CHAPTER 16
FARE STRUCTURE AND PROJECT VIABILITY

16.0 INTRODUCTION

For the purpose of planning fare policy, the revenue from 2007 onwards only have been considered, though some portion of the two corridors may become operational before 2007 also. This is done because it is presumed that the revenue and operational cost will match for the partial opening of the section and even if there is difference, positive or negative, it will be very small.

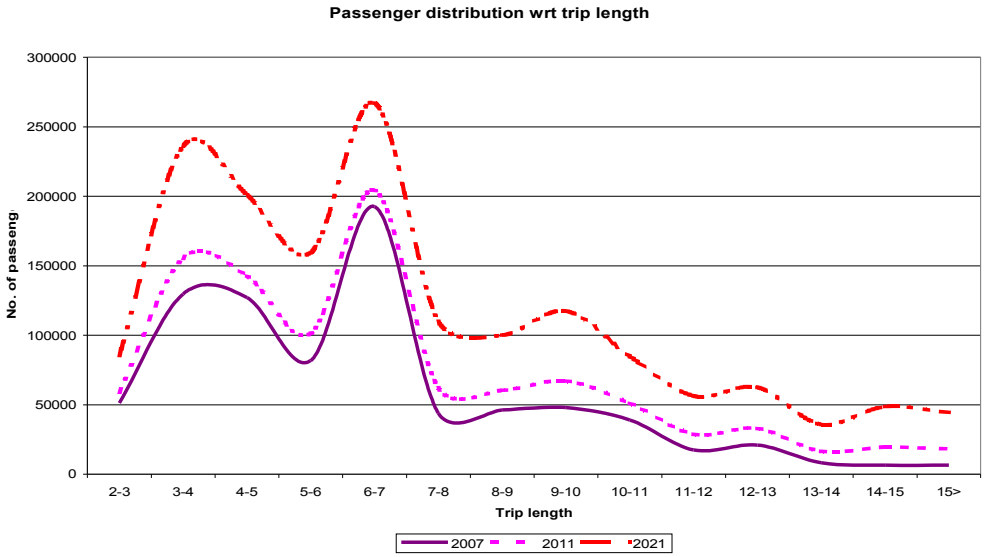
The decision on fare structure is based on multiple objectives that a public transport system is required to fulfill. At one hand the stakeholder may like to get certain return on the investments they have made or at least there is no subsidy in future. On the other hand more important goal of serving more and more people is to be achieved which in turn brings lot of indirect benefits. The attempt has been made to optimize the revenue with maximizing ridership. The various indirect benefits which a metro system brings to a city are reduced congestion on roads, improved environment quality, lesser number of accidents on road, reduced fuel bill etc. These are the benefits accruing to the economy of the city and so are required due consideration for deciding the optimal price of the public transport system.

16.1 BASIC INPUT

The ridership projections especially the trip length frequency distribution, are the basic input. In addition, the price of existing public transport system is also an important input.

The projections of traffic are available for the year 2007, 2011, 2021. A close scrutiny of trip length frequency distribution in these years shows that the mean trip length is increasing over years and has become from 6.37 Km. in 2007 to 7.19 Km. in 2021. This implies that as the Metro system gets established, more and more people get to use the system and travel to longer distances. And this trend can be further enhanced by a judicial fare policy based on the asymmetric zone system where in fare does not increase in proportionate to the distance travelled. This also will result in increased economic benefits to the city. **Figure 16.1** gives the trip length distribution for different years.

Figure 16.1 – Trip Length Distribution for Year 2007, 2011 and 2021.



16.3 FARE ELASTICITY OF TRAFFIC DEMAND

One of the most important constituents of devising a suitable fare structure is to estimate the reliable elasticity of traffic demand with respect to fare structure. The price elasticity with respect to percentage change in prices are mapped and the same has been used in our exercise for simulating different scenarios. This elasticity follows the similar trend as exist in other Mass Transit Systems world over.

