Economic Analysis
or
Cost Benefit Analysis {CBA}

Infrastructure Project

Infrastructure project is a basic physical and organizational structures needed for the operation of a society or enterprise,

- It is the ***services and facilities necessary for an economy to function***.
- It is a set of interconnected structural elements that provide framework ***supporting an entire structure of development***.
- It is an important term for ***judging a country or region's development***.

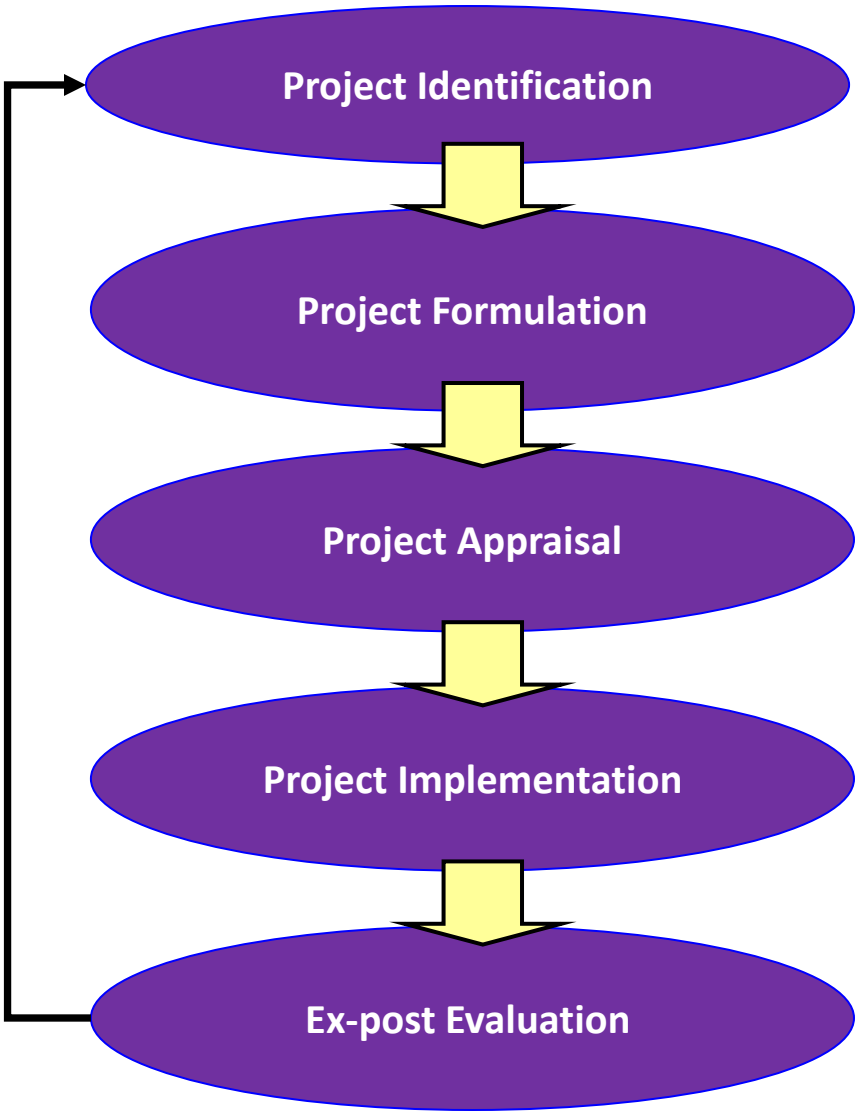
Infrastructure Projects..contd

It refers to the ***technical structures*** that support a society, such as

- Roads
- Highways
- Expressways
- Bridges
- Railways
- Ports & Shipping
- Airports
- Metros
- Monorails
- Pipelines
- Water Supply, Sewers, Sanitations, Dams
- Electrical Grids,
- Telecommunications, and so forth,

These are the ***Physical Components*** of interrelated systems providing ***commodities and services essential to enable, sustain, or enhance societal living conditions.***

