

# Cost Benefit Analysis of Public Project, Noida Greater Noida Metro Extension

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**ABSTRACT :** The colossal massive exponential growth of public transport in mega cities has grabbed the concentrated attention from all sectors of urban development authorities. Especially due to the atmospheric pollution, land use patterns, time consuming in travelling and ecological misbalance. The initiation of CNG vehicles and pioneer development of mass rapid transport system had foot printed huge success in achieving the depletion of atmospheric pollution. The metro network is considered one of the major stone in the economic, atmospheric pollution, reduction in accidental rates, fuel saving. This report is intended to provide a consistent approach for completing the cost benefit analysis of Noida –Greater Noida metro comprising of 21 stations covering distance of 29.707 km from Noida sector 1 Noida to Delta station Greater Noida. Regarding financial aspect, investment of about 40% by Noida Greater Noida, 19.25% by Noida authority, 14.28% by GOI and UP government both respectively. The financial internal rate of return 2.8% is taken taking estimation parameters study commissioned by government of India, Planning commission and institute of economic growth. Under economic analysis with economic internal rate of return 10% of this project is significantly viable project because it generates multiple social benefits which incorporate in economic analysis. Hence, adding all the social benefit and subtracting social cost, we calibrated Net Present Value (NPV) amounted Rs 26349.05 cr and Benefit Cost Ratio (BCR) is 2.5 which shows significantly viable project.

**KEYWORDS :** Benefit Cost Ratio, Economic and Financial Internal Rate of Return, Mass Rapid Transport System, Net Present Value.

## I. Introduction

Noida is a planned city under the management of the New Okhla Industrial Development Authority (also called NOIDA). It is a satellite city of Delhi and is part of the National Capital Region of India. Both Noida and Greater Noida located in the GautamBudh Nagar district of the Uttar Pradesh. The population of district was 1,674,714 as per 2011 census of India. Also the estimated population of Gautam nagar district was above 20 lakh as per 2011 census. Though the population has increased sharply, but public transport vehicles rose to only 36,000 in 2018 from 29,000 in 2016. In fact, there are two lakh private cars and 3.72 lakh bikes registered in Noida and Greater Noida. Besides harvesting such huge number of population and transport the catchment areas of twin urban cities mainly Delhi the capital of country also shares its 16 million as per 2011 census. The road length of Delhi will grow up to the 1340 km in 2021. The cumulative figure of registered private and government buses, the main means of public transport, is 41,872 in 1990 and it is expected to increase to 81,603 by the year 2011. The number of personal motor vehicles has increased from 5.4 lakhs in 1981 to 30 lakhs in 1998 and is projected to go up to 35 lakhs by 2011. In addition to this the traffic of highways and expressways of other states also contributed to the traffic congestion volume, hence resulted in enhancing of atmospheric pollution and delay in travelling. Henceforth the multi modal mass rapid transport system working successfully in Delhi under Delhi metro was developed connecting the twin urban cities Noida –Greater Noida by Noida Metro Rail cooperation ltd.

### 1.1 Need for Metro

Today the twin urban cities is witnessing the huge magnitude of population growth exponentially both into parental normal growth of population and secondary by migration of peoples from all corners of country for working, education and business purposes. The big IT giant companies have developed firm roots in the cities hence attracting huge number of employees on daily basis. The increase in per capita income due to healthy economy and the growing population in urban areas lead to steep increase in ridership on the road (two-wheelers, autos, cars and public transport buses), thus in turn lead to tremendous traffic congestions on the urban road. The Noida metro facilitates multiple benefits for all the concerns and in return avail the benefits to the number of economic agents like government, public, transporters, skilled and unskilled labours.