OTHER CONSIDERATIONS

One more important consideration for planning fare policy is that full cost of a system should not be loaded on the direct beneficiary only. And so the price is to be judiciously decided taking into account the paying capacity of the people. For this purpose the existing bus fare structure has been studied in depth and it has been the guiding principle that we should charge in the range of 1½ time of bus fare, which is acceptable fare for Metro. Recently there has been a hike in the bus fare from 13.04.03 where in the fare for more than 4 km has been increased. But while working out the proposed fare for Metro system, only old bus fare has been considered because of the fact, that in the initial period Metro would be competing with the bus system and therefore, the attempt should be draw clientele away from the bus system and once the system is populous, a decision can be taken for increase in fare.

Also there are different type of structures possible as

- Fixed Fare system wherein user pays same charge regard less of length of the trip.
- Symmetric Zone wherein the fare increases in proportion to the distance travelled.
- Asymmetric zone wherein the fare does not increases proportionately with the distance traveled.

Another way of looking at fare structure is fixed zone or floating zone concept. In fixed zone system or point to point system there is a unique fare for each combination of origin and destination. While in case of floating zone system, the fares are differentiated based on the distance traveled irrespective of the location of the travel. There can be several other ways of differentiating fare say by direction, i.e. peak direction travel may be charged more than non-peak direction, by cost to the stake holder, i.e. for underground portion, the charges may be more than the elevated portion. Also differentiation can be depending on the type of travel or the day of travel etc. Another popular way to differentiate the fare is by volume discount or multiple trip discount which is very common among the public transport system. For Bangalore Metro system asymmetric floating zone system has been recommended which is the most popular fare system world over.

SIMULATION OF FARE STRUCTURE

To arrive at an optimal fare structure various combinations of fare structures have been used. The ridership volume for the year 2007, 2011 and 2021 were available and for other years these have been interpolated. For simulation purpose, it has been assumed that the accepted fare level for Metro travel will be about 1½ times of existing bus fares. The two more scenarios are attempted for fare structure by changing the fare

- Increasing by 25%
- decreasing by 25%.

The results conform to the usual notion i.e. with the increase in fare, the ridership volumes fall but the total yearly revenue increases and vice versa. After doing various simulations, the two fare structures, which are found most acceptable are as follows :

Alternate – I	
Distance (Km.)	**Fare (Rs.)**
0 – 2	4
2 – 6	5
6 – 12	7
> 12	9

Alternate - II	
Distance (Km.)	**Fare (Rs.)**
0 –3	4
3 – 5	5
5 – 9	7
> 9	8

The expected revenue from these fare structures are also calculated upto the year 2036.

16.5 CONCULSION

Based on the above considerations, finally the fare structure which is recommended is as follows:

Alternate – I	
Distance (Km.)	**Fare (Rs.)**
0 – 2	4
2 – 6	5
6 – 12	7
> 12	9

The fare revision after 2007 has been suggested @ 4% per annum which is the prevalent escalation but the actual revision will depend on the amount of escalation and can be done after two to three years. Revenue from advertisement has been taken as 5% of the fare box collection and for property development another 5% of the fare box collection.

16.6 Economic Analysis

Implementation of Metro System in Bangalore will result in substantial reduction in number of buses, usage of private vehicles, air pollution and increase in the speed of road based vehicles. This, in turn, will result in substantial social benefits due to reduction in fuel consumption, vehicle operating cost and travel time of passengers. Reductions in accidents and air pollution are the other benefits to the society in general. Economic analysis of the project has been carried out using Social Cost-Benefit analysis method. A framework of **'with'** and **'without'** the project scenario has been considered. The **'with'** the project scenario takes into account, estimated total costs that the local economy would be called upon to bear. The **'without'** the project scenario envisages a situation wherein the existing infrastructure continues to be utilised taking into account increased estimated costs due to higher projected traffic.

The benefits accruing as a result of project implementation like savings in vehicle operating cost due to reduction in congestion, saving in passenger time, reduced pollution and fuel consumption are estimated and taken into account.