Infrastructure Projects Planning Cycle

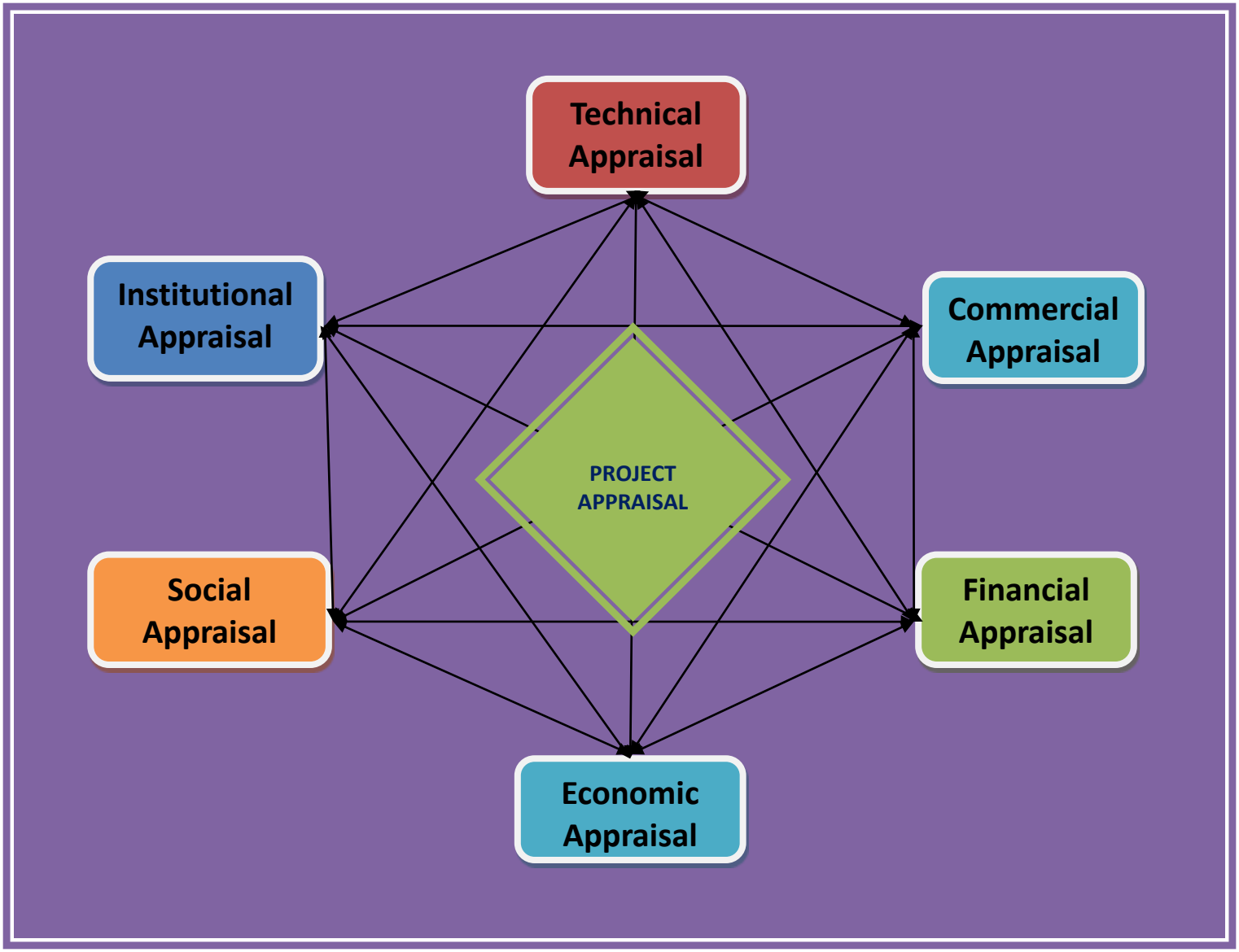


Project Appraisal

➢ **Project Appraisal** is the process whereby a Public Agency or Private Enterprise determines whether a project meets the country's ***economic and social objectives*** and whether it meets these **objectives efficiently**.

➢ Appraisal provides a comprehensive review of all aspects of the project and lays the ***foundation for its implementation*** after it has been approved and for its evaluation after it has been completed.

Aspects of Project Appraisal



Aspects of Project Appraisal….contd

Technical Appraisal: technical appraisal is concerned, for example, with ***engineering, design, and environmental matters and with estimates of capital and operating costs*** as they relate to the construction process and the operation of the project after it is completed.

Institutional Appraisal: institutional appraisal deals with the multitude of ***management, organizational, and staffing problems*** involved in the construction and operation of the project.

Social Appraisal: social appraisal address the social objectives of the project, such as a more ***equal income distribution or improved nutrition and health, and the social, cultural, and human variables*** affecting the project, such as involuntary population resettlement or the role of women in development.

Aspects of Project Appraisal….contd

Commercial Appraisal: commercial appraisal deals with the procurement of ***goods and services to implement*** and operate the project and with the ***marketing arrangements*** for the sale of its output.

Financial Appraisal: financial appraisal is used to determine what ***funds*** will be required and whether it can ***meet its financial obligations***, produce a reasonable ***return on the capital invested***, and, in appropriate cases, make a contribution from earning towards the cost of future investments. The financial analysis focuses on the ***costs and revenues of the enterprise*** responsible for the project and is usually summarized in the enterprise's ***income and cash flow statements and balance sheets***.

Economic Appraisal: economic appraisal has to do with the identification and measurement of the ***economic costs*** of the project and the size and ***distribution of benefits***. Economic Appraisal also called Cost Benefit Analysis ***{CBA}.***

Cost Benefit Analysis {CBA}

Cost Benefit Analysis is a method of investment appraisal which peruses the ***fundamental economic objective of optimizing welfare*** in the absence of normal market mechanism. It offers a framework within which the ***costs and benefits can be asserted and compared***.

