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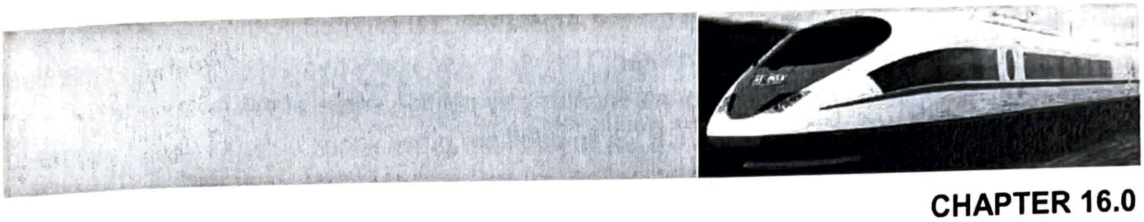

CHAPTER 16.0

ECONOMIC ANALYSIS

16.1. INTRODUCTION

The financial and economic analyses of the project are undertaken with different perspectives. Economic analysis measures the benefits to the society over and above the financial returns/profits accruing to the project entity/its owners. It is possible that project which is financially attractive may be economically unviable and vice versa.

In above perspective, the economic analysis of RRTS project is undertaken with an objective to evaluate its contribution to society at large. Investment in RRTS project would bring enormous socio-economic benefits to the society/region. RRTS project would contribute to the modal shift of current traffic from different modes to RRTS. As a result, there will be reduction of traffic on roads. This will lead to smooth and efficient movement of people, thereby enhancing productivity. Further, the RRTS project shall improve result in various benefits to the users, shifting to RRTS from other modes. These improvements will result in reduction in travel time, reduction in vehicle operating costs, reduction in pollution and several other multiplier benefits.

Economic analysis captures all the RRTS project related expenditure flow (life cycle cost) and all benefits likely to accrue to the society (irrespective of the investor) during a pre-defined analysis period. The project benefits have been estimated through comparison of costs arising out of "with project" and "without project" scenario. This cost benefit flow is used to arrive at annual benefits and subsequently to estimate the (i) Economic Internal Rate of return (EIRR) (ii) Economic Net Present Value (ENPV)

The chapter would proceed with description of approach and methodology followed by discussion on economic costs associated with the project and identification and quantification of benefits.

16.2. APPROACH AND METHODOLOGY FOR ECONOMIC ANALYSIS

The economic viability of the project has been carried out using the cost benefit analysis approach and discounted cash flow (DCF) technique. The financial project cost has been determined as detailed in Cost Estimate chapter of this report. The economic project cost has been computed by applying appropriate conversion factor to the financial project cost. This has been done to remove distortion due to externalities and anomalies in market pricing system so as to arrive at the true cost to the economy. The detailed discussion pertaining to economic project cost is specified in economic cost section.

The project benefits have been computed through comparison of costs arising out of "with project" and "without project" scenario. For instance, in without project scenario, the economic