The cost and benefit streams arising under the above situations have been estimated in terms of market prices and economic values have been computed by converting the former using appropriate **shadow prices**. This has been done to iron out distortions due to externalities and anomalies arising in real world pricing systems. Various assumptions made in carrying out the economic analysis are given in **Annexure 16.1**.

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16.6.1 Cost Stream

Cost components considered for the purpose of this exercise include:

Capital cost of infrastructure (civil engineering, land, track, power supply, traction system, signalling and telecommunications, etc.) and rolling stock for the Metro System

- Operating cost of Metro System and

- Capital and operating cost of residual buses and private vehicles that would continue to move on road even after the introduction of Metro.

16.6.2 Benefit Stream

The introduction of Metro will yield tangible and non-tangible savings due to equivalent reduction in road traffic and certain socio-economic benefits.

The benefit stream that has been evaluated and quantified includes:

- Capital and operating cost (on present congestion norms) of carrying the total volume of passenger traffic by existing bus system and private vehicles in case Metro project is not taken up.

- Savings in operating costs of all buses and other vehicles due to de-congestion including those that would continue to use the existing transport network even after the Metro is introduced.

- Savings in time of commuters using the Metro over the existing transport modes because of faster speed of Metro.

- Savings in time of those passengers continuing on existing modes, because of reduced congestion on roads.

- Savings on account of prevention of accidents and pollution with introduction of Metro.

- Savings in road infrastructure and development costs that would be required to cater to increase in traffic, in case Metro is not introduced.

- Savings in fuel consumption on account of less number of vehicles on road and decongestion effect with introduction of Metro are included in those of vehicle operating cost.

16.6.3 Quantification of some of the social benefits has not been attempted because universally acceptable norms do not exist to facilitate such an exercise. However, it has been considered appropriate to highlight the same, as given below:

- Reduced road stress
- Better accessibility to facilities in the influence area
- Economic stimulation in the micro region of the infrastructure
- Increased business opportunities
- Overall increased mobility
- Facilitating better planning and up-gradation of influence area.
- Improving the image of the city.

16.6.4 It is estimated that in the **'Business as Usual'** scenario, about 4349 number of buses will be required in the year 2007. The requirement of buses is estimated to reduce to about 3100 in the year 2007, if the Metro project is introduced. This

means, 1248 buses are likely to decrease with the introduction of Metro system. This will save Rs. 190 Crores in the year 2007 towards capital and operating cost of bus system.

For private vehicles, these estimations have been done for cars, 2 wheelers and 3 wheelers. With the introduction of Metro in 2007, the reduced number of vehicles to ply on the road will be as:

Cars	:	7250
2 wheelers	:	34667
3 wheelers	:	8111

The savings in capital and operating costs, due to less number of private vehicles has been worked put to Rs.249 crores.

The total savings in capital and operating cost for reduced number of private and public vehicles comes out to Rs.439 crores

16.6.5 Reduction in Vehicle Operating Costs

Metro will contribute towards reducing the congestion and journey time on roads because of diversion of some traffic to Metro. Reduction in traffic congestion will save the necessary capital investment and vehicle operating cost as well as increase in time saved per vehicle. Savings from vehicle operating costs due to decongestion effect of Metro has been estimated to be Rs. 253 crore in the year 2007 for Metro network.

16.6.6 Reduction in Fuel Consumption

The effect of Metro on fuel savings alone has been calculated separately as follows. The main fuels used in vehicles are petrol and diesel. The saving because of fuel alone from the savings in vehicle operating costs and savings due to decongestion effect for the year 2007 works out to about Rs. 186.29 crore for Metro Network as shown in **Table 16.1**.

TABLE 16.1

SAVINGS IN WITH THE PROJECT SCENARIO IN YEAR 2007.

(Rs. in Crores)

PARAMETERS	SAVINGS
1. Savings in Diesel due to	
- Less number of vehicles	54.74
- Decongestion effect	9.96
2. Savings in Petrol due to	
- Less number of vehicles	48.41
- Decongestion effect	73.17
TOTAL	**186.29**

16.6.7 Passenger Time Saving

Due to introduction of Metro, there will be reduced traffic congestion on the roads and correspondingly, there will be saving in time of commuters travelling by various modes of road transport. Similarly, Metro System itself being faster than conventional road transport modes will also lead to saving in time of commuters travelling on Metro. The savings are estimated at Rs 289 crore for the year 2007 for Metro system.

