



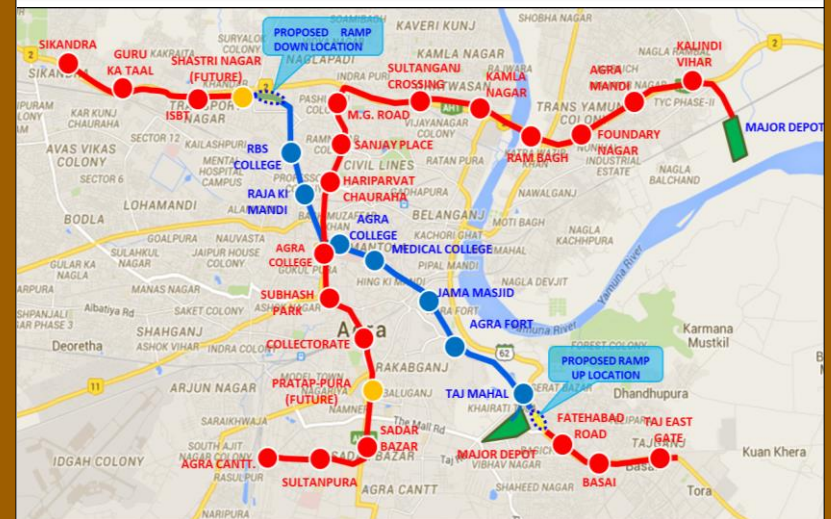
Government of Uttar Pradesh
through
Agra Development Authority



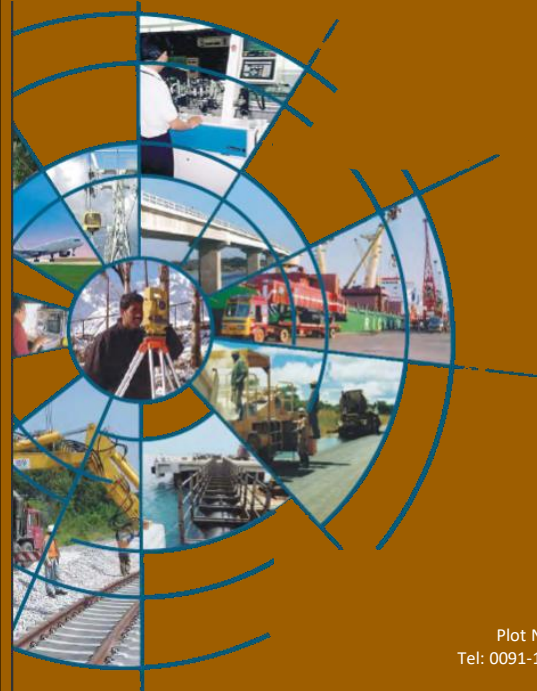
Coordinated by
Lucknow Metro Rail Corporation



SUPPLEMENTARY DOCUMENT TO DPR FOR RAIL BASED MASS RAPID TRANSIT SYSTEM IN AGRA



January 2019



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PREFACE

- 1.1 Government of Uttar Pradesh has engaged RITES Ltd. for preparation of Detailed Project Report (DPR) for Rail based Mass Transit System in Agra city as a long-term solution to meet the transportation demands of the most populous city of Uttar Pradesh. Agra Development Authority (ADA) has been the nodal agency and Lucknow Metro Rail Corporation (LMRC) the coordinator for preparation of DPR. The DPR has been prepared as per the new Metro Policy issued by Ministry of Housing and Urban Affairs (MoHUA), Government of India in August, 2017 and submitted to Government of Uttar Pradesh (GoUP) in December, 2017. The same has since been submitted to MoHUA, GOI on 24th January, 2018 after approval of the State Government.
- 1.2 RITES provided a detailed report on cost estimation of Kanpur and Agra Metro projects vide letter dated 24.08.2018 in response to MoHUA's D.O. No. K-14011/08/2016-MRTS-IV Dated: 20th July 2018 from OSD (UT) & Ex Officio Joint Secretary and forwarded to RITES by LMRC vide letter No. 2163/LMRC-P-15/16/17/2015 dated: 26.10.2018 along with GoUP letter No. 1460/आठ-7-18-15 मेट्रो /2017 dated: 23.10.2018 for re-examination of cost and ways & means to reduce them as desired by GoUP and make it comparable with cost of similar other recent Metro Rail projects in the Country. It was highlighted that comparing the cost of various metro projects on an average basis by simply dividing the project cost with total route length is not appropriate.
- 1.3 The land-use development densities, traffic requirements and ground constraints for various cities are different and thus the lengths of elevated, underground and at-grade sections of metro project vary in each city. In addition, the requirement of number and size of metro stations also vary from city to city based on the catchment and the ridership projections. The other city specific requirements which affect the project cost include frequency of services (Headways) resulting in higher rolling stock per route km, number of entry/exits that need to be planned at each station, requirement of multi-modal integration at each station etc.
- 1.4 Agra is one of the very old historical, industrial and densely populated cities of the country. Increasing population of the city and consequent increase in the number of vehicles with almost nil possibility of widening of existing roads is leading to increase

of traffic congestion on these roads. To meet the long-term traffic demand needs of the city, construction of Agra Metro has been proposed with 3-Car train configuration. According to the geographical structure of Agra, there is 7.7 km underground section, which is 25% of the total length (30 km) and the balance 22.3 km is elevated section.

- 1.5 A meeting was chaired by Secretary, MoHUA on 20.10.2018 where it was decided that various ways to reduce the project cost must be explored. This has also been desired by GoUP vide its letter dated 23.10.2018 forwarded to RITES vide LMRC letter dated 26.10.2018. RITES has identified certain facilities provided in DPR that can be curtailed to reduce the cost and a detailed report was submitted vide letter no. RITES/UT/CO/AGRA MRTS/AA/656/2017 dated 26.11.2018.
- 1.6 Further, the meetings have been held at MoHUA, GOI on 21.12.2018 and 22.12.2018 wherein rates for individual components of work have been decided on the basis of benchmarking exercise undertaken by MoHUA for similar projects. Based on these finalized rates and in reference to GoUP letter no. 1680 / आठ-7-18-15 मेट्रो / 2017 dated 28.12.2018 forwarded vide LMRC letter dated 31.12.2018, '**SUPPLEMENTARY DOCUMENT TO DPR**' containing revised Chapters on 'Cost Estimate', 'Financial Analysis & Non-Fare Box Revenue Assessment' and 'Economic Analysis' have been prepared for Agra Metro Rail project and is submitted herewith.
- 1.7 The cost optimization has been achieved by curtailing certain facilities earlier provided in the DPRs such as reducing number of entry/exits at stations, reducing number of lifts and escalators, reassessment of Govt as well as Private land quantities by optimizing the parking facilities etc. Design optimization on account of the above and reducing the Finishes and E&M works and reducing the number of rolling stock to be procured at this stage have also been considered to bring down the cost of Agra Metro project. Automatic Fare Collection system (AFC) has now been proposed to be undertaken on PPP. These are discussed as follows:

1.7.1 Rolling Stock:

Rolling stock has been provided as per the ridership forecast presented in the DPR. It has generally been observed that ridership materialization on a new mass transit system is slow and takes time to reach the expected levels. Therefore, the train operation and the rake requirement for the initial years has been planned for 70% of

the estimated ridership. As a result, requirement of coaches for Agra Metro comes down from 111 coaches to 84 coaches. The requirement of additional rolling stock as and when ridership picks up can be planned either through Lease or by SPV from its own resources.

1.7.2 Viaduct and Stations:

The rates for various items have been estimated based on approved rates of various Metro projects in the Country duly escalated @5% per annum to bring them to Nov'2017 price level. Now, the rate for viaduct has been revised considering the recently awarded average rates of Indore Metro and Bhopal Metro vide LOA no. 5778/MPMRCL/2018 dated: 04.10.2018 and LOA no. 5777/MPMRCL/2018 dated: 04.10.2018 respectively.

Numbers of entry/exits at stations have now been reduced along with reduction in number of lifts and escalators at stations. Also, the quantum of structural works for stations, architectural finishes and E&M works has been optimized for Agra Metro Project in line with benchmarking exercise by MoHUA.

For Corridor-1, University station was proposed as underground in private land. To optimize the cost, it is now proposed to delete the University station. Nearby underground station at RBS College can meet the traffic requirements for this area, however, it may require provisioning of some intermodal connectivity which may be planned later. Also, Shastri Nagar elevated station of Corridor-1 and Pratap-Pura elevated station of Corridor-2 are now proposed to be taken as future stations and cost reduced at this stage. These can be added later depending on the traffic pattern.

1.7.3 Land:

Area of Govt. as well as Private land to be taken for Agra Metro project has been optimized. The land rates have also been revised in line with the present circle rates.

1.7.4 Depot, Staff Quarters and OCC:

On account of reduction in rolling stock to be procured initially, number of stabling lines in depot area have been curtailed. Accordingly, the costs of P-way, Traction and Power Supply in depot have been optimized. Staff quarters and OCC cost has also been optimized and made part of the Depot cost.

1.7.5 Lifts and Escalators:

Number of entry/exits at stations have been reduced resulting in reduction in number of lifts and escalators. Number of escalators have been reduced from 181 to 88 and the number of Lifts from 128 to 88.

1.7.6 Automatic Fare Collection (AFC) system:

AFC system for Agra Metro is now proposed to be undertaken through PPP as being done in other metro projects in the Country.

1.7.7 Traction and GIS:

Quantum of Traction works has been suitably reduced on account of reduction in Depot tracks and Stabling lines.

1.7.8 Other items:

The item related to LED Wall for advertising has been removed. The Capital expenditure on Green building concept has also been removed in line with similar other metro projects to reduce the cost.

1.8 **Escalation:** Cost of Agra Metro project in DPR has been prepared at November, 2017 price level. As decided, no escalation is now considered till the project's start date. Completion cost has been re-worked based on cash flow and escalation @5% p.a. as decided in meetings held in MoHUA on 21.12.2018 and 22.12.2018.

1.9 Based on the above, the completion cost of Agra Metro project is reworked as under:

- i) Corridor-1 – Rs. 4984.66 crore
- ii) Corridor-2 - Rs. 3278.19 crore

Total Cost - Rs. 8262.85 crore

1.10 Revised FIRR and EIRR of the project have been worked out as under:

- FIRR: 10.07%
- EIRR: 17.32%

17. DETAILED PROJECT COST ESTIMATES

17.1 CAPITAL COST ESTIMATE

17.1.1 Coverage

Cost estimate for Agra Metro corridors has been prepared covering civil, electrical, signaling and telecommunications works, rolling stock, environmental protection, rehabilitation, etc. at Nov' 2017 price level.