## II LITERATURE REVIEW

A significant feature of a CBA approach to RDI is the stochastic nature of the model, intended to deal with the uncertainty and risk of optimism bias in the estimates. The core of CBA is an evaluation (ex-ante or ex-post) of the project intertemporal socio-economic benefits and costs; all expressed in units of welfare numeracies (usually money in present value terms). The net effect on society is finally computed by a quantitative performance indicator (the net present value, or the internal rate of return, or a benefit/cost ratio). The model on which the rest of the paper is built takes the form of a simple yet comprehensive equation. The implementation of project as ecologically sustainable platform and atmospheric pollution controlling, saving in travelling time and converting all these elements into the monetary value for the calculation of Cost Benefit Analysis. The social cost-benefit analysis of the Metro requires the identification of benefits and the economic agents affected by it. The number of techniques and formulas are used for converting the social benefits into monetary value thus gives the helping tool for the study. SBCA acts as an evidence of social commitments by ensuring distribution and redistribution of income among various classes of the society.

## III Cost Benefit Analysis

Cost-benefit analysis (CBA) is a systematic approach to estimate the short and long term consequences measuring all costs and all possible profits and benefits from an investment project proposal taking into account both quantitative and qualitative factors sometimes called benefit-cost analysis (BCA). The basic questions asked in a cost-benefit analysis are, "Do the economic benefits of providing this service outweigh the economic costs" and "Is it worth doing at all"? One important tool of cost-benefit analysis is the benefit-to-costs ratio, which is the total monetary cost of the benefits or outcomes divided by the total monetary costs of obtaining them. Another tool for comparison in cost-benefit analysis is the net rate of return, which is a basically total cost minus the total value of benefits.

### 3.1 PRINCIPLES OF COST BENEFIT ANALYSIS

1. First Principle Of The Cost-Benefit Analysis: Identifying Project Alternatives
2. The Second Principle Of Cost-Benefit Analysis: Concept Of Social Profitability
3. The Third Principle Of Cost-Benefit Analysis: Distributional Effects:
4. The Fourth Principle Of Cost-Benefit Analysis: Social Discount Rate:
5. The Fifth Principle Of Cost-Benefit Analysis: Net Present Value (Npv):

$$NPV = \sum \text{of benefits} - \sum PV \text{ of costs}$$

$$NPV = -CF_0 + \sum_{N=1}^n \frac{CF_N}{(1+i)^N}$$

Where:

$$\text{Initial investment} = -CF_0$$

$$\text{Cash inflows/outflows} = CF_1, CF_2, \dots, CF_n$$

- If the NPV is greater than 0, accept the project.
- If the NPV is less than 0, reject the project

6. The Sixth Principle Of Cost-Benefit Analysis: Shadow Prices
7. The Seventh Principle Of Cost-Benefit Analysis: Non-Valued And Non-Quantified Effects
8. The Eighth Principle Of Cost-Benefit Analysis: Sensitivity Analysis: Uncertainty Can Be Quantified By A Sensitivity Analysis
9. Last Principle Of Cost-Benefit Analysis: The Decision

#### IV. RESEARCH METHODOLOGY

**4.1 FINANCIAL ANALYSIS :** The financial evaluation of a project requires the analysis of its annual cash flows of revenue and costs considering it as a commercial organization operating with the objective of maximizing private profits. Construction was started on 25th May 2015 with and estimated end up was Target date 15th Sept.2018 but due to various obstacles it was started on 25 January 2019 but estimation was done on April 2014 price level.

**Table No. 1 Source of Financing**

Source of Fund	With Taxes & Duties	
	Amount (Rs/Crore)	% of Contribution
Equity by GOI	741.50	14.28%
Equity by UP Govt.	741.50	14.28%
SD for CT by UP Govt.(50%)	297.50	5.73%
SD for CT by GOI (50%)	297.50	5.73%
Grant by Noida Authority	1000.00	19.25%
Contribution from Noida Greater Noida	2116.00	40.73%
Total	<b>5194.00</b>	100%
Land free by Noida Greater Noida Authority	339.00	
Grand Total	<b>5533</b>	