16.6.8 Reduction in Accidents and Damages

Introduction of Metro system expected to reduce number of accidents. Any reduction in number of accidents will involve savings from damage to vehicles and savings to persons involved in accidents towards medical and insurance expenses. The benefits because of accidents prevented with the introduction of Metro works out to Rs. 78 crore in the year 2007 for Metro network.

16.6.9 Reduced Air Pollution

There will be substantial benefits arising out of reduced air pollution, with the introduction of Metro in the year 2007. These benefits have been calculated under 2 heads.

- From diverted vehicles
- Due to decongestion effects

The savings on account of these 2 heads comes out to Rs.28 crore and Rs.32 crore respectively, amounting to Rs.60 crore in total.

16.6.10savings in Road Infrastructure

The savings in investment in road infrastructure will be about Rs.128 crore in year 2007 after implementation of Metro.

16.6.11Result of Economic Analysis

The cost and benefit streams for 30-year period in the economic prices have been worked out and presented in **Tables 16.2** for Metro network. The residual value of METRO facilities (e.g. Equipment for power supply and tele-communication, rolling stock, etc.) at last year has not been taken into account as benefit in these tables. The total cost worked out on the above basis is then subtracted from the total benefits to estimate the net benefit of the project. This flow is then subjected to the process of discounting to work out the internal rate of return on the project, to examine the viability of the Project in Economic terms. Thereafter, the Project EIRR (**Annexure 16.5**) in economic terms is arrived at by using **shadow prices**.

The EIRR in economic terms work out to **22.30%** Metro.
It is accordingly seen that the proposed project is economically attractive.

16.7 PROJECT VIABILITY

Assumptions for profitability estimates.

16.7.1 Cost of Project estimation

1. Excluding the cost of land the construction cost of project (at April 2003 price estimates) has been taken as Rs 3610 cr. The same have been escalated at the rate of 4% p.a to arrive at the completion cost excluding the land cost of Rs 360 cr which has been taken to be fixed at April 2003 price level.
2. The completed project cost is estimated to be Rs 4379 cr and Interest during construction (excluding IDC subsidy amounting to Rs. 494 crores) is Rs 116 cr.
3. Total completed cost of the project is estimated at Rs 4495 crore (excluding IDC subsidy).
4. The impact of interest subsidy has been netted off and is not reflected in the cost of the project. The interest subsidy during construction has been estimated at Rs 494 crore.
5. No tax and duties has been taken into consideration for financial analysis.

Table 16.2
COST ESTIMATES (Figs in Rs. cr.)

Year	Construction cost (fixed)	Land cost	Current cost	IDC (borne by the project)	Total Current Cost
2003-04	168.50	30	211	0	211
2004-05	395.20	200	763	1	764
2005-06	862.60	130	1106	9	1115
2006-07	992.60		1015	24	1039
2007-08	794.10		845	37	882
2008-09	397		439	45	484
Total	3610	360	4379	116	4495

16.7.2 Implementation schedule

1. The start of the construction of the project has been taken to be 2003.
2. The project construction will be part completed in 2007 and fully completed in 2008.
3. Commencement of operations is in the year 2009-2010, though part revenues would start flowing in from 2007-08.

16.7.3 Means of financing

1. The project cost is assumed to be funded as follows:

Table 16.3 Sources of Funding

Particulars	%	Rs (crore)
Equity	40%	1798
Subordinate debt	8%	360
Rupee debt	52%	2338

Total	100%	4495

2. The terms of rupee debt are taken as follows:

Table 16.3.1

	Rupee Debt
Rate of Interest	10.5%
Moratorium (years)	10
Total Repayment period (Years)	15
Total tenure of debt (years)	25

Rate of interest on debt is 10.5% p.a. Out of this the interest allocable to the project is 2% while the remaining 8.5% is in the form of subsidy from the government.