While preparing the capital cost estimates, various items have generally been grouped under three major heads on the basis of (i) Route km length of alignment, (ii) Number of units of that item and (iii) Item being an independent entity. All items related with alignment, construction, permanent way, OHE, Signaling & Telecommunication, whether in main lines or in maintenance depot, have been estimated at rate per Route km/km basis.

Cost of station structures, other electrical services at these stations have been assessed in terms of each station as a unit. Similarly, for items like Rolling stock costs have been estimated in terms of number of units required for each item. In remaining items, viz. land, utility diversions, rehabilitation, etc. the costs have been assessed based on each item, taken as an independent entity. Automatic Fare Collection (AFC) installations at all stations has been considered through PPP.

Basic cost is exclusive of taxes and duties. i.e. GST and Custom duty. Taxes and duties mainly comprising of latest prevalent GST & Custom duty are worked out for each corridor. Current rates of Taxes have been taken into consideration.

17.1.2 Land Requirements

a) Finalization of alignment, location of stations, entry / exits etc. has been done with the objective of keeping land requirement to the bare minimum. For this purpose, alignment, stations and depots have been planned in the Govt. land to the extent possible. Depot for Corridor-1 and Corridor-2 has been planned in the State Govt. lands of PAC and Rajkiya Asthan land respectively. Due to non availability of public parks and other Government land coupled with narrow roads in corridor-1, only one underground station namely RBS College is proposed in private land. The summary of land requirement for Corridor - I & II given is as under **TABLE 17.1 & TABLE 17.2**

TABLE 17.1: LAND & STRUCTURES REQUIREMENT (IN HA.) : CORRIDOR-I

Ownership	Purpose	Permanent Land	Temporary Land	Structures (Floor area)
Central Govt. - RAILWAY	Alignment, Stations & Ancillary Building etc	591	4500	0
	Total	591	4500	0
Central Govt. - DEFENCE	Alignment, Stations & Ancillary Building etc	6032	5700	0
	Total	6032	5700	0
State Govt.	Alignment, Stations & Ancillary Building etc	32162	27000	200
	Depot	208000	0	47343
	PD & Parking	67415	0	0
	Construction Depot	0	123000	0
	RSS & MISC.	10000	0	0
	Total	317577	150000	47543
Private	Alignment, Stations & Ancillary Building etc	2431	4500	214
	Depot	0	0	0
	Total	2431	4500	214

TABLE 17.2: LAND & STRUCTURES REQUIREMENT (IN HA.) : CORRIDOR-II

Ownership	Purpose	Permanent Land	Temporary Land	Structures (Floor area)
Central Govt. - RAILWAY	Alignment, Stations & Ancillary Building etc	2798	0	278
	Total	2798	0	278
Central Govt. - DEFENCE	Alignment, Stations & Ancillary Building etc	5047	0	0
	Total	5047	0	0
State Govt.	Alignment, Stations & Ancillary Building etc	17775	0	909
	Depot	119000	0	0
	PD & Parking	60300	0	0
	Construction Depot	0	122300	0
	RSS & MISC.	10000	0	0
	Total	207075	122300	909

Ownership	Purpose	Permanent Land	Temporary Land	Structures (Floor area)
Private	Alignment, Stations & Ancillary Building etc	5388	0	6264
	Depot	0	0	0
	Total	5388	0	6264

- b) Rate of Central Govt. land ((Northern Central Railway for entry/exit at Agra Cantt., Raja Ki Mandi & Defence land near Jama Masjid for station facilities of Jama Masjid Metro station and Defence land at Agra Fort for Agra Fort Metro station) required on permanent basis has been taken from revised Circle rates. No solatium has been applied to the basic land cost.
- c) Rate of State Govt. Land required on permanent basis has been taken from DPR for Lucknow Metro. No solatium has been applied to the basic land cost. In case, State Govt. is in a position to provide its land free of cost or at reduced rates, it will further improve the financial statistics of the project.
- d) Rate of Central Govt. land and State Govt. land required on temporary basis has been taken from DPR for Lucknow Metro. No solatium has been applied to the basic land cost.
- e) Rate of Private land is based upon revised Circle rates. 100% solatium has been applied to the basic land cost. No administrative cost is added towards land acquisition activities, as it is understood that this activity shall be carried out by State Govt. from its own resources.
- f) On lines with DPR for Kanpur MRTS, efforts have been made to provide parking for maximum possible stations. To make the project financially viable, property development has been proposed on suitable land pieces on preliminary stage. Moreover, in line with DPR for Lucknow Metro, cost of land towards parking cum PD is not loaded to the cost estimates and this cost will be borne by State Govt. separately.
- g) The depreciated rates for State Govt. structures have been taken based upon revised Circle rates. Basic construction cost of Class II RBC structures @ Rs. 10,000/- per sqm has been accounted for. Further, maximum allowable depreciation of 60% has been applied and accordingly, depreciated cost comes out to Rs. 4000/- per sqm. As construction cost of new structures will be more

than the depreciated cost of old structures, Cost differential will be borne by State Govt.

- h) The depreciated rates for private structures have been taken assuming the cost of the structures @ Rs. 10000/- per sqm . 100% solatium has also been applied. The allowable depreciation of 20% has been applied and accordingly, the depreciated rate comes out to Rs. 16000/- per sqm. No administrative cost is added towards land acquisition activities, as it is understood that this activity shall be carried out by State Govt. from its own resources.
- i) Annual cost of private land required on temporary basis (for construction of U/G stations at RBS college) is calculated as 6% of corresponding circle rate of that locality. Construction period is taken as 4 years. No solatium has been applied to basic land cost.
- j) The total cost of Land works out to be **Rs. 243.92 Crore** for Corridor-I and **Rs. 174.24 Crore** for Corridor-II.

17.1.3 Items other than Land:

As explained in preface, the rates of items other than land has been finalized on the basis of benchmarking exercise undertaken by MoHUA for similar works. The rates of cost components at Nov'2017 price level are given in **TABLE 17.3**.

TABLE 17.3: RATES OF ITEMS OTHER THAN LAND

Item No.	Item	Unit	Rates (Rs. In Crore)
2.0	Alignment and Formation		
2.1	Underground section by T.B.M excluding station length	R. Km.	125.00
2.2	Underground section by cut & cover for Ramp	R. Km.	122.52
2.3	Elevated section excluding viaduct length in station	R. Km.	37.04
2.2	Elevated Section (Special Span -34m+45m+34m = 113m)	Each	14.84
2.4	Elevated Section (Yamuna River Bridge - 34m+7*45m+34m = 383m)	Each	55.46
3.0	Station Buildings		
3.1	Underground Station incl. EM works, VAC etc. by Cut & Cover		

Item No.	Item	Unit	Rates (Rs. In Crore)
a	Underground Station- Structural Civil works including Architectural Finishes	Each	98.11
b	Underground Station- EM works etc.	Each	18.32
c	Underground Station- ECS & TVS etc.	Each	24.02
3.2	Elevated Station Buildings		
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	19.50
b	Elevated station - EM Works etc.	Each	3.33
3.3	Lifts & Escalators (Elevated and UG stations)		
a	Lifts	Each	0.47
b	Escalators	Each	0.73
4.0	Maintenance Depot including OCC building		
a	Civil works	LS	95.00
b	EM works + Machinery & Plant + General Works	LS	55.00
5.0	P-Way		
5.1	Ballastless track for elevated & underground Section	Route Km.	7.00
5.2	Ballasted track for Depot	Track Km.	3.50
6.0	Traction & power supply incl. OHE, ASS etc. Excl. lifts & Escalators		
6.1	UG Section	R. Km.	13.10
6.2	Elevated section including SCADA	R. Km.	11.34
6.3	For Depot	Track Km.	5.67
6.4	For 132 kV GIS & and 132kV cable/transmission line in RSS	Each	48.83
7.0	Signalling and Telecom etc		
7.1	Signalling	R. Km.	6.75
7.2	Telecommunication	Per Station	5.00
8.0	Environment and R & R incl. Hutments etc.		

Item No.	Item	Unit	Rates (Rs. In Crore)
a	Environmental Cost	As per details given in Chapter 15	
b	R & R		
9.0	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's, Environmental protection and traffic management		
a	Civil works	R. Km.	3.00
b	Electrical Works	R. Km.	3.00
10.0	Capital Expenditure on Security		
a	Civil works	Per Station	0.30
b	EM works	Per Station	0.07
11.0	Staff Quarters		
a	Civil works	R. Km.	1.31
b	EM works	R. Km.	0.32
12.0	Capital Expenditure on Inter modal integration including Footpath for pedestrians	Per Station	3.00
13.0	Rolling Stock	Each	8.00

17.2 INNOVATIONS PROPOSE TO REDUCE THE COST

The size of the tunnels proposed is similar to what has been / being constructed in Lucknow Metro for optimal utilization of Tunnel Boring Machines being used. This shall encourage indigenous development and manufacturing of components that are being presently imported. Such steps shall induce progressive increase in local content in procurement, construction etc.

17.3 COSTING OF ENTIRE PROJECT

17.3.1 Corridor-wise Capital Cost Estimate

Detailed capital cost estimate for Corridor-1 & 2 is given in **TABLE 17.4 & TABLE 17.5** respectively.