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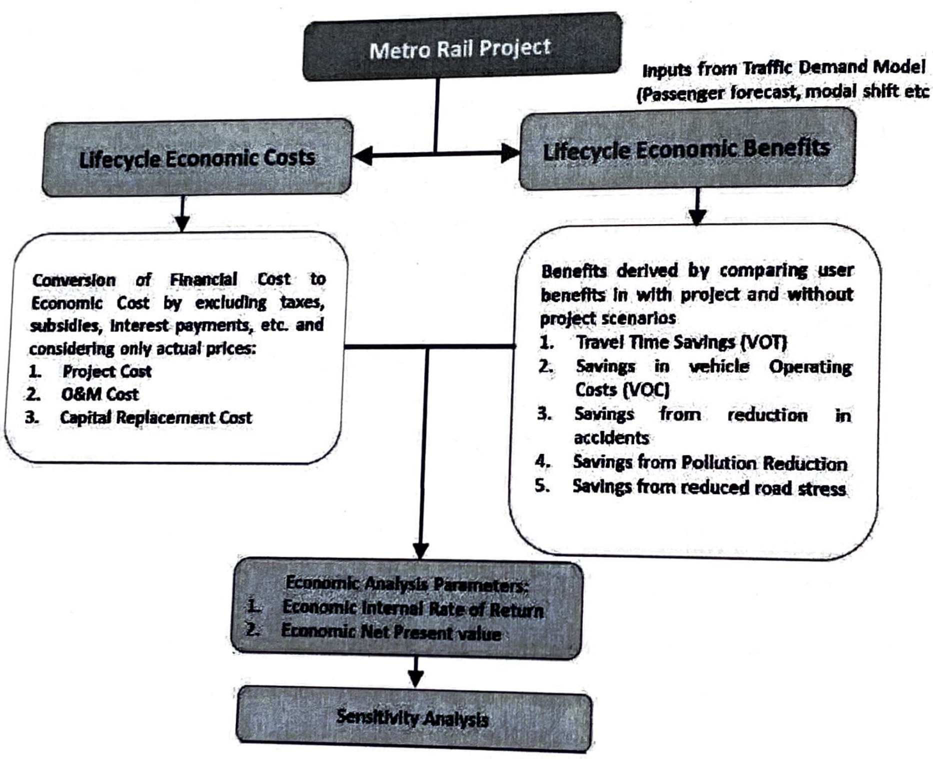
costs incurred by the economy in carrying the diverted traffic through the existing mode of transport viz., road, rail have been computed. Therefore, the economic benefits would arise due to savings in cost that would accrue to the economy by shifting some of the existing traffic over from the current mode of transport to RRTS. In addition, other social benefits would accrue to the economy due to savings of direct/indirect costs, namely, fuel savings, environmental pollution, accident reduction, maintenance cost, etc. These savings in social costs have also been considered to the extent that they are quantifiable and have been computed based on economic prices instead of market prices. Shadow prices have been used to arrive at the economic costs/benefits wherever applicable. To arrive at the shadow prices, appropriate conversion factors (for converting market prices to economic cost) have been applied.

The economic cost benefit analysis for the RRTS corridor is based on the framework for economic cost benefit analysis as given in Appraisal Guidelines for Metro Rail Project Proposals, 2017.

Framework for Economic Analysis as per Appraisal Guidelines for Metro Rail Project Proposals, 2017



The annual stream of economic costs and benefits has been computed for analysis period of 30 years. Further, 'sensitivity analysis' for critical factors affecting the cost and benefits streams of the proposed project, in order to ascertain their effect on the economic feasibility indicators i.e. ENPV, EIRR has been carried out.

16.3. ESTIMATION OF ECONOMIC PROJECT COST OF RRTS

The economic project cost of the RRTS is calculated from the financial project cost on the following basis:

- Tax components are excluded from the financial project cost as it represents transfer payments.
- Interest during Construction (IDC), escalations have also been excluded.

On capital cost side, subsidies and market distortion including foreign exchange distortions are very difficult to evaluate. Therefore, the practice is to apply an overall conversion factor (CF) to cost figures to eliminate all possible distortions including foreign exchange distortions if applicable. In line with MoHUA appraisal guidelines, a conversion factor of 83% has been applied on capital cost of the project. Accordingly, phasing of the base capital cost has been derived and is shown below.

Table 16.1 Phasing of Capital cost of the project

Financial year	Economic cost of the project (Rs. Cr)
2020-21	1,239
2021-22	4,369
2022-23	4,764
2023-24	5,822
2024-25	5,133
2025-26	1,013
2026-27	30

16.4. ESTIMATION OF OPERATION & MAINTENANCE COST

Operation and maintenance costs under "with the project" situation are derived from financial O&M estimates. As per the prevailing practice, only real prices have been considered in computation of economic O&M estimates. The conversion factor equal to 87% is applied to arrive at economic O&M estimates (as per MoHUA appraisal guideline). This is owing to adjust the market prices for transfer payment like taxes, subsidies etc. for operation, repair& maintenance, material requirement and staff salary. The O&M Cost also includes replacement cost. Detailed discussion on financial O&M cost is specified in financial analysis chapter. Economic cost of Operation and Maintenance of RRTS project of key years is summarized in table below.

