUBLIC TRANSPORT COST MODEL

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