TABLE 17.4: CAPITAL COST ESTIMATE CORRIDOR-1

CORRIDOR - 1: SIKANDARA TO TAJ EAST GATE

Total Length = 14.25Km, From = (-) 50m to 13950m, UG = 7.681 Km, ELEV = 6.319 Km,

Depot Entry = 0.25 Km**Stations = 13, Elevated = 6 No's & U/G by Cut & cover = 7 No's. Future Station = 1 No (Elevated)****November' 2017, Price Level (Rs. In Crores)**

S N	Item	Unit	Rate	Qty.	Amount
1.0	Land				
a	Central Govt. Railway Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	69.00	0.06	4.08
b	Central Govt. Railway Land -Temporary without Solatium	Ha	1.32	0.45	0.59
c	Central Govt. Defence Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	40.76	0.60	24.59
d	Central Govt. Defence Land -Temporary without Solatium	Ha	1.32	0.57	0.75
e	State Govt. Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	5.50	25.02	137.61
f	State Govt. Land - Permanent (for PD & Parking identified along Corridor)	Ha	0.00	6.74	0.00
g	State Govt. Land -Temporary	Ha	1.32	15.00	19.80
h	State Govt. Structures- Permanent without Solatium	Ha	3.96	4.75	18.83
i	Private Land -Permanent (for Alignment, RSS, Ancillary Bldgs., Misc., including Solatium)	Ha	124.57	0.24	29.90
j	Pvt. Land -Temporary without Solatium	Ha	16.56	0.45	7.45
k	Private Structure - Permanent including Solatium as per LARRA	Ha	16.00	0.02	0.32
	Sub Total (1)				243.92
2.0	Alignment and Formation				
2.1	Underground section by T.B.M excluding station length	R. Km.	125.00	4.60	574.38
2.2	Underground section by cut & cover excluding station length	R. Km.	122.52	2.08	255.09
2.4	Elevated section excluding viaduct length in station	R. Km.	37.04	5.86	217.17
2.7	Underground Entry to Depot (by cut & cover)	R. Km.	122.52	0.25	30.63
	Sub Total (2)				1077.26
3.0	Station Buildings				
3.1	Underground Station (180 m length, 2 Level) incl. EM works, VAC etc. by Cut & Cover				
a	Underground Station- Structural Civil works including Architectural Finishes	Each	98.11	3.00	294.34
b	Underground Station- EM works etc.	Each	18.32	3.00	54.96
c	Underground Station- ECS & TVS works etc.	Each	24.02	3.00	72.06

S N	Item	Unit	Rate	Qty.	Amount
3.2	Underground Station (130 m or less length, 3 Level) incl. EM works, VAC etc. by Cut & Cover				
a	Underground Station- Structural Civil works including Architectural Finishes	Each	98.11	4.00	392.46
b	Underground Station- EM works etc.	Each	18.32	4.00	73.28
c	Underground Station- ECS & TVS works etc.	Each	24.02	4.00	96.08
3.4	Elevated Station Buildings				
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	19.50	6.00	117.00
b	Elevated station - EM Works etc.	Each	3.33	6.00	19.98
3.6	Lifts & Escalators (Elevated and UG stations)				
a	Lifts	Each	0.47	46.00	21.62
b	Escalators	Each	0.73	46.00	33.58
	Sub Total (3)				1175.35
4.0	Maintenance Depot including OCC building				
a	Civil works including boundary wall	LS			95.00
b	EM works + Machinery & Plant + General Works	LS			55.00
	Sub Total (4)				150.00
5.0	P-Way				
5.1	Ballastless track for elevated & underground Section	Route Km.	7.00	14.00	98.00
5.2	Ballasted track for Depot	Track Km.	3.50	4.58	16.03
5.3	Ballastless track for entry to Depot	Route Km.	7.00	0.25	1.75
	Sub Total (5)				115.78
6.0	Traction & power supply (750V DC)				
6.1	UG Section	Route Km.	13.10	7.68	100.61
6.1	Elevated including SCADA	Route Km.	11.34	6.32	71.67
6.2	For Depot entry	Route Km.	13.10	0.25	3.28
6.3	For Depot	Track Km.	5.67	4.58	25.97
6.4	For 132 kV GIS & and 132kV cable/transmission line in RSS	LS			48.83
	Sub Total (6)				250.35
7.0	Signalling and Telecom.				
7.1	Signalling	R. Km.	6.75	14.00	94.50
7.2	Telecommunication	Per Station	5.00	13.00	65.00
7.3	Automatic fare collection	Through PPP			
	Sub Total (7)				159.50

S N	Item	Unit	Rate	Qty.	Amount
8.0	Environment and R & R incl. Hutments etc.				
a	Environmental Cost	As per details given in Chapter 15			6.87
b	R & R				1.92
	Sub Total (8)				8.79
9.0	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's, Environmental protection and traffic management				
a	Civil works	R. Km.	3.00	14.00	42.00
b	Electrical Works	R. Km.	3.00	14.00	42.00
	Sub Total (9)				84.00
10.0	Capital Expenditure on Security				
a	Civil works	Per Station	0.30	13.00	3.86
b	EM works	Per Station	0.07	13.00	0.92
	Sub Total (10)				4.78
11.0	Staff Quarters				
a	Civil works	R. Km.	1.31	14.00	18.28
b	EM works	R. Km.	0.32	14.00	4.44
	Sub Total (11)				22.72
12.0	Capital Expenditure on Inter modal integration including Footpath for pedestrians	Per Station	3.00	13.00	39.00
13.0	Rolling Stock	Each	8.00	36.00	288.00
14.0	Total of all items except Land				3375.52
15.0	General Charges including Design charges, incl. Metro Bhawan Building (Civil+EM works) @ 5% on all items except land				168.78
16.0	Total of all items including G. Charges				3544.30
17.0	Contingencies @ 3 % on all items except land				106.33
18.0	Gross Total including Contingencies (excluding Land Cost)				3650.63
19.0	Gross Total including Contingencies (including Land Cost)				3894.54
20.0	Total Central GST & Basic Customs duty				335.64
21.0	Total State GST				275.80
22.0	Gross Total including Taxes & Duties				4505.98

TABLE 17.5: CAPITAL COST ESTIMATE CORRIDOR-2**CORRIDOR - 2: AGRA CANTT. TO KALINDI VIHAR****Total Length = 16.20 Km, From = (-) 50m to 15350m, ELEV = 15.40 Km &****Depot Entry = 0.80 Km****Stations = 14, Elevated = 14 No's, Future Station = 1 No.****November' 2017, Price Level (Rs. In Crores)**

S. No.	Item	Unit	Rate	Qty.	Amount
1.0	Land				
a	Central Govt. Railway Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	35.00	0.28	9.80
b	Central Govt. Railway Structures- Permanent without Solatium	Ha	3.96	0.03	0.12
c	Central Govt. Defence Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	35.00	0.50	17.50
d	State Govt. Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	5.50	14.68	80.74
e	State Govt. Land - Permanent (for PD & Parking identified along Corridor)	Ha	0.00	6.03	0.00
f	State Govt. Land -Temporary	Ha	1.32	12.23	16.14
g	State Govt. Structures- Permanent without Solatium	Ha	3.00	0.09	0.27
h	Private Land -Permanent (for Alignment, RSS, Ancillary Bldgs., Misc., etc. including Solatium)	Ha	73.41	0.54	39.59
i	Private Structure - Permanent including Solatium as per LARRA	Ha	16.00	0.63	10.08
	Sub Total (1)				174.24
2.0	Alignment and Formation				
2.1	Elevated section excluding viaduct length in station	R. Km.	37.04	13.41	496.63
2.2	Elevated Section (Special Span -34m+45m+34m = 113m)	Each	14.84	2.00	29.68
2.3	Elevated Section (Special Span -34m+4*45m+34m = 248m)	Each	32.56	1.00	32.56
2.4	Elevated Section (Yamuna River Bridge - 34m+7*45m+34m = 383m)	Each	55.46	1.00	55.46
2.5	Elevated Entry to Depot	R. Km.	37.04	0.80	29.63
	Sub Total (2)				643.96
3.0	Station Buildings				
3.1	Elevated Station Buildings				
a	Elevated station - Civil Works including Viaduct & Architectural finishes	Each	19.50	14.00	273.00

S. No.	Item	Unit	Rate	Qty.	Amount
b	Elevated station - EM Works etc.	Each	3.33	14.00	46.62
3.4	Lifts & Escalators				
a	Lifts	Each	0.47	42.00	19.74
b	Escalators	Each	0.73	42.00	30.66
	Sub Total (3)				370.02
4.0	Maintenance Depot				
a	Civil works including boundary wall	LS			65.09
b	EM works + Machinery & Plant + General Works	LS			40.93
	Sub Total (4)				106.02
5.0	P-Way				
5.1	Ballastless track for elevated Section	Route Km.	7.00	15.40	107.80
5.2	Ballasted track for Depot	Track Km.	3.50	4.52	15.82
5.3	Ballastless track for entry to Depot	Route Km.	7.00	0.80	5.60
	Sub Total (5)				129.22
6.0	Traction & power supply (750V DC)				
6.1	Elevated including SCADA	Route Km.	11.34	15.40	174.64
6.2	For Depot entry	Route Km.	11.34	0.80	9.07
6.3	For Depot	Track Km.	5.67	4.52	25.63
6.4	For 132 kV GIS & and 132kV cable/transmission line in RSS	LS			48.83
	Sub Total (6)				258.16
7.0	Signalling and Telecom.				
7.1	Signalling	R. Km.	6.75	15.40	103.95
7.2	Telecommunication	Per Station	5.00	14.00	70.00
7.3	Automatic fare collection	Per station	through PPP		
	Sub Total (7)				173.95
8.0	Environment and R & R incl. Hutments etc.				
a	Environmental Cost	As per details given in Chapter 15			11.53
b	R & R				3.45
	Sub Total (8)				14.98
9.0	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's, Environmental protection and traffic management				
a	Civil works	R. Km.	3.00	15.400	46.20
b	Electrical Works	R. Km.	3.00	15.400	46.20

S. No.	Item	Unit	Rate	Qty.	Amount
	Sub Total (9)				92.40
10.0	Capital Expenditure on Security				
a	Civil works	Per Station	0.30	14.00	4.16
b	EM works	Per Station	0.07	14.00	0.99
	Sub Total (10)				5.15
12.0	Capital Expenditure on Inter modal integration including Footpath for pedestrians	Per Station	3.00	14.00	42.00
13.0	Rolling Stock	Each	8.00	48.00	384.00
14.0	Total of all items except Land				2219.87
15.0	General Charges including Design charges, incl. Metro Bhawan Building (Civil+EM works) @ 5% on all items except land				110.99
16.0	Total of all items including G. Charges				2330.86
17.0	Contingencies @ 3 % on all items except land				69.93
18.0	Gross Total including Contingencies (excluding Land Cost)				2400.79
19.0	Gross Total including Contingencies (including Land Cost)				2575.03
20.0	Total Central GST & Basic Customs duty				210.25
21.0	Total State GST				179.76
22.0	Gross Total including Taxes & Duties				2965.04

TABLE 17.6: COST COMPONENT UNDER PPP

November' 2017, Price Level (Rs. In Crores)

S. No.	Item	Unit	Rate	Qty.	Amount
1.0	AFC for Corridor-1	Per Station	3.63	14.00	50.82
2.0	AFC for Corridor-2	Per Station	3.63	15.00	54.45
3.0	Total of AFC				105.27
4.0	General Charges @ 5%				5.26
5.0	Total including GC				110.53
6.0	Contingencies @ 3 % on all items including GC				3.32
7.0	Total including GC & Contingencies				113.85
8.0	Central GST & Basic Customs duty				14.38
9.0	State GST				10.31
10.0	Total Cost including Taxes & Duties				138.54

17.3.2 Taxes and Duties

Taxes and duties are worked out for each corridor separately. Current rates of GST (i.e. 12% on Metro projects) have been taken into consideration and have been applied as per prevalent practice. Components of Taxes & duties considered for calculation are shown in **TABLE 17.7**. Taxes & duties for Corridor-1 & 2 have been worked out in

TABLE 17.8 & TABLE 17.9 respectively.