#### 4.2 COST:

**Table No. 2 Detailed Cost**

S No.	Item	Amount
1	Land	329
2	Alignment and formation	1067.40
3	Station Buildings (including E&M Works)	478.02
4	Depot	145.00
5	Permanent Way	283.62
6	Traction & Power	360.83
7	Signaling and Telecom	564.57
8	R & R incl. Hutments and road restoration etc	7.35
9	Misc. Utilities, other civil works such as median road signage , etc	87.26
	Sub Total (9)	
10	Rolling Stock (BG)	440.00
11	Capital expenditure on security	75.00
	Sub Total (12)	
12	Total of all items except Land	3509.05

13	Capital expenditure on multimodal traffic integration at station for first and last mile connectivity	75.00
14	Total of all items except Land	3584.78
15	General charges incl. design charge @7% on all items except land	250.93
16	Total of all items including general charges	3835.71
17	Total of cost inclusive land cost	4164.71
18	Contingencies @ 3%	124.94
	Gross Total	4289.65

**4.3 Calculation of Net Present Value and Benefit Cost Ratio:** For estimating the NPV first we have to calculate the total revenue, the total revenue is the product of annual passenger and average passenger rate (taken as 18) for the period of 30 years starting from 2019 with 25000 daily passenger with the increment of 30% upto 2876063.23 daily passenger in 2047. Hence giving the total fare box collection of 13951.8 cr. Also adding property development cost of 22289 cr. Hence total revenue = 36240.8 cr.

Total Cost = 5533 + 12873.84 = 18406.8 (operation and maintenance cost for the period of 30 years = 12873.84 cr data by Noida Metro Rail Corporation).

Net Benefit = 17834

NPV = -572.8

Benefit – cost ratio = .9

**4.4 FINANCIAL INTERNAL RATE OF RETURN :** The FIRR is obtained by equating the present value of investment costs (as cash out-flows) and the present value of net incomes (as cash in-flows). In our study, we assume 30 years life of this project so we use the Ms Excel for calculating the IRR.

Table No. 3 Calculation of FIRR

Year	Outflow				Total costs	Inflow			Cash Flow
	Completion cost	Additional cost	Running Expenses	Replacement costs		Fare Box Revenue	PD & ADVT	Total Revenue	
2014-15	559				559				-559
2015-16	1313				1313				-1313

2016-17	1659				1659				<b>-1659</b>
2017-18	1109		58		1167		5	5	<b>-1162</b>
2018-19	893		126		1019		12		<b>-1007</b>
2019-20	0		137		137	16.5	-501	-484.5	<b>-621.5</b>
2020-21	0		148		148	20.6	-415	-394.4	<b>-542.4</b>
2021-22	0		160		160	25.9	-304	-278.1	<b>-438.1</b>
2022-23	0	800	175		975	38.5	220	260.4	<b>-714.6</b>
2023-24	0		210		210	40.4	234	274.4	<b>64.4</b>
2024-25	0		228		228	50.5	300	350.5	<b>122.5</b>
2025-26	0		246		246	63.1	370	433.1	<b>187.1</b>
2026-27	0		267		267	78.8	440	518.8	<b>251.8</b>
2027-28	0		288		288	98.5	517	615.5	<b>327.5</b>
2028-29	0		312		312	103.4	589	692.4	<b>380.4</b>
2029-30	0		338		338	129.3	932	1061.3	<b>723.3</b>
2030-31	0		366		366	161.6	979	1140.6	<b>774.6</b>
2031-32	0		396		396	201.9	1038	1239.9	<b>843.9</b>
2032-33	0	2467	490		2966	223.3	1089	1312.3	<b>-1653.7</b>
2033-34	0		530		530	267.1	1157	1424.1	<b>8941.1</b>
2034-35	0		574		574	307.1	1214	1521.1	<b>947.2</b>
2035-36	0		620		620	353.2	1293	1646.2	<b>1026.2</b>
2036-37	0		671		671	406.2	1357	1763.2	<b>1092.2</b>
2037-38	0		726		726	467.1	1447	1914.1	<b>1188.1</b>
2038-39	0		785	683	1468	537.2	1519	2056.2	<b>588.2</b>
2039-40	0		849	717	1566	617.8	1623	2240.8	<b>1321.8</b>
2040-41	0		919		919	710.4	1704	2414.4	<b>1495.4</b>
2041-42	0		994		994	816.9	1825	2641.9	<b>1647.9</b>
2042-43	0		1076		1076	939.5	1916	2855.5	<b>1779.5</b>
2043-44	0		1164		1164	1080.4	2058	3138.4	<b>1974.4</b>
2044-45	0		1256		1256	1242.5	2184	3426.5	<b>2170.5</b>
2045-46	0		1296		1296	1428.8	2230	3658.8	<b>2362.8</b>
2046-47	0		1325		1325	1643.2	2275	3918.2	<b>2593.2</b>
2047-48	0		1395		1395	1889.9	2296	4195	<b>2800</b>