3. Drawal of funds

a. Equity will be injected equally over the construction period. The equity of Rs. 299.69 cr. per annum would be shared equally between the state and central government over the construction period of five years.

b. The subordinate debt, which will be interest free, will be drawn in the first 3 years in the ratio 40%, 40% and 20% in each of the years and would shared equally between the both the governments. This is assumed to be repaid after the repayment of senior debt.

c. The balance debt will be drawn down based on actual fund requirement.

16.7.4. Operating and Maintenance Expenses

The operating and maintenance costs have been worked based on experience derived from the Delhi Metro Rail Corporation and other international metros. The basic assumption that governs the whole computation is that the number of staff deployed for each kilometer shall be 40. This would be the requirement for the full phase operation, however, the number has been assumed from the first year itself since staff needs to be recruited and trained prior to opening of sections. The expenditure per employee at April 2003 prices is assumed to be Rs. 17,000 p.m. This is assumed to be escalated @ 10% p.a. keeping in view the increases in the payments due to increments and also the factor of inflation.

The energy cost, which constitutes a significant portion of the project cost, has been assumed as Rs. 2.75 per unit. This is so because the energy supplied to the metro should be on a no – profit no – loss basis. The total energy consumption is as below:

Table 16.4 Energy Consumption

Annual energy consumption in million units			
	2007	2011	2021
Total	82.1	130.3	184.1

The material cost has been taken as equivalent to the same percentage as the energy cost. Both energy and material cost have been escalated at the rate of 4% p.a. (**Annexure 16.2**)

4. Depreciation on Plant & Machinery (including rolling stock) is assumed to be at the

rate of 4.75% p.a. and on other fixed asset at the rate of 1.63% p.a.

16.7.5 Revenues

1. Revenues have been taken as per the estimates detailed in the report of National Council of Applied Economic Research (NCAER). The fare pattern as per traffic projections is growing at an average rate of 9 -10 % p.a.
2. Other revenue is envisaged in the form of Property Development Revenue and advertising revenue of 5% each of the fare box revenue. (**Annexure16.3**)

16.7.6 Others

1. No estimation of income tax and dividend for the project has been done, as it would not materially impact the investment decision.
2. Based on the traffic projections, the traffic would necessitate additional rolling stock. The project company through its own accruals/equity would manage additional rolling stock requirements.

16.7.7 Profitability projections

Based on the above assumptions, the key indicators of the financial performance of the project are given in **Table 16.5**. The detailed projections are given in **Annexure 16.4.1 & Annexure 16.4.2**.

Table 16.5 Profitability Projections (Rs in crore)

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Income	174	191	210	232	257	281	306	333	363
Interest subsidy	**158**	**191**	**199**	**199**	**199**	**199**	**199**	**199**	**185**
PBDIT	240	285	305	320	301	315	329	346	350
Net Cash Accruals	45	49	59	74	56	69	84	100	121
DSCR	**1.23**	**1.21**	**1.24**	**1.30**	**1.23**	**1.28**	**1.34**	**1.41**	**1.53**
ADSCR			2.27						
Adjusted DSCR	**6.45**	**6.34**	**6.51**	**6.84**	**6.44**	**6.73**	**7.05**	**7.40**	**8.03**
Adjusted ADSCR			4.14						
Project FIRR			3.16%						

The DSCR has been calculated on the basis of total interest burden on the project and the adjusted interest burden on the project, netted for the interest subsidy support available to the project.

The interest subsidy improves the financial position of the project very significantly and the project is viable only with this support. Without the interest subsidy, the project becomes unviable with a negative FIRR of -1.0%.

Sensitivity Analysis

The profitability of the project is critically dependent on the following parameters:

1. Increase in the project cost
2. Delay in the completion of the project
3. Decline in the projected revenue of the project

The impact of these parameters has been analysed on key project parameters including cost of the project, interest subsidy required, IRR & debt service coverage ratios (DSCR).