TABLE 17.7: TAXES AND DUTIES COMPONENTS

S.No.	Tax Component	=	%
1	Basic Customs duty	=	5.1500%
2	CGST Customs Duty	=	9.4635%
3	SGST Customs Duty	=	9.4635%
4	Total Customs Duty	=	24.0770%
5	General IGST	=	12.0000%
6	General CGST	=	6.0000%
7	General SGST	=	6.0000%

TABLE 17.8: TAXES AND DUTIES FOR CORRIDOR-1

(Rs. In Crores)

S. No.	Description	Total cost	Taxes and duties							Total Taxes & Duties
			Basic Custom Duty	IGST (CGST portion)	IGST (SGST portion)	Total Custom Duty	CGST	SGST	Total GST	
1	Alignment & Formation									
	Underground	860.09	13.29	24.42	24.42	62.13	36.12	36.12	72.25	134.37
	Elevated	217.17	0.00	0.00	0.00	0.00	13.03	13.03	26.06	26.06
2	Station Buildings									
	Underground station-civil works	686.80	10.61	19.50	19.50	49.61	28.85	28.85	57.69	107.30
	Underground station-EM works	364.85	9.39	17.26	17.26	43.92	10.95	10.95	21.89	65.81
	Elevated station - civil works	117.00	0.00	0.00	0.00	0.00	7.02	7.02	14.04	14.04
	Elevated station-EM works	58.12	0.60	1.10	1.10	2.80	2.79	2.79	5.58	8.38
3	Depot including OCC Buildings									

S. No.	Description	Total cost	Taxes and duties							
			Basic Custom Duty	IGST (CGST portion)	IGST (SGST portion)	Total Custom Duty	CGST	SGST	Total GST	Total Taxes & Duties
	Civil works	95.00	1.47	2.70	2.70	6.86	3.99	3.99	7.98	14.84
	EM and M&P works	55.00	0.57	1.04	1.04	2.65	6.16	6.16	12.32	14.97
4	P-Way	115.78	4.77	8.77	8.77	22.30	1.39	1.39	2.78	25.08
5	Traction & power supply									
	Traction and power supply	250.35	5.16	9.48	9.48	24.11	9.01	9.01	18.02	42.14
6	S and T Works									
	S & T	159.50	6.57	12.08	12.08	30.72	2.87	2.87	5.74	36.46
7	R & R hutments	1.92	0.00	0.00	0.00	0.00	0.12	0.12	0.23	0.23
8	Misc.									
	Civil works	42.00	0.00	0.00	0.00	0.00	2.52	2.52	5.04	5.04
	EM works	42.00	0.00	0.00	0.00	0.00	5.88	5.88	11.76	11.76
9	Security									
	Civil works	3.86	0.00	0.00	0.00	0.00	0.23	0.23	0.46	0.46
	EM works	0.92	0.00	0.00	0.00	0.00	0.13	0.13	0.26	0.26
10	Staff quarters									
	Civil works	18.28	0.00	0.00	0.00	0.00	1.10	1.10	2.19	2.19
	EM works	4.44	0.00	0.00	0.00	0.00	0.62	0.62	1.24	1.24
12	Intermodal Integration	39.00	0.00	0.00	0.00	0.00	2.34	2.34	4.68	4.68
13	Rolling stock	288.00	7.42	13.63	13.63	34.67	12.96	12.96	25.92	60.59
14	Rent on Temporary Land	28.60	0.00	0.00	0.00	0.00	2.57	2.57	5.15	5.15
15	General Charges	168.78	0.00	0.00	0.00	0.00	15.19	15.19	30.38	30.38
16	Total	3617.45	59.84	109.96	109.96	279.77	165.84	165.84	331.67	611.44
	Total taxes & Duties							SAY		611.44

TABLE 17.9: TAXES AND DUTIES FOR CORRIDOR-2**(Rs. In Crores)**

S. No.	Description	Total cost	Taxes and duties							
			Basic Customs Duty	IGST (CGST portion)	IGST (SGST portion)	Total Customs Duty	CGST	SGST	Total GST	Total Taxes & Duties
1	Alignment & Formation									
	Underground	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Elevated	643.96	0.00	0.00	0.00	0.00	38.64	38.64	77.28	77.28
2	Station Buildings									
	Underground station-civil works	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Underground station-EM works	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Elevated station - civil works	273.00	0.00	0.00	0.00	0.00	16.38	16.38	32.76	32.76
	Elevated station-EM works	132.29	1.36	2.50	2.50	6.37	6.35	6.35	12.70	19.07
3	Depot									
	Civil works	65.09	1.01	1.85	1.85	4.70	2.73	2.73	5.47	10.17
	EM and M&P works	40.93	0.42	0.77	0.77	1.97	4.58	4.58	9.17	11.14
4	P-Way	129.22	5.32	9.78	9.78	24.89	1.55	1.55	3.10	27.99
5	Traction & power supply									
	Traction and power supply	258.16	5.32	9.77	9.77	24.86	9.29	9.29	18.59	43.45
6	S and T Works									
	S & T	173.95	7.17	13.17	13.17	33.51	3.13	3.13	6.26	39.77
7	R & R hutments	3.45	0.00	0.00	0.00	0.00	0.21	0.21	0.41	0.41
8	Misc.									
	Civil works	46.20	0.00	0.00	0.00	0.00	2.77	2.77	5.54	5.54
	EM works	46.20	0.00	0.00	0.00	0.00	6.47	6.47	12.94	12.94
9	Security									
	Civil works	4.16	0.00	0.00	0.00	0.00	0.25	0.25	0.50	0.50

S. No.	Description	Total cost	Taxes and duties							
			Basic Customs Duty	IGST (CGST portion)	IGST (SGST portion)	Total Customs Duty	CGST	SGST	Total GST	Total Taxes & Duties
	EM works	0.99	0.00	0.00	0.00	0.00	0.14	0.14	0.28	0.28
10	Staff quarters									
	Civil works	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EM works	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	OCC Buildings									
	Civil works	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	EM works	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Intermodal Integration	42.00	0.00	0.00	0.00	0.00	2.52	2.52	5.04	5.04
13	Rolling stock	384.00	9.89	18.17	18.17	46.23	17.28	17.28	34.56	80.79
14	Rent on Temporary Land	16.14	0.00	0.00	0.00	0.00	1.45	1.45	2.91	2.91
15	General Charges	110.99	0.00	0.00	0.00	0.00	9.99	9.99	19.98	19.98
16	Total	2370.74	30.49	56.02	56.02	142.53	123.74	123.74	247.48	390.01
	Total taxes & Duties							SAY		390.01

17.4 SUMMARY OF CAPITAL COST

17.4.1 Summary of Capital Cost

The abstract of capital cost estimate of Corridor-1 & 2 is given in **TABLE 17.10**.

TABLE 17.10: ABSTRACT OF COST ESTIMATE OF CORRIDOR-1 & 2

November'17 Price Level (Rs. In Crores)

S. No.	Item	Corridor-1	Corridor-2	Total Amount
1	Land	243.92	174.24	418.16
2	Alignment and Formation	1077.26	643.96	1721.22
3	Station Buildings incl. Civil works, EM works, ECS, TVS, Lift, escalators & Architectural Finishes etc	1175.35	370.02	1545.37
4	Depot including civil, EM, Machinery & plants, general works & OCC building	150.00	106.02	256.02
5	P-Way for main line, depot and depot connectivity	115.78	129.22	245.00

S. No.	Item	Corridor-1	Corridor-2	Total Amount
6	Traction & power supply for main line and depot incl. OHE, ASS, GIS etc.	250.35	258.16	508.51
7	Signalling and Telecom. etc.	159.50	173.95	333.45
8a	Environment	6.87	11.53	18.40
8b	R & R incl. Hutments etc.	1.92	3.45	5.37
9	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's, Environmental protection and traffic management	84.00	92.40	176.40
10	Capital Expenditure on Security including civil and EM works	4.78	5.15	9.94
11	Staff Quarters including civil, electrical works	22.72	0.00	22.72
12	Capital Expenditure on Inter modal integration including Footpath for pedestrians	39.00	42.00	81.00
13	Rolling Stock	288.00	384.00	672.00
14	Total of all items except Land	3375.52	2219.87	5595.39
15	General Charges incl. Design charges, including Metro Bhawan, (Civil+EM works) @ 5% on all items except land (Metro Bhawan is charged to corridor-1 only and it will cater to both the corridors)	168.78	110.99	279.77
16	Total of all items including G. Charges	3544.30	2330.86	5875.16
17	Contingencies @ 3 %on all items except land	106.33	69.93	176.25
Gross Total including Contingencies (excluding Land Cost)		3650.63	2400.79	6051.41
Gross Total including Contingencies (including Land Cost)		3894.54	2575.03	6469.57
Central GST & Basic Customs duty		335.64	210.25	545.89
State GST		275.80	179.76	455.56
Total Cost including Taxes & Duties		4505.98	2965.04	7471.02
Completion Cost		4984.66	3278.19	8262.85

17.5 COMPARATIVE STATEMENT OF REDUCED COST WITH ORIGINAL DPR

The revised capital cost estimate is compared with original DPR cost estimate in **TABLE 17.11.**

TABLE 17.11: COMPARISON OF REVISED COST ESTIMATE WITH ORIGINAL DPR

S N	Item	Original Cost as per DPR			Revised Cost finalised in MoHUA, GoI during meeting on 21.12.2018/22.12.2018			Resultant Reduction in cost
		Corr-1	Corr-2	Total Amount	Corr-1	Corr-2	Total Amount	
1	Land	364.58	313.45	678.03	243.92	174.24	418.16	259.87
2	Alignment and Formation	1221.91	811.67	2033.59	1077.26	643.96	1721.22	312.37