The C B Analysis or Economic Analysis is ***not a substitute*** for exercise of judgment or financial analysis. It is **complementary**

Cost Benefit Analysis……contd

The investment consists of incoming some costs immediate or in the near future in order to achieve some benefits in the longer term. This necessitates consideration of ***different streams of costs and benefits over time***. The appraisal of a project needs identification for each period the difference between the ***value of the output which are produced and the value of inputs which are used 'with' or 'without' the investment***.

Objective

- The main objective of the Economic Evaluation is to assess the viability of the proposed project in terms of ***the benefits likely to accrue*** to the economy as a whole, thereby justifying its implementation based on the ***profits to the nation/ economy.***
- The economic viability is commonly expressed in terms of ***Economic Internal Rate of Return (EIRR)***.

Approach

- The economic appraisal of the project is to be carried out within the broad framework of ***Social Cost-Benefit Analysis Technique.***
- It is based on the ***incremental costs and benefits*** and involves comparison of project costs and benefits in economic terms under the ***with and without project scenario***

Main Steps

- Estimation of economic cost of the project- ***capital cost*** along with phasing, ***routine and periodic maintenance cost***.

- Identification and quantification of ***direct benefits*** in monetary terms.

- ***Comparison of economic costs and benefits*** for the study period and estimation of EIRR using Discounted Cash Flow (DCF) technique.

Project Cost

Measuring the economic costs of a project involves ***adjusting the actual expenditures on inputs where the prices paid do not properly reflect the real scarcity value of the inputs***. Such adjustments of market prices involve the determination of "***economic accounting prices***" or "shadow prices".

Project Cost..contd

The project cost comprises of

1] Capital Cost

2] Routine Maintenance Cost

3] Periodic Maintenance Cost

The estimated **Financial Costs,** Capital as well as Maintenance, have been converted into ***Economic Costs*** by applying ***Conversion Factor of 0.90.***

Project Cost..contd

Adjustment in **cost**-Main input costs which need correction in India are

- Foreign Exchange,
- Taxes, Sales and other Indirect Taxes, License Fees, Import Duties,
- Wages and Interest,
- Interest during construction (IDC),
- Contingencies-for Unforeseen Expenses, and
- Inflation
- Investment funds
- Energy cost

Project Benefits

Economic Benefits: Measuring the economic benefits of transport projects usually ***involves more complex conceptual and practical problems*** than does measuring their economic costs. Because;

Some benefits, even though direct-such as the ***increased comfort and convenience*** made possible when a road is improved or the time savings made possible when a bridge replaces ferry service-are ***difficult to express in monetary terms*** since there are usually ***no market prices*** to indicate what people are willing to pay for them.

Benefits in the form of ***reduced transport costs*** accrue to a wide range and a great number of people over a long period of time; this makes ***it difficult to forecast and trace their impact***.

Many ***benefits from improved transport are indirect***, such as the ***stimulation of the economy***; for these benefits to materialize, investments in fields other than transport are often necessary, but they are not always assured.

Project Benefits….contd

The economic benefits from the project will fall in the two main categories i.e. ***user benefits (****direct****) & non-user benefits(****indirect****)***. The most important benefits from transport include any or all of the following:

- ❑Reduced Operating Expenses ***(VOC)*** - initially for the users of the new or improved facility and sometimes also for those who continue to use the existing facilities, which may become less congested
- ❑Stimulation of Economic Development ***(ED)***
- ❑Savings in Time ***(VOT)*** for both Passengers and Freight Shipments
- ❑Fewer Accidents and reduced Property Damage
- ❑Increased Comforts and
- ❑Convenience & Accessibility Level

Project Benefits

The economic benefits considered for the project are as follows:

1] Saving in ***Journey Time*** for Vehicle Users ***(VOT)***

2] Saving in Vehicle ***Operating Cost (VOC)*** for vehicle users due to improved operating conditions

Travel Time Benefits

- Unit VOT/vehicle values have been converted into Unit VOT/PCU by dividing VOT in Rs./ hour/ veh. by mode-wise PCU factor. For estimating unit VOT/vehicle values, unit VOT/passenger values have been multiplied by mode-wise occupancy.

- The occupancy of 50 for buses, 3 for car/taxi, 2 for auto and 1.5 for two-wheeler have been considered. Further composite VOT/PCU has been estimated by considering traffic composition.

VOC Benefits

- For estimating ***VOC benefits***, speed in km/hr for without improvement and with improvement scenarios has been used. The unit VOC values at different speeds and roughness of pavement (mm/km) have been taken from latest Road User Cost Study and updated to suit to the urban road conditions.

- ***VOC savings*** have been estimated by multiplying the traffic volume with difference in unit VOC values for without improvement and with improvement case.