Table 16.2 O&M cost of selected years

Financial year	Economic Value of Operation & maintenance cost of the project (Rs. Cr)
2025-26	786
2026-27	1,056
2031-32	1,164
2041-42	1,656
2048-49	1,984

16.5. QUANTIFIABLE ECONOMIC BENEFITS OF THE PROJECT

As discussed, in the approach and methodology section, proposed project will accrue tangible and non-tangible benefits due to reduction in traffic to existing system. It also contributes to diversion of passenger traffic from alternate mode i.e. road and rail to RRTS system. As a result there will be reduction in number of vehicles carrying passengers with introduction of RRTS and hence it also reduces congestion. In addition, other social benefits that would accrue to the economy due to savings of direct/indirect costs namely, environmental pollution, accident reduction, maintenance cost, etc.

The following quantifiable benefits will be accrued to the society owing to implementation of the RRTS corridor:

16.5.1. Travel Time Savings

The RRTS project will significantly contribute to modal shift owing to higher speeds and comfort to passengers. This leads to travel time savings due to the following:

- Travel Time Savings due to higher speed of RRTS as compared to do nothing or alternative scenario.
- Congestion reduction due to modal shift leads to fewer vehicles on roads. This also contributes to time savings of passengers travelling on other modes.

16.5.2. Savings in Vehicle Operating Cost

Savings in Vehicle Operating Cost arise owing to following:

- Absence of vehicles of modal shift passengers.
- Smoother operations of passenger trips of other mode vehicles owing to congestion reduction.

16.5.3. Savings from Accident Reduction

The reduction in traffic volumes on roads due to modal shift to RRTS is expected to reduce the accidents on the project corridor owing to following:

- Lower number of vehicles on roads due to reduction of vehicles of modal shift passengers.
- Lower accidents from vehicles due to decongested roads / other modes.

Further reduction in accidents will also lead to savings from damages to vehicle and savings towards medical, insurance expense, administrative expense on police and the intangible psychosomatic cost of pain to personal involved in the accidents. This also leads to savings because of reduction of productivity to the economy by the personnel involved in the accident.

16.5.4. Savings from Pollution Reduction

RRTS will significantly contribute to pollution reduction and are thus a pre-requisite for sustainable development. RRTS will lead to modal shift and hence fewer vehicles on road. This leads to reduction in the use of fuel. Thus, absence of Green House Gas emission (GHG) from the vehicles of modal shift passengers' and lower emission due to decongested roads contributes in reduction in GHG emissions in the region.

- The environmental savings come from the reduction in air pollution. Due to the modal shift from the existing modes of transport to RRTS, the air pollutants released will significantly reduce.
- It is to be noted that in addition to savings due to reduction in treatment cost of pollutants, the reduction in pollution will also result in other significant economic benefits, such as savings due to improved health of citizens, reduced expenditure on treatment of diseases/medicines, etc., which are currently not captured in the economic analysis.

16.5.5. Savings due to Reduced Road stress

This benefit arises due to a reduced need for road maintenance owing to reduced traffic on account of modal shift. The savings will accrue due to two reasons:

- Maintenance of the existing road infrastructure – As the traffic congestion on the roads will be lesser due to a modal shift to RRTS, the wear and tear of the road will reduce.
- Upgrading existing road infrastructure – To solve the congestion problem, an alternative could be to expand the existing roads to accommodate for traffic. Due to the construction of RRTS, this cost will now be saved.

16.5.6. Additional economic benefit quantified – Reliability due to improved journey planning time

Urban and regional rail projects contribute to travel time savings for passengers in terms of improved reliability of the entire journey.

Passengers travelling on RRTS is estimated to have more reliable trip with scheduled arrivals and departures compared to highway trips which are subject to typical as well as unexpected delays. Generally, travellers on road,budget some extra time on a trip in order to compensate/ adjust with the additional time spent on delays. This additional time is expressed as Planning Time Index (PTI) which is a measure of the amount of actual time spent on a trip after incorporating a certain additional time over and above the standard travel time.