**4.5 Discussion of Result And Recommendations:** According to the recent guidelines of ministry of urban development (MOUD) to achieve FIRR greater than 8%. The IRR calculated from the above table was less than the targeted mark. Henceforth few recommendations have to be put on the ground so the project will be financially sound .

A. 50 Hectare of free land have to provide by the Noida Authority for the Property Development .

B . Minimum 500 Cr amount have to grant by Noida or Greater Noida Authority. In this connection Noida metro rail corporation ltd. Vide letter no. NMRC/ED/2014/23 dated 18/12/2014 has intimated that Noida has agreed to increase the grant amount from Rs 500Cr. To Rs 1000Cr and the balance amount shall be borne by Noida-Greater Noida Authority out of their own sources instead of loan.

C. The Total completion tax with central tax and land duties cost summing and amount of 732 Cr have to reimburse or to be exempted.

D. The additional costs have to be observed by the Central Government.

Applying any two recommendations from the above aforesaid statements for getting the FIRR greater than 8%, we get FIRR=9%.while as without considering recommendations the calculated FIRR was 2.9 %.

#### 4.6 ECONOMIC ANALYSIS:

An economic benefit is any benefit that we can quantify in terms of the money that it generates.

##### 4.6.1Reduction in the number of vehicles on road due to traffic diversion:

Gautham Nagar district has a total population of 1,674,714 according to the 2011 census .The total registered vehicles in UP according to record by government is 21.6 million, the total registered vehicles in delhi is 8.5 million and total registered vehicles of Noida Greater Noida is .6 million. RITES (2005) estimated that depending on the population density of where the rail line passes, about 30% of road transport is influenced by the rail. The remaining vehicles operating on the road network are assumed to be used by riders who by choice prefer road transport.

Note: It is assumed that 5 % of delhi transport and 2% of UP transport will have the ridership on twin cities

Total Diverted Traffic = 16.512 million

##### 4.6.2Savings in fuel consumption :

The saving s in fuel consumption is calculated by multiplying total diverted traffic by fuel saving multiplied by conversion price =5981.7 million The fuel savings further translates into savings on foreign exchange for the Indian economy. Murty and Goldar (2006) estimated the shadow prices of the foreign exchange as being 10% higher than the market exchange rate. Therefore the value of fuel saving = 6579.87 million.

##### 4.6.3Reduction in air pollution:

To monetize this impact, we find the product of the total coefficient of emission by different pollutants and the number of diverted traffic due to the introduction of NMRC. Further we use shadow prices estimated by recent literatures in India (Murty and Gulaty, 2005 and Dhavala et al, 2006). So the total the total emission coefficient (14.785) and multiply by the diverted traffic gives Rs 224 million.

##### 4.6.4Savings in passenger time:

The savings of travel time of passengers travelling by the Metro instead of by road are calculated as the product of the number of passengers travelled daily and the time saved on the average passenger .



**Table No. 4 savings in Passenger Timing**

	<b>Metro</b>
Daily Passengers carried(m) average of 30 years	.5
Time saved on average lead(Estimated by RITES1995)(Hours)	.31
Value of time per passenger(Estimate by RITES1995) (Rs)	5.96
Value of daily time savings(Rs. Million)	.92

**4.6.5 Savings in vehicular operating costs:**

It is estimated by multiplying the residual traffic, time saved on average lead per vehicle annually and the vehicle operating cost per hour. After calculations savings in vehicular operation cost = 85 cr for NMRC.