Economic Appraisal

- The annual stream of ***economic costs and benefits*** has been computed over the analysis period. The project's economic viability is assessed in terms of EIRR by applying ***Discounted Cash Flow (DCF) technique*** to the annual stream of the ***Net Benefits*** of the project.

- The discounting rate of return considered minimum for investment decisions by the Government of India and international funding agencies. This, at present, is taken as ***12% for infrastructure projects***, including road projects.

Basic Assumptions

1] Analysis Period: 37 years (2014 to 2050)

2] Construction Period: 07 years (2014 to 2020) & Operation 30 years (2021 to 2050)

3] Cost Phasing: 10:15:15:20:20:10:10 (2014, 2015, 2016, 2017, 2018, 2019, & 2020)

4] Conversion Factor: 0.90 (Financial Cost to Economic Cost)

5] The Financial & Economic Cost: **Rs. 8330.00 Millions & Rs. 7497.00 Millions**

6] The Annual Maintenance Cost: @ Rs. 30 Lakhs per km/year (3.00 Millions)

7] Periodic Maintenance Cost: @ Rs. 90 Lakhs per km (every 5th Year) (9.00 Millions)

8] Length (km): 14.40

Basic Assumptions….contd

9] Annual VOT and VOC Savings Considered: 365 days

10] Economic Benefit Considered: Saving in Journey Time (VOT) &
Saving in Vehicle Operating Cost (VOC)

11] Value of VOT:

Sr. No.	Mode	VOT (Rs/hr/Veh.) 2006 prices	VOT (Rs/hr/Veh.) 2013 prices
1	Bus	753.04	1059.60
2	Car	96.02	135.11
3	Two Wheeler	35.55	50.02
4	Taxi	49.89	70.02
5	Auto	45.49	64.01

12] The VOC values for at different Speeds and Roughness of pavement have been taken from Road User Cost Study and updated to suit to the urban road conditions

The annual stream of economic costs and benefits has been computed over the analysis period. The project's economic viability is assessed in terms of EIRR by applying Discounted Cash Flow (DCF) technique to the annual stream of the net benefits of the project.

EIRR

Year	in Rs. Millions								
	Financial Cost				Economic Cost	Benefits		Total Benefits	Benefits-Cost = Net Benefit
	Capital Cost	Regular Maintenance Cost	Periodic Maintenance Cost	Total Cost		VOT Time Saving	VOC Cost Saving		
2014	833.00	0	0	833.00	749.70	0	0	0	-749.70
2015	1249.50	0	0	1249.50	1124.55	0	0	0	-1124.55
2016	1249.50	0	0	1249.50	1124.55	0	0	0	-1124.55
2017	1666.00	0	0	1666.00	1499.40	0	0	0	-1499.40
2018	1666.00	0	0	1666.00	1499.40	0	0	0	-1499.40
2019	833.00	0	0	833.00	749.70	0	0	0	-749.70
2020	833.00	0	0	833.00	749.70	0	0	0	-749.70
2021	**0**	**43.20**	**0**	**43.20**	**38.88**	**513.38**	**352.70**	**866.09**	**827.21**
2022	0	43.20	0	43.20	38.88	551.00	360.46	911.47	872.59
2023	0	43.20	0	43.20	38.88	591.38	368.40	959.77	920.89
2024	0	43.20	0	43.20	38.88	634.72	376.50	1011.22	972.34
2025	0	43.20	0	43.20	38.88	681.23	384.78	1066.01	1027.13
2026	0	43.20	129.60	172.80	155.52	731.15	393.25	1124.40	968.88
2027	0	43.20	0	43.20	38.88	784.73	401.90	1186.63	1147.75
2028	0	43.20	0	43.20	38.88	842.23	410.75	1252.98	1214.10
2029	0	43.20	0	43.20	38.88	903.95	419.78	1323.73	1284.85
2030	0	43.20	0	43.20	38.88	970.19	429.02	1399.21	1360.33
2031	0	43.20	129.60	172.80	155.52	1041.28	438.46	1479.74	1324.22
2032	0	43.20	0	43.20	38.88	1117.59	448.11	1565.69	1526.81
2033	0	43.20	0	43.20	38.88	1199.48	457.97	1657.45	1618.57
2034	0	43.20	0	43.20	38.88	1287.38	468.04	1755.42	1716.54
2035	0	43.20	0	43.20	38.88	1381.72	478.34	1860.06	1821.18
2036	0	43.20	129.60	172.80	155.52	1482.97	488.87	1971.84	1816.32
2037	0	43.20	0	43.20	38.88	1591.64	499.62	2091.26	2052.38
2038	0	43.20	0	43.20	38.88	1708.28	510.62	2218.89	2180.01
2039	0	43.20	0	43.20	38.88	1833.46	521.85	2355.31	2316.43
2040	0	43.20	0	43.20	38.88	1967.81	533.33	2501.15	2462.27
2041	0	43.20	129.60	172.80	155.52	2112.01	545.07	2657.08	2501.56
2042	0	43.20	0	43.20	38.88	2266.78	557.06	2823.84	2784.96
2043	0	43.20	0	43.20	38.88	2432.89	569.32	3002.20	2963.32
2044	0	43.20	0	43.20	38.88	2611.17	581.85	3193.01	3154.13
2045	0	43.20	0	43.20	38.88	2802.51	594.65	3397.16	3358.28
2046	0	43.20	129.60	172.80	155.52	3007.88	607.73	3615.61	3460.09
2047	0	43.20	0	43.20	38.88	3228.29	621.10	3849.40	3810.52
2048	0	43.20	0	43.20	38.88	3464.86	634.77	4099.63	4060.75
2049	0	43.20	0	43.20	38.88	3718.76	648.74	4367.50	4328.62
2050	0	43.20	0	43.20	38.88	3991.27	663.01	4654.28	4615.40
Total	**8330**				**7497**		**EIRR**		**12.03%**