A study undertaken by International Journal of Engineering Research & Technology (IJERT) on Evaluation of Travel Time Reliability on Urban Arterial roads of Delhi concluded that the highest planning time index (PTI) value obtained for working day during morning peak hour (9:00 AM to 9:15 AM) is 1.86. This indicates that travel time is 1.86 times of free flow travel time. Highest buffer index BI value obtained during the same period was about 0.86. This indicates that travellers should budget an additional 138 seconds buffer to ensure 95% on time arrival at the destination. The mean 95th % travel time for urban corridor varied between 164 seconds to 300 seconds during morning hour and 121 seconds to 280 seconds in the evening hours. Highest PTI value obtained for non- working day during morning peak hour (10:00 AM to 10:15 AM) is 2.40. This indicates that travel time is 2.40 times of free flow travel time. Highest BI value obtained during the same period was about 1.40. This indicates that travellers should budget an additional 205 seconds buffer to ensure 95% on time arrival at the destination on study Corridor.

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The mean 95th % travel time for urban corridor varied between 134 seconds to 351 seconds during morning hour and 117 seconds to 252 seconds in the evening hours.

However, internationally, PTI in cities like San Francisco and Los Angeles range between 1.25 to 1.47. On a conservative basis, for quantifying reliability benefit for RRTS commuters, a PTI of 1.25 has been considered.

Accordingly, reliability benefit has been added to travel time savings as this benefit gets accrued to travel time savings.

16.6. RIDERSHIP AND MODAL SHARE ON RRTS CORRIDOR

Existing transport system on project corridor consist of buses, railway, shared auto rickshaw, cars, two wheelers, etc. Traffic chapter provides details of the traffic demand estimates. The current and future modal share is shown below, owing to implementation of the corridor.

Table 16.3 Modal share before & after RRTS

Mode	Average modal share before RRTS	Average modal share after RRTS
Car	33%	25%
Auto	1%	0.3%
Shared Auto	7%	5%
2 wheeler	16%	11%
Taxi	6%	4%
Metro	13%	9%
Bus	14%	10%
Mini Bus	2%	1%
Express train	2%	1%
Commuter rail	7%	5%
RRTS	0%	28%
Total	**100%**	**100%**

The following table shows the estimated daily ridership and average trip length during the projection period:

Table16. 4 Ridership details

#	Particulars	2025-26	2026-27	2031-32	2041-42	2051-52
1	Daily Ridership (passenger in Lakh)	8.69	9.04	10.95	13.90	19.38
2	Average trip length (km)	29.7	29.7	30.0	30.5	30.8

The annual vehicle run has been derived based on product of annual numbers of vehicle plying on the RRTS corridor, number of vehicle trips and average trip length.

16.7. KEY ASSUMPTIONS CONSIDERED FOR ECONOMIC ANALYSIS

Various key assumption necessary to calculate above five quantifiable benefits has been considered / taken from MoHUA appraisal guidelines, 2017.

16.8. ECONOMIC INTERNAL RATE OF RETURN (EIRR) OF PROJECT

The net cash flow statements due to economic benefits as per the guidelines are presented in table below. Since the EIRR of proposed RRTS facility is more than 19%, which is above 14 % cut-off rate, the project is considered economically viable.

Table No. 16.5 Net Cash Flow Statement as per guidelines (in Rs. Crore)