S N	Item	Original Cost as per DPR			Revised Cost finalised in MoHUA, Gol during meeting on 21.12.2018/22.12.2018			Resultant Reduction in cost
		Corr-1	Corr-2	Total Amount	Corr-1	Corr-2	Total Amount	
3	Station Buildings incl. Civil works, EM works, ECS, TVS, Lift, escalators & Architectural Finishes etc	1827.10	640.38	2467.48	1175.35	370.02	1545.37	922.11
4	Depot including civil, EM, Machinery & plants, general works & OCC building	220.32	191.28	411.60	150.00	106.02	256.02	155.58
5	P-Way for main line, depot and depot connectivity	164.60	184.18	348.78	115.78	129.22	245.00	103.78
6	Traction & power supply for main line and depot incl. OHE, ASS, GIS etc.	295.35	333.17	628.52	250.35	258.16	508.51	120.01
7	Signalling and Telecom. etc.	306.60	306.02	612.62	159.50	173.95	333.45	279.17
8a	Environment	6.87	11.53	18.40	6.87	11.53	18.40	0.00
8b	R & R incl. Hutments etc.	1.92	3.45	5.37	1.92	3.45	5.37	0.00
9	Misc. Utilities, road works, Topographic Surveys, Geotechnical Investigation, Barricading, Tree Cutting and replanting, other civil works such as signage's, Environmental protection and traffic management	113.11	124.42	237.53	84.00	92.40	176.40	61.13
10	Capital Expenditure on Security including civil and EM works	5.15	5.51	10.66	4.78	5.15	9.94	0.72
11	Staff Quarters including civil, electrical works	93.72	32.99	126.70	22.72	0.00	22.72	103.99
12	Capital Expenditure on Inter modal integration including Footpath for pedestrians	85.13	52.89	138.03	39.00	42.00	81.00	57.03
13	Rolling Stock	521.28	684.18	1205.46	288.00	384.00	672.00	533.46
14	Total of all items except Land	4863.06	3381.68	8244.74	3375.52	2219.87	5595.39	2649.35
15	General Charges incl. Design charges, including Metro Bhawan, (Civil+EM works) @ 5% on all items except land	217.09	134.88	351.96	168.78	110.99	279.77	72.19
16	Total of all items including G. Charges	4558.87	2832.38	7391.24	3544.30	2330.86	5875.16	1516.08
17	Contingencies @ 3 % on all items except land	152.40	105.50	257.90	106.33	69.93	176.25	81.65
Gross Total including Contingencies (excluding Land Cost)		5232.55	3622.05	8854.61	3650.63	2400.79	6051.41	2803.19
Gross Total including Contingencies (including Land Cost)		5597.13	3935.50	9532.63	3894.54	2575.03	6469.57	3063.06

S N	Item	Original Cost as per DPR			Revised Cost finalised in MoHUA, GoI during meeting on 21.12.2018/22.12.2018			Resultant Reduction in cost
		Corr-1	Corr-2	Total Amount	Corr-1	Corr-2	Total Amount	
	Central GST & Basic Customs duty	490.09	334.30	824.39	335.64	210.25	545.89	278.50
	State GST	394.28	272.27	666.55	275.80	179.76	455.56	210.99
	Total Cost including Taxes & Duties	6481.50	4542.07	11023.57	4505.98	2965.04	7471.02	3552.55
	Completion Cost	8112.22	5668.81	13781	4984.66	3278.19	8262.85	5518.18

17.6 ESTIMATIONS OF OPERATIONS AND MAINTENANCE COST

The Operation and Maintenance cost has been worked under three major heads:

- Staff costs
- Maintenance cost which includes expenditure towards upkeep and maintenance of the system and consumables
- Energy costs

17.6.1 Staff Cost

The O&M staff is assumed to be provided @ 35 persons per kilometer and the annual cost this account is estimated considering average staff salary of Rs. 7.12 Lakhs per annum in the year 2017. The escalation factor used for staff costs is 9% per annum to provide for growth in salaries. No escalation has been considered till the start of construction i.e. till 2024. The staff cost for corridor 1 and corridor 2 is estimated to be Rs. 49.31 Cr. and Rs. 54.24 Cr. respectively.

17.6.2 Maintenance Expenses

Maintenance expenses are taken @ Rs. 1.37 Crores/km in the year 2017. Maintenance cost for Agra Metro corridors would be Rs. 23.45 Crores for Sikandara to Taj East Gate corridor and Rs. 25.80 Crores for Agra Cantt to Kalindi Vihar corridor in the inception year i.e. 2024 considering escalation @ 5% p.a. for every year of operation. No escalation has been considered till the start of construction period.

17.6.3 Energy Charges

The energy consumption to meet the traction and non-traction power requirement is based on traffic demand for different horizon years. The cost of electricity is a significant part of O&M charges, constituting about 30% of total annual working cost. The traction power tariff is taken @ Rs. 6.17 per kVAh in the year 2017, which is escalated @ 5% every year of operation. No escalation has been considered till the start of construction period.

It is observed in most urban rail transit systems that ridership materialization in the initial years of operation is less than projected and takes time to reach the expected levels. Based on the above, the energy charges during the first five years of operation are taken as 80% of the actual calculated energy cost. After first five years of operation, the energy charges are gradually increased to 100% of the actual in the subsequent years.

Annual energy consumption charges have been estimated as Rs. 67.30 Crores in year 2024, Rs. 121.83 Crores in 2031 and Rs. 232.28 Crores in 2041 for Sikandara to Taj East Gate corridor and Rs. 26.41 Crores in year 2024, Rs. 49.50 Crores in 2031 and Rs. 98.49 Crores in 2041 for Agra Cantt. to Kalindi Vihar corridor.

17.6.4 Additional Investment

To cater to increased traffic demand, additional investment will have to be made for purchase of additional coaches. The additional investment for Sikandara to Taj East Gate Corridor works out to **Rs. 252.84 Crores** for purchase of 21 additional coaches in the year 2031 and **Rs. 220.15 Crores** for 15 additional coaches in year 2041.

For Agra Cantt. to Kalindi Vihar corridor, an investment of **Rs. 288.96 Crores** would be required for purchase of 24 additional coaches in the year 2031 and **Rs 176.12 Cores** for purchase of 12 additional coaches in the year 2041. These additional investment costs for Rolling Stock have been worked out considering an escalation factor of 2% per annum. No escalation has been considered till the start of construction period.

Two future stations (Shastri Nagar & Pratap-pura in Corridor -1 & 2 respectively) shall be constructed on attainment of 100% ridership alongwith purchase of additional rolling stock. The cost for future stations is given in **TABLE 17.12**

TABLE 17.12: ADDITIONAL COST OF FUTURE STATIONS (SHASTRI NAGAR IN C-1 & PRATAP-PURA IN C-2)

S. No.	Item	Unit	Rate	Qty.	Amount
1.0	Elevated Station Buildings				
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	16.54	2.00	33.07
b	Elevated station - EM Works etc.	Each	3.33	2.00	6.66
2.0	Lifts & Escalators				
a	Lifts	Each	0.47	6.00	2.82
b	Escalators	Each	0.73	6.00	4.38
3.0	Telecommunication	Per Station	5.00	2.00	10.00
4.0	Capital Expenditure on Security				

S. No.	Item	Unit	Rate	Qty.	Amount
a	Civil works	Per Station	0.30	2.00	0.59
b	EM works	Per Station	0.07	2.00	0.14
5.0	Capital Expenditure on Inter modal integration incl. Footpath for pedestrians	Per Station	3.00	2.00	6.00
14.0	Total of all items				63.67
15.0	General Charges including Design charges @ 5% on all items				3.18
16.0	Total of all items including G. Charges				66.85
18.0	Contingencies @ 3 % on all items incl. GC				2.01
19.0	Gross Total including GC & Contingencies				68.86
21.0	Central GST & Basic Customs duty				5.11
22.0	State GST				4.55
23.0	Total Cost including Taxes & Duties				78.51

17.6.5 Replacement Cost

The replacement costs are provided for meeting the cost on account of replacement of equipments due to wear and tear. With the nature of equipment proposed to be provided for the corridor, it is expected that about 25% of the equipment comprising Electrical, Rolling stock and 50% of Signalling & Telecom would require replacement/rehabilitation after 20 years and 30 years.

The replacement cost for the Sikandara to Taj East Gate corridor works out to be **Rs. 1110.48 Crores** and the replacement cost for Agra Cantt to Kalindi Vihar corridor works out to be **Rs. 952.84 crores** in year 2044. The replacement cost has been worked out considering an escalation factor of 5% per annum.

The year wise total Operation and Maintenance cost for the corridors of Agra MRTS is indicated in **TABLE 17.13 and TABLE 17.14**

TABLE 17.13: OPERATION AND MAINTENANCE COSTS CORRIDOR-I

Cost in Crore Rs

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M cost	Addition/ Replace - ment Cost (Cr.)	
	Esc @9%	Esc @5%	Esc @5%			
2024	49.31	23.45	67.30	140.06		
2025	53.75	24.62	71.44	149.81		
2026	58.59	25.85	75.82	160.26		
2027	63.86	27.14	80.46	171.46		
2028	69.61	28.50	85.38	183.49		

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M cost	Addition/ Replace - ment Cost (Cr.)	
	Esc @9%	Esc @5%	Esc @5%			
2029	75.87	29.93	96.25	202.05		
2030	82.70	31.43	108.11	222.24		
2031	90.14	33.00	121.83	244.97	252.84	Addition of 21 coaches
2032	98.25	34.65	136.07	268.97		
2033	107.09	36.38	144.35	287.82		
2034	116.73	38.20	153.13	308.06		
2035	127.24	40.11	162.42	329.77		
2036	138.69	42.12	172.27	353.08		
2037	151.17	44.23	182.68	378.08		
2038	164.78	46.44	193.71	404.93		
2039	179.61	48.76	205.39	433.76		
2040	195.77	51.20	217.75	464.72		
2041	213.39	53.76	232.28	499.43	220.15	Addition of 15 coaches
2042	232.60	56.45	247.19	536.24		
2043	253.53	59.27	263.02	575.82		
2044	276.35	62.23	279.81	618.39	1,110.48	Replacement of 25% of Elec. & 50%S&T assets
2045	301.22	65.34	297.63	664.19		
2046	328.33	68.61	316.52	713.46		
2047	357.88	72.04	336.57	766.49		
2048	390.09	75.64	357.82	823.55		
2049	425.20	79.42	380.36	884.98		

TABLE 17.14: OPERATION AND MAINTENANCE COSTS CORRIDOR-II

Cost in Crores Rs

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M cost	Addition/ Replace - ment Cost (Cr.)	
	Esc @9%	Esc @5%	Esc @5%			
2024	54.24	25.80	26.41	106.45		
2025	59.12	27.09	28.16	114.37		
2026	64.44	28.44	30.02	122.90		
2027	70.24	29.86	31.99	132.09		
2028	76.56	31.35	34.09	142.00		
2029	83.45	32.92	38.59	154.96		
2030	90.96	34.57	43.52	169.05		
2031	99.15	36.30	49.50	184.95	288.96	Addition of 24 coaches
2032	108.07	38.12	55.51	201.70		
2033	117.80	40.03	59.13	216.96		

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M cost	Addition/ Replace - ment Cost (Cr.)	
	Esc @9%	Esc @5%	Esc @5%			
2034	128.40	42.03	62.97	233.40		
2035	139.96	44.13	67.04	251.13		
2036	152.56	46.34	71.37	270.27		
2037	166.29	48.66	75.96	290.91		
2038	181.26	51.09	80.84	313.19		
2039	197.57	53.64	86.01	337.22		
2040	215.35	56.32	91.49	363.16		
2041	234.73	59.14	98.49	392.36	176.12	Addition of 12 coaches
2042	255.86	62.10	105.39	423.35		
2043	278.89	65.21	112.73	456.83		Replacement of 25% of Elec. & 50%S&T assets
2044	303.99	68.47	120.54	493.00	952.84	
2045	331.35	71.89	128.85	532.09		
2046	361.17	75.48	137.69	574.34		
2047	393.68	79.25	147.09	620.02		
2048	429.11	83.21	157.09	669.41		
2049	467.73	87.37	167.72	722.82		

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19. FINANCIAL ANALYSIS & NON FARE BOX REVENUE ASSESSMENT

19.1 INPUT FOR THE ANALYSIS

The DPR Chapter has been modified due to revision in projects costs and revenues incorporating comments and observations received from the Stakeholders. During the consultations, it was decided that it generally takes 4-5 years to achieve the estimated ridership on a new mass transit system. Accordingly, for estimating the revenue from fare box, 70% of the projected ridership has been assumed for first 5 years and then gradual increase of 10% every year for next 3 years. Due to reduction in ridership, O&M costs have been revised accordingly.