Comparison of Cost per Vehicle-km by Vehicle & Road Surface (in Rs.)

Cost Item	Bus		Truck		Car	
	With	Without	With	Without	With	Without
Fuel and Oil	21.6	27.3	21.3	27.3	17.7	19.5
Tire Wear	21.9	48.6	21.9	48.6	4.5	10.2
Depreciation	52.2	78.0	36.3	54.6	28.5	36.6
Interest	30.0	42.0	21.0	30.0	21.10	27.0
Maintenance	39.9	63.3	28.2	44.7	7.8	10.5
Wages	12.0	16.2	12.0	16.2	-	-
Total	**177.60**	**275.40**	**140.70**	**220.80**	**79.50**	**103.80**
Benefits	**97.80**		**80.1**		**24.3**	

Vehicle Operating Cost (VOC) = No of Vehicles x No. of Kms x No of Days x Benefits

Thane–Kasarvadavli Metro Corridor

Salient Features

- **Route Length (Elevated)**

a. Main Line	9.86 Km
b. Car Depot Line	0.65 Km (at Owale)

- **Track Length**

• Ballast less	10.51 Km
• Ballasted	10 Km

- **Number of Stations** — 10 Nos.

a. Terminal Stations	2 Nos. (Teen Haath Naka & Kasarvadavli)
a. Intermediate Stations	8 Nos.
b. Interchange Stations	3 Nos. (Teen Haath Naka, Kapurbawadi & Kasarvadavli)

Salient Features…cont'd

- **Platforms Length (6 Coach Length)** 135 m

- **Train Composition** 4 Coaches (DMC+TC+TC+DMC)

- **Train Operation**

Year	**2016**	**2021**	**2031**
PHPDT	17654	24587	31051
Headway in minutes	4.0	2.8	2.3
Coaches Required	48	64	76

Salient Features…cont'd

- **Power Supply**

  i. Traction Receiving Sub Station – 33KVA/25 KVA, 2 Nos. x 25 MVA
  ii. Auxiliary Sub Station – For Car Depot & Stations

- **Land Requirement**

i. Main Line	NIL
ii. Car Depot	40.0 Ha at Owale

- **Total Cost Per Km**

i. Without Land	190.27 Cr.
ii. With Land	212.14 Cr.
iii. With Land & Taxes & Duties	243.86 Cr.

The implementation of Rail-based Mass Rapid Transit System will result in;

- Reduction of the number of buses
- Reduction of Vehicles on the road and
- Increase in the journey speed of road-based vehicles.

This is expected to generate substantial benefits to the economy as a whole in terms of;

- Reduction in fuel consumption,
- Vehicle operating costs, and
- Passenger time.

In addition, there will be;

- Reduction in accidents and atmospheric pollution.
- Reduction in noise,
- Increase in mobility levels,
- Improvement in quality of life and
- General economic growth.

Approach and Methodology

- Economic analysis for MRTS has been carried out within the framework of "with" and "without" the project.

- The **"without the project"** situation assesses the cost to the economy in case the projected volume of traffic continues to move with the prevailing modes of transport.

- The **"with the project"** situation estimates the total costs that the economy would have to bear for introducing the MRTS.

- The cost under the above two situations has been evaluated in terms of **market prices** and then in **economic terms**, deriving the latter from the former by converting market prices into appropriate shadow prices.

Cost

Cost streams

a. Capital cost of infrastructure (civil engineering, track, power supply, signaling an telecommunication etc.) and rolling stock fleet for the MRTS, including additional capital cost and replacement costs.

b. Operating cost of the MRTS and

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

The capital cost, O&M cost and asset replacement costs at constant prices from 2012 onwards after applying the **conversion factor of 0.90** is considered.