The parameters taken for the sensitivities and the ranges evaluated are as follows:

Increase in project cost	5% to 20%
Delay in completion of the project	Upto 3 years
Decline in projected revenues	Upto 40%

Table 16.6 Increase in Project Cost

Parameters	Base case	5%	10%	15%	20%
Cost of project (Rs crore)	4,495	4,701	4,907	5,113	5,319
FIRR	3.16%	2.51%	2.32%	2.14%	1.97%
ADSCR					
▪ Actual	2.27	2.19	2.12	2.05	1.99
▪ Minm DSCR	0.97	0.95	0.93	0.91	0.89
Interest subsidy support (Rs crore)	3,077	3,216	3,355	3,494	3,632
During construction	494	515	535	556	576
During operation	2,583	2,701	2,820	2,938	3,056

The increase in the project cost does not have a significant impact on the interest during construction (IDC) component on account of low rate of interest allocated to the project. The other indicators continue to be satisfactory primarily on account of the interest subsidy element in the project financing and operations.

16.7.8 Delay in the completion of the project

Table 16.7 Delay in Project Completion

Parameters	Base case	1 yr	2 yr	3 yr	1yr after incurring 10% Capital Expend.
Cost of project (Rs crore)	4,495	4,540	4,584	4,628	4619
FIRR	3.16%	1.32%	-0.05%	-1.38%	0.84%
ADSCR					
▪ Actual	2.27	2.09	1.91	1.71	2.30
▪ Minm DSCR	0.97	0.99	0.91	0.84	1.01

▪ Adjusted	4.14	3.77	3.39	2.99	3.69
▪ Minm Adjusted DSCR	1.82	1.77	1.53	1.39	1.62
Interest subsidy support (Rs crore)	3,077	3,206	3,325	3,436	2241
During construction	494	685	872	1,056	400
During operation	2,583	2,521	2,453	2,380	1841

Delay in the completion of the project would lead to an increase in the project cost and also a loss of projected revenue thus impacting the ratios significantly. Each year's delay in the completion of the project would increase the fund requirement by about Rs 236 crore comprising IDC component of Rs 45 crore and interest subsidy support of Rs 191 crore.

As may be noted, the IRR of the project declines significantly with the delay in the completion of the project with the project becoming unviable with a delay of 2 years and it is imperative that the project be implemented in a strict timeframe.

1. In case after incurring 10% of the estimated project cost, the project gets delayed by 1 year, the total project cost would go up to Rs. 4619 crore, that is, an increase of about Rs. 124 crore over and above the base case scenario. In this case, the project IRR would dip significantly to 0.84%, thereby seriously undermining the viability of the project.
2. A delay of one year in the project completion would have an impact in terms of loss of contribution (Revenue – O&M Expenses) of about Rs. 100 crore.
3. In case the project is completed on time, but there is a delay of 1 year in commencement of the operations, the impact in terms of loss of contribution (Revenue – O&M Expenses) would be about Rs. 94 crore.

16.7.9 Decline in the projected revenues

Table 16.8
Decline in Projected Revenues

Parameters	Base case	10%	20%	30%	40%
Cost of project (Rs crore)	4,495	4,495	4,495	4,495	4,495
FIRR	3.16%	1.37%	-0.24%	-2.32%	-5.37%
ADSCR					
▪ Actual	2.27	1.86	1.45	1.04	0.63
▪ Minm DSCR	0.97	0.86	0.75	0.64	0.33
Interest subsidy support (Rs crore)	3,077	3,077	3,077	3,077	3,077
During construction	494	494	494	494	494
During operation	2,583	2,583	2,583	2,583	2,583

Since it is very difficult to project the revenue stream of the project very accurately as it is dependent on a host of factors, it is imperative for the state government to provide necessary assistance to ensure optimum ridership.

16.7.10 Conclusion:

The financial prospects of the project are an outcome of numerous factors as discussed above. it is, therefore, imperative that there is time bound implementation of the project to avoid time and cost overruns.

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