The financial analysis has been carried out combined for the two MRTS corridors. Accordingly, the capital costs and O&M costs for the two corridors have been added to arrive at the total capital and O& M costs for proposed Agra MRTS.

19.1.1 Capital Cost

The Construction cost of the metro corridors at Nov' 2017 prices is estimated at **Rs. 6046Crore**. The cost of land is estimated at **Rs. 418Crore**. The cost of R&R is estimated to be **Rs 5 Crore**. The total cost of project including land & R&R cost is estimated at **Rs. 6470 Crore**. The Central and State GST amount to **Rs. 1001Crore**. The capital cost components at Nov'17 prices are given in **Table 19.1**.

TABLE 19-1CAPITAL COSTS (Nov'2017 Prices)(Rs. in Crore)

Cost Component	Corridor I (Sikandara to Taj East Gate)	Corridor II (Agra Cantt. to Kalindi Vihar)	Total
Construction Cost excluding land and R&R	3649	2397	6046
Land Cost	244	174	418
R & R incl. Hutments	2	3	5
Construction Cost including land& R&R	3895	2575	6470
Taxes & Duties	611	390	1001
Total Central GST & Basic Customs duty	336	210	546
Total State GST	276	180	456
Total Cost with Land & Taxes	4506	2965	7471
Total Cost with Central Taxes only	4230	2785	7015

19.1.2 Completion Cost

With escalation factor of 5 % p.a., the Completion Cost of the project including land&R&R is estimated to be **Rs. 7146Crore** and with central taxes it is estimated at **Rs 7755 Crore**. For financial analysis both govt and private land costs have been considered as acquisition of

govt land will also require payouts. The land cost has not been escalated since land acquisition would be completed in the initial two years. It is proposed to start land acquisition and construction work prior to Year 2019 and commission the system by January 2024. The Contingency Costs estimated at **Rs 176Crore** have also not been escalated and have been distributed throughout the construction period in the same proportion as that of construction costs. The details of completion cost under different scenarios are as per **Table 19.2**.

TABLE 19-2 DETAILS OF COMPLETION COSTS (RS in Crore)

Particulars	Completion Cost
Cost without taxes	7146
With Central Taxes	7755
With both Central and State taxes	8263

19.1.3 Phasing of Construction

Considering the elevated and underground lengths of MRTS network, it is expected that the construction of Agra metro will take 5-6 years but the operation can start after 5 years. **Table 19-3** gives the % distribution of costs during the construction period based on typical construction schedule.

TABLE 19-3% DISTRIBUTION OF COSTS DURING CONSTRUCTION

Year	% Distribution of Cost
2020-2021	10%
2021-2022	20%
2022-2023	25%
2023-2024	30%
2024-2025	15%

19.1.4 Requirement of Funds

The year wise requirement of funds under different scenarios has been given in **Table 19-4** (Without any Taxes), in **Table 19-5** (With Central and State Taxes) and **Table 19-6** (With Central Taxes only). The cost of land is divided into two initial years during which it is expected that the land acquisition work would be over and related payments would be released.

TABLE 19-4 YEAR WISE FUND REQUIREMENTS WITHOUT TAXES (Rs. in Crore)

Year	Completion Cost	Land & R&R Cost	Total Completion Cost
2020-2021	605	212	817
2021-2022	1,268	212	1480
2022-2023	1,662		1662
2023-2024	2,091		2091
2024-2025	1,097		1097
Total	6722	424	7146

TABLE 19-5YEAR WISE FUND REQUIREMENTS WITH TAXES (Rs in Crore)

Year	Completion Cost	Land, R&R Cost	Taxes	Total Completion Cost
2020-2021	605	212	100	917
2021-2022	1,268	212	210	1,690
2022-2023	1,662		276	1,938
2023-2024	2,091		348	2,439
2024-2025	1,097		183	1,279
Total	6722	424	1,117	8263

TABLE 19-6YEAR WISE FUND REQUIREMENTS WITH CENTRAL TAXES (Rs in Crore)

Year	Completion Cost	Land R&R Cost	Central Taxes	Total Completion Cost
2020-2021	605	212	55	871
2021-2022	1,268	212	115	1,594
2022-2023	1,662		150	1,812
2023-2024	2,091		190	2,281
2024-2025	1,097		100	1,196
Total	6722	424	609	7755

19.1.5 Operation & Maintenance Costs Estimates

➤ Basis of O&M Cost Estimates

The O&M Cost has three major components which include:

- Manpower Cost
- Energy Cost
- Maintenance Cost

The manpower cost and the maintenance expenses have been calculated considering the operating costs of DMRC and BMRCL projects for years 2007-2012 as mentioned in Operations and Maintenance report, November 2013, by Ministry of Urban Development.

The per km manpower deployment for DMRC and BMRCL projects is 35.3 per route km and 38.4 persons per route km respectively. For Agra Metro project, this has been considered as 35 persons per route km. The average salary of the staff is assumed to be Rs 7.12 lakhs per annum for the year 2017. The maintenance expenses for the Agra project have been considered as Rs. 1.37 Cr/km for the year 2017. The energy cost has been calculated as per the train operation plan (explained in detail in Chapter 8).

The operations and maintenance expenses for DMRC has been considered as the basis for the estimations of the Agra Metro project. DMRC has the least operating cost per passenger journey as compared to the metros which are the member of NOVA/CoMET. As per the operating cost details of Delhi metro project for the year 2012, the staff cost is around 44% of the total O&M cost and energy cost is around 33% of the total O&M cost.

The estimated staff and energy cost of the Agra Metro project for the year 2024 i.e. the inception year has been calculated as 42% and 38% respectively.

Several measures have been proposed for the Agra Metro project which will help in reduction of O&M cost. These include:

- Use of energy efficient LED lights in place of conventional lights.
- Installation of solar panels on the rooftops of all elevated stations and the sheds of the depot. The solar energy harnessing is proposed with RESCO model as adopted in various metro projects. Fixed tariff as per the power purchase agreement shall be applicable for a period of 20-25 years. This shall result in savings in energy cost due to use of solar energy.
- Preventive maintenance schedule as given in Maintenance depot chapter shall be followed so as to reduce the number of breakdowns. This will ensure the smooth operation of the trains.
- Gas insulated substations which are maintenance free have been proposed for all Receiving cum Traction Substations (RSS cum TSS). This will minimize the maintenance needs in the substation area.
- CBTC (Communication Based Train Control) Signalling system has been proposed which will enable the trains to operate with high frequency and improve the operational capability of the system.
- Outsourcing of various activities like ticketing, crowd control, housekeeping etc.

➤ **O&M Cost Estimates**

Based on above principles, O&M Cost for Agra Metro has been worked out. Corridor wise details of O&M cost are given in Chapter 17. The combined O&M cost for the two corridors is given in **Table 19-7**. The total O&M cost in the year 2024 is estimated at **Rs. 247Crore**. The total O&M cost in the year 2031 is estimated at **Rs. 430Crore**.

➤ **Additional & Replacement Costs Estimates**

To cater to increased traffic demand additional Rolling Stock would be required. Additional investment of **Rs. 676Crore** in the Year 2031 and **Rs. 396Crore** in Year 2041 has been estimated. The replacement cost for the corridors is estimated to be **Rs. 2063Crore** in the year 2044.

The additional cost of **Rs 676 Crore** include **Rs 542 Crore** towards additional rolling stock and **Rs 134 Crore** towards completion costs (including contingencies and taxes) of 2 future stations which are expected to come in the year 2031. Table 19.7 gives the details of additional costs also.

TABLE 19-7 OPERATION AND MAINTENANCE COSTS (RS IN CRORE)

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M Cost	Additional Rolling Stock / Replacement Cost
2024	103.55	49.25	93.71	246.51	
2025	112.87	51.71	99.60	264.18	
2026	123.03	54.29	105.84	283.16	
2027	134.10	57.00	112.46	303.56	
2028	146.17	59.85	119.46	325.48	
2029	159.32	62.85	134.84	357.01	
2030	173.66	66.00	151.63	391.29	
2031	189.29	69.30	171.32	429.91	676.08
2032	206.32	72.77	191.58	470.67	
2033	224.89	76.41	203.48	504.78	
2034	245.13	80.23	216.10	541.46	
2035	267.20	84.24	229.46	580.90	
2036	291.25	88.46	243.64	623.35	
2037	317.46	92.89	258.64	668.99	
2038	346.04	97.53	274.55	718.12	
2039	377.18	102.40	291.40	770.98	
2040	411.12	107.52	309.24	827.88	
2041	448.12	112.90	330.77	891.79	396.27
2042	488.46	118.55	352.58	959.59	
2043	532.42	124.48	375.75	1,032.65	
2044	580.34	130.70	400.35	1,111.39	2063.32
2045	632.57	137.23	426.48	1,196.28	
2046	689.50	144.09	454.21	1,287.80	
2047	751.56	151.29	483.66	1,386.51	
2048	819.20	158.85	514.91	1,492.96	
2049	892.93	166.79	548.08	1,607.80	

19.2 MEANS OF FINANCE

The Revenue for Agra metro will mainly consists of fare box collection and revenue from other non fare box sources such as property development, advertisement, parking, taxes etc. Estimation of revenue from fare box and non fare box source has been made.