Capital Cost, O&M Cost and Asset Replacement Costs (*Costs in Rs crores*)

Year			Completion Cost	Running Expenses	Replacement Cost	Total costs
2013	**-**	**2014**	259.20	0.00	0.00	259.20
2014	**-**	**2015**	396.32	0.00	0.00	396.32
2015	**-**	**2016**	490.47	0.00	0.00	490.47
2016	**-**	**2017**	480.53	0.00	0.00	480.53
2017	**-**	**2018**	752.68	0.00	0.00	752.68
2018	-	2019	0.00	69.83	0.00	69.83
2019	-	2020	0.00	69.83	0.00	69.83
2020	-	2021	0.00	69.83	0.00	69.83
2021	-	2022	0.00	69.83	0.00	69.83
2022	-	2023	0.00	69.83	106.62	176.45
2023	-	2024	0.00	70.92	0.00	70.92
2024	-	2025	0.00	70.92	0.00	70.92
2025	-	2026	0.00	70.92	0.00	70.92
2026	-	2027	0.00	70.92	0.00	70.92
2027	-	2028	0.00	70.92	0.00	70.92
2028	-	2029	0.00	70.92	0.00	70.92
2029	-	2030	0.00	70.92	0.00	70.92
2030	-	2031	0.00	70.92	0.00	70.92
2031	-	2032	0.00	70.92	0.00	70.92
2032	-	2033	0.00	70.92	71.08	142.00
2033	-	2034	0.00	72.79	0.00	72.79
2034	-	2035	0.00	72.79	0.00	72.79
2035	-	2036	0.00	72.79	0.00	72.79
2036	-	2037	0.00	72.79	0.00	72.79
2037	-	2038	0.00	72.79	0.00	72.79
2038	-	2039	0.00	72.79	51.02	123.81
2039	-	2040	0.00	72.79	0.00	72.79
2040	-	2041	0.00	72.79	0.00	72.79
2041	-	2042	0.00	72.79	0.00	72.79
2042	-	2043	0.00	72.79	0.00	72.79
2043	-	2044	0.00	72.79	0.00	72.79
2044	-	2045	0.00	72.79	0.00	72.79
2045	-	2046	0.00	72.79	0.00	72.79
2046	-	2047	0.00	72.79	0.00	72.79

Benefits

The introduction of rail based MRTS will yield tangible and non-tangible savings due to equivalent reduction in road traffic and certain socio-economic benefits. These include;

- 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
- Benefits due to structuring effects as discussed above
- Real estate price increase, thereby increasing overall wealth held by the public.

Benefits taken into account

a. **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 MRTS project is not taken up.

b. Savings, due to decongestion in vehicle operating cost of all buses and other vehicles including those that would continue to use the existing transport network even after the MRTS is introduced.

c. Savings in time of commuters using the MRTS over the existing transport modes because of faster speeds of MRTS and because of reduced congestion on roads.

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

e. Savings on account of prevention of accidents and pollution, with introduction of MRTS and 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.

Effects on bus transportation system

The transport scenario in years 2016, 2021 and 2031 in terms of modal split amongst vehicular trips with and without MRTS is projected to be as under:

Vehicular Trips with and without MRTS (*Trips in Lakh*)

SN	Mode	Trips Without MRTS			Trips With MRTS		
		2016	2021	2031	2016	2021	2031
1	Bus	2.46	3.31	4.06	0.93	1.14	1.68
2	Car	2.43	3.31	4.30	0.98	1.26	2.05
3	Taxi	0.09	0.13	0.16	0.04	0.05	0.08
4	2-Wheelers	0.55	0.75	0.97	0.22	0.28	0.46
5	3-Wheelers	0.14	0.19	0.24	0.06	0.07	0.11
6	MRTS	0.00	0.00	0.00	3.44	4.88	5.35
	Total	**5.67**	**7.68**	**9.73**	**5.67**	**7.68**	**9.73**

1. Capital Cost Savings of Bus System

The traffic on MRTS will come from shifting from traffic from buses, train, IPT and private modes. The major shifting of traffic would be from buses. It has been estimated that 115 buses are likely to decrease with the introduction of this MRT corridor. This will save Rs. 26.89 Crores in the year 2018 towards capital cost of bus system.

2. VOC savings

The Vehicle Operating Cost (VOC) savings on account of overall reduced road vehicles estimated for horizon years 2018, 2021, 2031 and 2041 at constant prices is as under:

2018	2021	2031	2041
Rs 237.92 crore	Rs 296.37 crore	Rs 373.91 crore	Rs 480.82 crore

The above savings have been worked out with the following assumptions / considerations:

Mode	Average speed (kmph)		Daily vehicle utilization (Km)	Occupancy / vehicle	Vehicles in the influence area
	Without metro	With metro			
Bus	10	12	211	34	30%
Car	15	20	30	2	30%
2 wheeler	15	20	30	1.2	30%
3 wheeler	15	20	100	1.8	30%

Mode	Vehicle Operating Cost (VOC)	
	Rs / Km	Rs / Hour
Bus	52.66	840.48
Car	9.21	160.07
2/3 wheeler	4.62	80.19

3. Vehicle operating costs (VOC) saved on account of decongestion effect

Consequent to the introduction of MRTS, the decongestion effect of road vehicles will be experienced in the influence zone of MRTS. This will **increase average speed of road vehicles (buses, cars, 2-wheelers etc.)** and thus will be required to spend less time on road for same distance covered, thus reducing the vehicle operating costs. This saving at constant prices is estimated as under with consideration that 30% of all road vehicles will be in the influence zone of MRTS.