Financial year	Capital Costs	O&M Cost	VOC Savings	Travel Time Savings with reliability benefit	Pollution Reduction Benefits	Accident Reduction Benefits	Road Infra Savings	Total Savings	Net benefits
2020	1,239	-	-	-	-	-	-	-	-1239
2021	4,369	-	-	-	-	-	-	-	-4369
2022	4,764	-	-	-	-	-	-	-	-4764
2023	5,822	-	-	-	-	-	-	-	-5822
2024	5,133	-	-	-	-	-	-	-	-5133
2025	1,013	-	-	-	-	-	-	-	-1013
2026	30	786	815	3,655	163	16	174	4,822	4006
2027	-	1,056	1,128	4,983	226	22	241	6,600	5544
2028	-	1,099	1,172	5,321	234	23	250	7,001	5902
2029	-	1,110	1,218	5,681	244	24	260	7,427	6317
2030	-	1,120	1,266	6,065	253	25	270	7,879	6758
2031	108	1,152	1,316	6,474	263	26	281	8,359	7098
2032	-	1,164	1,367	6,855	273	27	292	8,814	7650
2033	-	1,218	1,400	7,153	280	28	299	9,159	7941
2034	-	1,231	1,434	7,464	287	28	306	9,519	8287
2035	-	1,245	1,469	7,788	294	29	313	9,892	8647
2036	-	1,259	1,504	8,126	301	30	321	10,281	9022
2037	-	1,274	1,540	8,478	308	30	329	10,686	9412
2038	-	1,343	1,578	8,846	315	31	336	11,106	9764
2039	-	1,359	1,616	9,228	323	32	345	11,543	10184
2040	-	1,377	1,655	9,627	331	33	353	11,998	10622
2041	2,562	1,637	1,695	10,043	339	33	361	12,472	8273
2042	-	1,656	1,736	10,516	347	34	370	13,003	11347
2043	-	1,743	1,794	11,114	359	35	383	13,684	11942
2044	-	1,764	1,855	11,745	371	37	396	14,402	12638
2045	1,026	1,801	1,917	12,411	383	38	409	15,158	12331
2046		1,823	1,982	13,115	396	39	423	15,955	14132
2047		1,847	2,049	13,858	410	40	437	16,794	14947

Financial year	Capital Costs	O&M Cost	VOC Savings	Travel Time Savings with reliability benefit	Pollution Reduction Benefits	Accident Reduction Benefits	Road Infra Savings	Total Savings
2048		1,957	2,118	14,642	424	42	452	17,677
2049		1,984	2,190	15,470	438	43	467	18,608
2050		502	564	5,589	113	11	120	6,398
Total	26,065	34,507	38,379	224,247	7,673	755	8,185	279,239
								EIRR
								ENPV@10%

16.9. SENSITIVITY ANALYSIS

The robustness of the project's viability is further demonstrated by the sensitivity analysis. Because of the uncertainties pertaining to traffic forecasts and critical parameters relating to cost and benefits, a sensitivity analysis was carried out to test the economic strength of the project. The variations in the following parameters have been examined:

- Increase in cost by 5% - 15% (Capital and O&M)
- Decrease in ridership by 5% - 15%
- Reduction in benefits by 5% - 15%

The results of the sensitivity analysis are presented below.

Parameter/ Sensitivity	5%	10%	15%
Increase in Capital Cost	18.6%	18.1%	17.6%
Increase in O&M Cost	19.1%	19.0%	18.9%
Reduction in Ridership	18.7%	18.3%	17.8%
Reduction in Benefits	18.5%	17.7%	17.0%

Sensitivity of EIRR (combination of factors)		Reduction in Benefits	
		10%	15%
Increase in Capital Cost	10%	16.7%	15.9%
	15%	16.2%	15.5%

16.10. ADDITIONAL ECONOMIC BENEFITS OF REGIONAL RAIL PROJECTS

While the "Appraisal Guidelines for Metro Rail Project Proposals" recognizes the economic benefits a metro rail system brings in, they do not fully capture the additional economic benefits of a broader regional rail system such as RRTS.

It is pertinent to mention that RRTS projects inherently has multiple additional aspects in comparison to metro rail systems. While metro rail projects generally operate within a metropolitan city like Chennai or Kochi, etc., RRTS will connect suburban and urban centers in NCR, and will run right across the city centers, thus providing a seamless transit network to the entire region. Additionally, while the metro rails have an average speed of 32 kmph, RRTS will have an average speed of 100kmph, three time the average speed of a metro rail. Also, globally, it has been observed that similar regional rail projects, such as Crossrail in London, RER in Paris, and Cercanias in Spain, bring wider range of economic benefits on account of similar aspects such as high speed, seamless travel, urban/sub-urban connectivity, etc. Given such significant value propositions, once operational, RRTS has the potential to transform the transportation landscape of entire NCR.