19.2.1 Fare Box Revenue

➤ Projected Traffic Demand

The ridership on the proposed Agra metro system has been estimated at 5.73 Lakh passenger trips per day in the year 2024. Based on decisions taken during stakeholder consultation, as the ridership takes time to stabilize after the operation, the actual ridership has been assumed to be 70% of the projected ridership. The ridership figures for key horizon years are given in **Table 19-8**.

TABLE 19-8 EXPECTED METRO RIDERSHIP IN HORIZON YEARS

Year	Passenger Trips per day (Lakh)
2024	5.73(4.01*)
2031	10.17
2041	13.96

*70% of the projected ridership

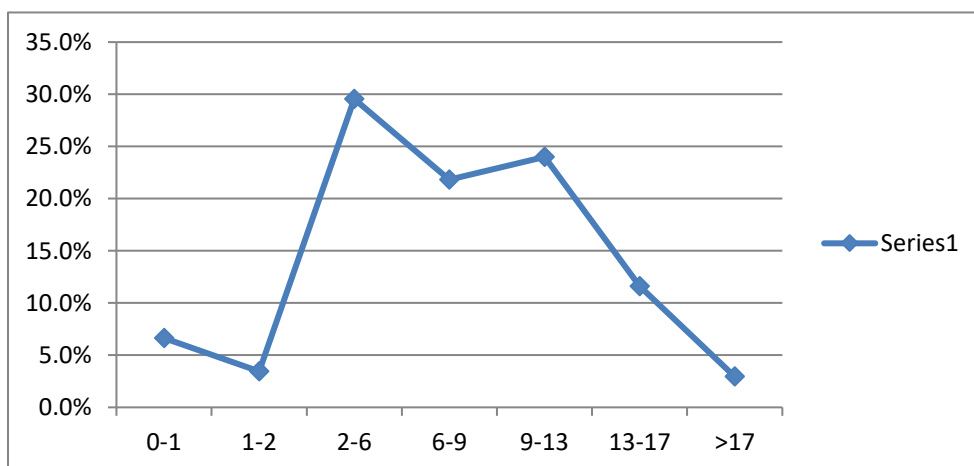
➤ **Trip Length Distribution**

The trip length distribution has been taken on the basis of the available details on land use, corridor composition and existing traffic characteristics in the catchment areas of various sections of the corridor. Average trip length on the corridor is about 7.90 km. The trip length distribution is given in **Table 19-9** and **FIGURE 19-1**.

TABLE 19-9 TRIP LENGTH DISTRIBUTION

Trip Length (Km)	% Distribution
0-1	7%
1-2	3%
2-6	30%
6-9	22%
9-13	24%
13-17	12%
>17	3%
Total Trips (Km)	100%

FIGURE 19-1 EXPECTED TRIP DISTRIBUTION ON THE PROPOSED METRO CORRIDOR



➤ **Fare Structure**

Table 19-10 gives the fare structure adopted by LMRC for Lucknow Metro in the year 2017. Same fare structure is proposed for Agra Metro also. Assuming fare revision of 5 % every 2nd year same as adopted by Lucknow Metro, the fare structure for Agra Metro for horizon years has been worked out (**Table 19-11**).

TABLE 19-10 FARE STRUCTURE FOR LUCKNOW METRO-2017-2018

DISTANCE SLAB	FARE IN RS.
0-1	10
1-2	15
2-6	20
6-9	30
9-13	40
13-17	50
>17	60

TABLE 19-11 FARE STRUCTURE FOR AGRA METRO FOR HORIZON YEARS

YEAR		FARE						
FROM	TO	0-1	1-2	2-6	6-9	9-13	13-17	>17
2017	2018	10	15	20	30	40	50	60
2018	2019	10	15	20	30	40	50	60
2019	2020	11	16	21	32	42	53	63
2020	2021	11	16	21	32	42	53	63
2021	2022	11	17	22	33	44	55	66
2022	2023	11	17	22	33	44	55	66
2023	2024	12	17	23	35	46	58	69
2024	2025	12	17	23	35	46	58	69
2025	2026	12	18	24	36	49	61	73
2026	2027	12	18	24	36	49	61	73
2027	2028	13	19	26	38	51	64	77
2028	2029	13	19	26	38	51	64	77
2029	2030	13	20	27	40	54	67	80
2030	2031	13	20	27	40	54	67	80
2031	2032	14	21	28	42	56	70	84
2032	2033	14	21	28	42	56	70	84
2033	2034	15	22	30	44	59	74	89
2034	2035	15	22	30	44	59	74	89
2035	2036	16	23	31	47	62	78	93
2036	2037	16	23	31	47	62	78	93
2037	2038	16	24	33	49	65	81	98
2038	2039	16	24	33	49	65	81	98
2039	2040	17	26	34	51	68	86	103
2040	2041	17	26	34	51	68	86	103
2041	2042	18	27	36	54	72	90	108
2042	2043	18	27	36	54	72	90	108
2043	2044	19	28	38	57	75	94	113
2044	2045	19	28	38	57	75	94	113
2045	2046	20	30	40	59	79	99	119
2046	2047	20	30	40	59	79	99	119
2047	2048	21	31	42	62	83	104	125
2048	2049	21	31	42	62	83	104	125
2049	2050	22	33	44	65	87	109	131
2050	2051	22	33	44	65	87	109	131

19.2.2 Non Fare Box Revenue

Non-fare box sources of revenue considered for Agra metro are:

- Advertisement a) in stations, b) on trains and c) outside Stations and Off-Road Underground Stations areas and other prospective areas of advertisements are assumed @ 10% of the total advertisement revenue;
- Rental from kiosks inside stations;
- Parking charges for 4 wheeler vehicles at stations;
- Film shooting Charges
- Telecom cable & Tower license fee.

The assumptions of unit rates and rates of increase are tabulated in **Table 19-12**.

TABLE 19-12 RATES FOR NON FARE BOX REVENUES

Type of revenue	Unit Rate (Rs)	Rate of increase (%)
Advertising panels inside stations and train coach	2000 per sqm per month in 2018	5% every year
Kiosk rentals	614 per sqm per month	5% every year
Parking charges at stations	Average of 4 hrs. @ rate for 3-6 Hrs i.e. Rs. 20/- & 8 hrs for 6-12 Hrs i.e. Rs. 30/- Plus 20% for time slots and vehicle variations	15% every 3 years
Film shooting charges	Rs. 2 Lakhs per hour for inside Train/Station assumed for 8 hrs and once in 8 months i.e. 12 hrs in a year	5% every year
Telecom cable license fee	2000 per month for entire track length; 50000 per month in underground section	10% every 2 year
Telecom Tower license fee	15000 per month for elevated stations	10% every 2 year

Details of advertising within stations is given in **Table 19-13**

TABLE 19-13 ADVERTISING AREA

S. No.	Place of Advertisement	Area of Advertising (Sqm)
1	Under Ground Stations Advt. (8 Stations)	3,838
2	Elevated Stations Advt. (23 Stations)	9,249
3	10% Extra Advertisement for rest of Advt. possibilities (i.e. total advertisement revenues including Train Rap revenues)	

Based on above parameters, revenue estimation from non fare box sources has been made. The summary of non-fare revenue under the heads of advertisement receipts, rentals from kiosks, parking receipts, Film Shooting, Telecom Cable & Tower (License fees) is presented in **Table 19-14**.

TABLE 19-14NON FARE BOX REVENUE

Revenue Stream	Total Revenues (in Rs. Crore)		
	2024-25	2031-32	2041-42
Advertisement Receipts	50.9	71.7	117.9
Rentals from Kiosks	2.0	2.9	4.7
Parking Receipts	18.1	25.5	58.4
Film Shooting	0.3	0.5	0.8
Telecom Cable & Tower (License fees)	1.4	1.9	3.6
Total	72.8	102.5	185.3

19.2.3 Total Revenue

The total annual revenue through the fare box and other sources for the study corridors is given in **Table 19-15**.

TABLE 19-15TOTAL REVENUE COLLECTION (Rs. in Crore)

Source of Revenue	2024	2031	2041
Fare Box Revenue	487	1499	2625
Non Fare Box Revenue	73	102	185
Total Revenue	559	1601	2810

19.3 OPERATIONAL VIABILITY/FIRR

The FIRR for the project with capital costs with central taxes and revenue from fare box and non fare box sources works out to be **10.07%** and is presented in **Table 19-17**.

19.4 SENSITIVITY ANALYSIS

The FIRR of the project is sensitive to revenues, and capital costs. The sensitivity of the project with respect to these factors is given in **Table 19-16**. It can be seen that the project is more sensitive to ridership variations than to variations in costs.

TABLE 19-16 COST AND RIDERSHIP SENSITIVITY

Parameter	+5%	+10%	-5%	-10%
Capital Cost	9.70%	9.35%	10.46%	10.88%
Ridership	10.67%	11.24%	9.43%	8.76%

19.5 ALTERNATE MEANS OF FINANCING

The financing option for metro implementation depends upon selection of the dedicated agency created to implement the project. As per Metro Rail Policy '2017, the prominent models are:

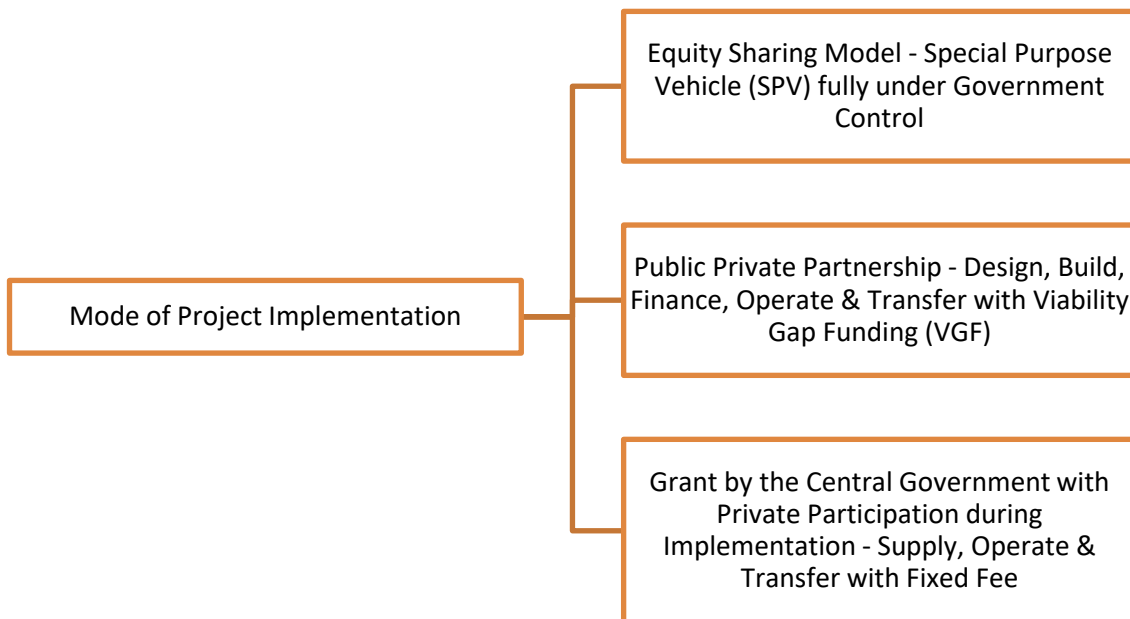
- Equity Sharing Model (Special Purpose Vehicle fully under Government Control)
- Built, Operate & Transfer (BOT) or Public Private Partnership (PPP)
- Grant by the Central Government

Figure 19-2 details the implementation models graphically.