2018	2021	2031	2041
Rs 7.69 crore	Rs 8.98 crore	Rs 15.35 crore	Rs 19.74 crore

4. Value of passenger time saved

With the introduction of MRTS, not only the passengers traveling by MRTS but also others traveling by buses and private vehicles will commute at faster speeds.

The time saving has been converted to equivalent monetary benefit to economy/society. With the help of traffic volume counts, time and delay studies and computer modeling, the average speeds of cars and 2-wheelers in year 2018 and beyond have been estimated as 20 kmph **with MRTS**.

The **speed without MRTS** has been estimated to be 15 kmph respectively. The corresponding average speeds of buses have been taken as 12 kmph and 10 kmph respectively.

2018	2021	2031	2041
Rs 170.10 crore	Rs 200.73 crore	Rs 356.50 crore	Rs 458.43 crore

Determining Value of passenger travel time

The value of passenger time is considered as **average cost per hour of travel and waiting time**

Mode	Waiting time (Rs / hr)	Travel Time (Rs / hr)	Average of WT and TT (Rs / hr)
Two wheeler	44.00	36.50	40.25
Car	--	79.00	79.00
Bus	22.50	20.00	21.25
Trains	15.00	13.00	14.34

5. Benefits due to less pollution

There will be substantial benefits arising out of reduced air pollution, with the introduction of MRTS in the year 2018 due to less number of vehicles on road with MRTS implemented. The savings at constant prices has been estimated as under:

2018	2021	2031	2041
Rs 15.59 crore	Rs 18.75 crore	Rs 22.28 crore	Rs 25.86 crore

Assumptions for fuel consumption & emission

Mode	Fuel consumption (Litre / km)	Reduction in fuel consumption due to decongestion effect (Litre / km)	Pollution emission (kg/1000 Litres)
Bus	0.279	0.0682	96.5
Car	0.077	0.0287	447.6
2 wheeler	0.029	0.0096	447.6
3 wheeler	-	0.0192	447.6

Damage cost of pollution : **Rs 51/- per kg** (escalated to current prices)

6. Reduction in Accidents

Introduction of MRT system is 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.** It is considered reasonable to take a figure of 2.5 (fatal accidents per 10000 vehicles) and 6.5 (non-fatal accidents per 10000 vehicles).

Cost of road accidents

The estimated average costs due to road traffic crashes in India as per 1999 evaluation of road accident costs in India in rupees for the year 1999 damage cost due to road accidents have been researched over the years and a summary of cost implication due to road accidents as estimated by various studies is as under:

Type of accident	Estimated average costs in Rupees for year of study
Fatal	535489
Serious injury	106959 (Serious) 242736 (Major)

In the analysis, the 1999 data have been escalated to 2012 using WPI figures. The escalation factor is about 1.60.

Reduction in Accidents…cont'd

The savings in accident cost due less number of accidents in case MRTS scenario, works out as under:

2018	2021	2031	2041
Rs 3.89 crore	Rs 4.73 crore	Rs 5.18 crore	Rs 6.02 crore

Cost Benefit Analysis

Measuring the economic cost and benefits of a project involves adjusting the actual expenditures on inputs where the prices paid do not properly reflect the real scarcity value of the inputs. The financial cost of the MRTS system is converted into the economic cost by using the conversion factor 0.90.

The cost and benefit streams for 35-year period in the economic prices have been worked out for MRTS network.

The residual value of MRTS facilities (e.g. equipment for power supply and telecommunication, 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 in economic terms** is arrived at by using conversion factor. The EIRR in economic terms work out to **17.06 %** for the MRTS project. It is accordingly seen that the proposed project is economically viable.