**4.6.6 Savings due to fewer accidents:**

The Road User Cost Study (CRRRI, 1982) later updated by Dr. L. R. Kadiyaliet. al. in association with the Loss Prevention Association of India provides estimates of the cost of various accidents on road. Components like gross loss of future output due to death/major injury, medical treatment expenses, legal expenses, and administrative expenses on police, insurance companies and the intangible psychosomatic cost of pain were included in the estimation. In the case of buses and other public vehicles, the loss due to lay off period and unproductive wages paid to the crew are also included. These studies have found that the following relationships exist between the number of vehicles affected and the number of persons killed and injured in road accidents.

$$Y1 = 49.43X + 750.42 \quad R2 = 0.89 \quad Y2 = 257.04X + 3181.41 \quad R2 = 0.90 \quad \text{where,}$$

X: number of vehicles affected in lakhs

Y1: number of persons killed in road accidents in a particular year

Y2: number of persons injured in road accidents in a particular year

<b>Accident rate in the year 2016</b>	<b>Per Cr. Vehicle KM</b>	<b>Cost in Rs.</b>
All Types	1.8	588911
Fatal Accident	.018	169264

**4.7 Economic Evaluation:**

Hence taking into considerations all user benefits and converted benefits into the monetary form.

$$A. \text{ Total cumulative Benefit} = 765.555 + 45219.5 = 45985.05 \text{ cr}$$

$$\text{Total Cost} = 19636 \text{ cr}$$

$$\text{Net Present Value} = 26349.05 \text{ cr}$$

$$\text{Benefit - Cost Ratio} = 2.5$$

$$B. \text{ Applying Discount Rate of 10\% :}$$

$$\text{Total Benefit} = 4632.81$$

$$\text{Total Cost} = 2833.4$$

$$\text{NPV} = 1799.4$$

$$\text{Benefit - Cost Ratio} = 1.6$$

#### 4.8 SENSITIVITY ANALYSIS:

Sensitivity analysis is a systematic method for examining how the outcome of benefit-cost analysis changes with variations in inputs, assumptions, or the manner in which the analysis is set up.

**Table No.6 Sensitivity Analysis**

Traffic	Cost	EIRR	B/C
0 %	0%	10 %	2.5
-5 %	0%	9.7%	2.3
-10%	0%	9.2%	2.1
0%	5	9.5	2.2
0%	10%	8.9	2.1

#### V. CONCLUSION :

The detailed analysis of the mega public projects in terms of financially and economically feasible parameters is a comprehensive and extensive process. The Noida – Greater Noida Metro, with 21 stations (15 in Noida and 6 in Greater Noida) fully elevated on the stretch distance of 29.707 km with total completion cost of 5533 cr. The implementation of Noida metro was principally designed for counterbalance for the exponential increase in traffic both public and private. It also facilitates in various benefits like reduction in pollution, saving in travel time, saving in vehicle operating cost, healthy control on accident. The comprehensive study was done using embellished literature review, descriptive analysis of data and focussed approach in applying the collected data. The financial internal rate of return was estimated 9% when property development and other cost recommendation was applied and the Benefit –Cost Ratio was calculated .9 .Hence demanding task for catching private firms for the project. With regard to the economic analysis taking monetary values of inferential benefit parameters the economic rate of return was around 10% with a healthy Benefit Cost ratio 2.5 without discount and 1.6 with discount rate of 10%. Hence symbolize and firms the study on valid conclusion that this project is financially and economically profitable and worthwhile. While executing the project the analysis part of converting the economic benefits into monetary values needs to be done on valid, non-hypothetical mathematical methods. The Conversion factors practised should get freed from hypothetical shadows. For calculating the ridership figures and other economic parameters should employ the in depth study and concrete favourable assumptions. Any future use of Cost – Benefit Analysis of public projects should use a solid, refined models ,cultivate methodologies for getting the actual values and conversion factors like scenario analysis can be done for getting the real time values etc.

#### VI. Acknowledgements

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