Based on benchmarking with similar regional rail projects, and with domestic and international policies/ guidelines, it is felt that additional economic parameters may also be considered under the existing appraisal guidelines by MoHUA, especially for appraisal of regional rail projects.

After review and analysis of various economic parameters considered in economic appraisals of the similar regional rail projects across the world, the additional parameters relevant for RRTS have been shortlisted below:

16.10.1. Savings in capital costs in other modes of transport

The traffic on the existing modes of transportation shall keep increasing without the project under consideration, i.e., without RRTS. The cost of transport services to cater to this growing traffic will include purchasing/leasing of new buses both by the public and private sector. Though MoHUA has considered savings due to reduced stress owing to modal shift, it is also important to note that there will be reduction in the capital costs in other modes of transport due to the modal shift. Thus, investment in RRTS projects will result in the reduction of the following costs due to modal shift in transportation.

- Government investments on purchase of new buses for public transport
- Private sector investment on buses

These savings have been valued by both Mumbai Metro and Ahmedabad Metro in their respective economic appraisals.

- Savings in capital costs = Modal shift vehicles * Capital costs of vehicle (for each vehicle type)

16.10.2. Indirect employment benefits

Urban rail projects result in creation of direct jobs, and indirect jobs. Direct jobs are those generated by the project activities like appointment of contractors and sub-contractors, which employ construction workers, planners, engineers and others. Indirect jobs represent spending on goods and services that support direct investment, such as material suppliers, machine rental companies, etc.

A letter (Letter No. NCRTC/2017/Metro-Policy, dated 11th December, 2017) regarding economic appraisal of regional rail projects, recommending the additional economic benefits of regional rail projects, has been submitted to Ministry of Housing and Urban Affairs for consideration.

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16.11. WIDER ECONOMIC BENEFITS AND ECONOMY-WIDE BENEFITS

Additionally, apart from the above-mentioned quantifiable economic benefits, the following economic benefits have also been identified, the methodologies for which are subjective and can be a matter of discussion, especially in Indian context.

The following section below describes these identified economic benefits:

16.11.1. Wider economic benefits:

It has been observed that rail projects worldwide are also capturing wider economic benefits (WEBs) apart from conventional transport/user benefits. WEBs refer to the impacts of transport investments on agglomeration economies, increased competition as a result of better transport system, output change in imperfectly-competitive markets, productivity gains from job relocation, and economic welfare benefits arising from an improved labour supply. It may be noted that WEBs are over and above the conventional transport/user benefits (time savings, VOC, etc.). Generally, 3 sub-parameters come under the umbrella of WEBs:

16.11.2. Agglomeration Benefits

Transportation projects change the way firms interact with each other, with final consumers and with the labour force, enabling production efficiencies that would otherwise not be available to them. Agglomeration externalities relate to the benefits which flow to firms and households from locating in areas which have a high density of economic activity (measured by employment). Such locations allow firms to achieve economies of scale through access to an extensive customer base. This large customer base presents firms the opportunity for economies of scope.

16.11.3. Output Change in Imperfectly Competitive Market

A reduction in transport cost allows firms to profitably increase output of the goods or services that require use of transport in their production. Also, when a transport project reduces business travel time, firms can respond to cost savings by increasing output.

16.11.4. Improved Labour Supply

Transport costs affects the overall costs and benefits of a working individual. As a result of improvement in transportation network, more people will decide to work and more people will be prepared to travel further to higher paying jobs.

It has been observed that WEBs have been captured in economic benefit analysis of Cross rail project in London, one of the transformational regional rail projects in the world. The project has captured these economic benefits over and above the conventional user/transport benefits.

Further, Department for Transport (DfT), UK, standardized the WEBs framework, and published "Transport Analysis Guidance (TAG), Unit 2.1, Wider Impacts" which provides guidance on how to capture WEBs.

Furthermore, countries such as New Zealand and Australia have also modified their appraisal guidance documents in order to capture the wider economic impacts (WEBs) arising due to transformational urban/regional rail projects.

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