Sr. No.	Year			Capital Cost	O&M Expenses	Total Cost	Capital Cost Saving of Bus System	VOC Saving of all Vehicles	Decongestion Effect	Passenger Time	Less Pollution	Accident Costs	Total Savings	Net Cash Flow
1	2013	-	2014	259.20		259.20							0	-259.2
2	2014	-	2015	396.32		396.32							0	-396.3
3	2015	-	2016	490.47		490.47							0	-490.5
4	2016	-	2017	480.53		480.53							0	-480.5
5	2017	-	2018	752.68		752.68							0	-752.7
6	2018	-	2019	0.00	69.83	69.83	26.89	237.92	7.69	170.10	15.59	3.89	462.09	392.3
7	2019	-	2020	0.00	69.83	69.83	28.83	257.00	8.11	180.10	16.64	4.17	494.86	425.0
8	2020	-	2021	0.00	69.83	69.83	30.77	276.48	8.54	190.31	17.70	4.45	528.25	458.4
9	2021	-	2022	0.00	69.83	69.83	32.16	296.37	8.98	200.73	18.75	4.73	561.73	491.9
10	2022	-	2023	106.62	69.83	176.45	32.47	303.52	9.57	214.98	19.10	4.78	584.42	408.0
11	2023	-	2024	0.00	70.92	70.92	32.78	310.80	10.16	229.53	19.46	4.82	607.55	536.6
12	2024	-	2025	0.00	70.92	70.92	33.08	318.24	10.77	244.37	19.81	4.87	631.14	560.2
13	2025	-	2026	0.00	70.92	70.92	33.39	325.84	11.39	259.52	20.16	4.91	655.21	584.3
14	2026	-	2027	0.00	70.92	70.92	33.70	333.59	12.02	274.99	20.52	4.96	679.77	608.9
15	2027	-	2028	0.00	70.92	70.92	34.01	341.33	12.66	290.63	20.87	5.00	704.50	633.6
16	2028	-	2029	0.00	70.92	70.92	34.31	349.23	13.31	306.59	21.22	5.05	729.72	658.8
17	2029	-	2030	0.00	70.92	70.92	34.62	357.28	13.98	322.89	21.57	5.09	755.44	684.5
18	2030	-	2031	0.00	70.92	70.92	34.93	365.51	14.66	339.52	21.93	5.14	781.68	710.8
19	2031	-	2032	0.00	70.92	70.92	34.84	373.91	15.35	356.50	22.28	5.18	808.06	737.1
20	2032	-	2033	71.08	70.92	142.00	35.36	383.35	15.74	365.50	22.61	5.26	827.83	685.8
21	2033	-	2034	0.00	72.79	72.79	35.89	393.07	16.14	374.77	22.95	5.34	848.17	775.4
22	2034	-	2035	0.00	72.79	72.79	36.43	403.08	16.55	384.31	23.30	5.42	869.09	796.3
23	2035	-	2036	0.00	72.79	72.79	36.98	413.39	16.97	394.14	23.65	5.50	890.63	817.8
24	2036	-	2037	0.00	72.79	72.79	37.53	424.01	17.41	404.26	24.00	5.58	912.80	840.0
25	2037	-	2038	0.00	72.79	72.79	38.10	434.71	17.85	414.47	24.36	5.67	935.16	862.4
26	2038	-	2039	51.02	72.79	123.81	38.67	445.74	18.30	424.98	24.73	5.75	958.17	834.4
27	2039	-	2040	0.00	72.79	72.79	39.25	457.09	18.77	435.81	25.10	5.84	981.84	909.1
28	2040	-	2041	0.00	72.79	72.79	39.84	468.78	19.25	446.95	25.47	5.93	1006.21	933.4
29	2041	-	2042	0.00	72.79	72.79	40.43	480.82	19.74	458.43	25.86	6.02	1031.29	958.5
30	2042	-	2043	0.00	72.79	72.79	41.04	492.96	20.24	470.01	26.24	6.11	1056.59	983.8
31	2043	-	2044	0.00	72.79	72.79	41.66	505.46	20.75	481.92	26.64	6.20	1082.63	1009.8
32	2044	-	2045	0.00	72.79	72.79	42.28	518.33	21.28	494.20	27.04	6.29	1109.41	1036.6
33	2045	-	2046	0.00	72.79	72.79	42.91	531.58	21.83	506.83	27.44	6.39	1136.99	1064.2
34	2046	-	2047	0.00	72.79	72.79	43.56	545.24	22.39	519.85	27.85	6.48	1165.37	1092.6
35	2047	-	2048	0.00	72.79	72.79	44.21	559.01	22.95	532.98	28.27	6.58	1194.00	1121.2
													EIRR =	**17.06%**

Economic Profile of the Project

The economic internal rate of return of **17.07%** for the Thane - Kasarvadavli MRTS project is above the cut-off criterion of 12% as prescribed by Planning Commission for infrastructure projects, implying that the economic benefits accruing out of this project are substantial and will yield savings to the economy as a whole.

Based on the above criterion, the **project is recommended for implementation.**

Sensitivity Test

Further, as a sensitivity test, the effect on IRR of 10% increase in capital cost and 10% decrease in economic benefits has also been estimated. On the basis of the analysis, the EIRR works out as follows:

S. No.	Description	EIRR (%)
1.	Base Case	**17.06**
2.	Sensitivity test 10% increase in capital cost	**15.96**
3.	Sensitivity test 10% decrease in economic benefits	**15.67**
4.	Both Cases	**14.64**

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