TABLE 19-17AGRA MRTS FIRR WITH CENTRAL TAXES (RS. IN CRORE)

Year			Nov' 2017, Price Level	Completion Cost	Land Cost & R&R	Central Taxes	Total Completion Cost	Fare Box Revenue	Revenue from Adv & PD	Gross Revenue	O&M Cost	Additional Capital	Operational Surplus
2020	-	21	605	605	212	55	871	0.00	0.00	0			-871
2021	-	22	1,209	1,268	212	115	1,594	0.00	0.00	0			-1594
2022	-	23	1,512	1,662	0	150	1,812	0.00	0.00	0			-1812
2023	-	24	1,814	2,091	0	190	2,281	0.00	0.00	0			-2281
2024	-	25	907	1,097	0	100	1,196	487	73	559	247	0	-883
2025	-	26						555	76	631	264	0	367
2026	-	27						602	80	682	283	0	399
2027	-	28						686	84	770	304	0	467
2028	-	29						744	89	833	325	0	507
2029	-	30						969	93	1062	357	0	705
2030	-	31						1184	98	1281	391	0	890
2031	-	32						1499	102	1601	430	676	495
2032	-	33						1547	108	1655	471	0	1184
2033	-	34						1677	113	1790	505	0	1285
2034	-	35						1731	131	1862	541	0	1320
2035	-	36						1875	138	2013	581	0	1432
2036	-	37						1936	145	2081	623	0	1457
2037	-	38						2098	152	2250	669	0	1581
2038	-	39						2165	160	2325	718	0	1607

Year			Nov' 2017, Price Level	Completion Cost	Land Cost & R&R	Central Taxes	Total Completion Cost	Fare Box Revenue	Revenue from Adv & PD	Gross Revenue	O&M Cost	Additional Capital	Operational Surplus
2039	-	40						2347	168	2514	771	0	1743
2040	-	41						2422	176	2598	828	0	1770
2041	-	42						2625	185	2810	892	396	1522
2042	-	43						2678	194	2872	960	0	1912
2043	-	44						2868	204	3072	1033	0	2039
2044	-	45						2925	229	3154	1111	2063	-21
2045	-	46						3133	240	3373	1196	0	2177
2046	-	47						3196	253	3448	1288	0	2160
2047	-	48						3422	265	3688	1387	0	2301
2048	-	49						3491	278	3769	1493	0	2276
2049	-	50						3739	292	4031	1608	0	2423
TOTAL			6046	6722	424	609	7755	52599	4126	56725	19275	3136	26559
												IRR %	10.07

FIGURE 19-2 MODEL OF IMPLEMENTATION OF MRTS PROJECTS

19.5.1 Equity Sharing Model (SPV Model)

Under this model, a Special Purpose Vehicle (SPV) is set up as a joint venture between Central Government and State Government for the implementation of the project and for its subsequent Operation & Maintenance. Under this arrangement Government of India and State Government make equal equity contribution and run SPV as a commercial enterprise. As per the prevalent practice, Central Government contribute 20% of the project cost as their equity contribution. An equal amount can be contributed by State Government aggregating the total equity to 40%. Remaining 60% is arranged as soft loan from funding agencies. Delhi Metro Rail Corporation, Bangalore Metro Rail Corporation, Chennai Metro Rail Corporation, Lucknow Metro Rail Corporation & Kolkata Metro Rail Corporation are some of the examples of success of such a SPV.

19.5.2 Public Private Partnership

As per Metro Rail Policy 2017, it is essential to explore private participation either for complete provisioning of metro rail or for some unbundled components of operations and maintenance costs of metro rail.

The fundamental principle underlying Public Private Partnerships (PPP's) as a development option for any infrastructure project is to combine the strengths of the private sector with those of the public sector in order to overcome challenges faced during construction & operation and to achieve better outcomes. The private sector

can be expected to contribute to efficiency gains in the development of land, construction, operations and maintenance through the use of technology, better management and construction practices. In addition, the private sector should be expected to bring economies of scale from large projects and by involving a larger number of private partners.

However, the success of PPP will depend critically on designing PPP structures that make an appropriate allocation of risks, responsibilities, rewards and penalties, and create the incentives for value creation. Indeed, this risk allocation is the defining feature of the PPP strategy. The golden principle is that risks should be allocated to the entity best equipped to manage each risk. The expectation is that such an allocation of risks will not only produce the best possible program and project outcomes but also optimize costs. This should lead to good quality outcomes at optimum prices.

19.5.3 Grant by Central Government

Under this option Central Government would fund 10% of the project completion cost excluding private investment Land, R&R and state taxes. Remaining costs to be borne by state with Private sector participation.

These models have been explored for implementation of Agra Metro Rail.

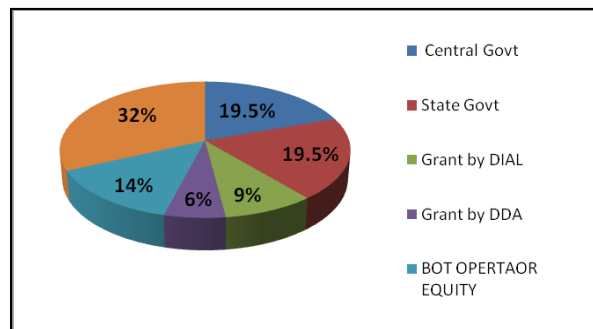
19.5.4 Case Studies of Private Sector Participation in MRTS in Indian Cities

Metro systems being planned in the cities of India have majorly adopted equity sharing model. Some of the cities have gone for private sector participation also. **Exhibits 19-1 to 19-4** give the examples of PPP in construction and operation of MRT system

Some of the metro companies have involved private sector in O&M also. **Exhibits 19-5 to 19-7** give the examples of PPP in some of the O&M activities. The involvement of private sector in O&M activities in case of Agra Metro, can be finalized at the time of operation.

EXHIBIT 19-1 DELHI AIRPORT LINE UNDER PPP MODEL

DMRC has implemented a High Speed Airport Link from New Delhi Railway Station to IGI Airport and further extension to Sector-21, Dwarka covering a distance of 22.7 KM with private sector participation. The project with an estimated cost of Rs. 3869 Crore has been implemented under a unique model of PPP where in the DMRC has undertaken the civil works with the funds being contributed by Gol, GNCTD, Delhi International Airport Limited and DDA (54%) and the cost of systems and Rolling Stock (46%) is being met by the private operator who will operate the system for 30 years, after which the system will revert back to DMRC. The approved funding pattern of the line is depicted in **Figure 19-3**. There have been some issues with the concessionaire and DMRC is now operating the system.

FIGURE 19-3 APPROVED FUNDING PATTERN OF DELHI AIRPORT LINE**EXHIBIT 19-2 HYDERABAD METRO UNDER PPP MODEL**

Hyderabad Metro is the first PPP Metro Rail Project that has been sanctioned by Government of India. GoAP has undertaken the Hyderabad Metro Rail Project under Viability Gap Funding (VGF) scheme of GoI. The MRTS network include three high density traffic corridors with total length of about 71 km. The Project is being executed by L&T on design, build, and finance, operate and transfer (DBFOT) basis. GoAP will spend another ₹ 1,980 Crore towards land acquisition, R&R package, shifting of utilities and GoI will support the project with grant of ₹ 1,458 Crore as VGF. **Figure 19-4** gives the funding plan of Hyderabad metro.

FIGURE 19-4 FUNDING PATTERN OF HYDERABAD METRO

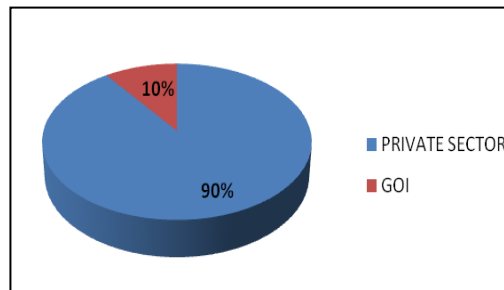


EXHIBIT 19-3 GURGAON METRO UNDER PPP MODEL

Gurgaon's Rapid Metro project is India's first fully privately financed metro. With the project cost of Rs 1100 Crore, it has a network of 5.1 km connecting Cyber City, NH-8 & Sikanderpur Station (DMRC) in Phase I. The planned route for Rapid Metro acts as a feeder to the MRC's Jahangirpuri-Central Secretariat-HUDA City Centre (Yellow Line). A special purpose vehicle (SPV), Rapid Metro Rail Gurgaon Limited (RMGL) was formed to construct, operate and maintain the metro.

EXHIBIT 19-4 MUMBAI METRO LINE 1 & 2 UNDER PPP MODEL

In contrast to the SPV model adopted for construction of metro rail system in the city of Delhi, Bangalore, Chennai & Kolkata, the Maharashtra government has opted Build Own, Operate & Transfer (BOOT) model in the city of Mumbai.

So far, 2 lines covering a distance of 44 KMs (Line 1 of 11.07 KMs from Versova – Andheri – Ghatkopar with a total cost of Rs. 2356 Crore and Line 2 of 32 KMs from Charkop – Bandra – Mankurd with an estimated cost of Rs. 8250 Crore) have been awarded to private operator for construction and operation by giving Viability Gap Funding by GoI & Maharashtra State Government to the extent of Rs. 650 Crore and Rs. 1532 Crore for Line 1 & Line 2 respectively.

Mumbai Metro One Private Limited is a Joint Venture Company formed by Reliance Energy Limited, a Reliance ADA Group Company, Veolia Transport, France and Mumbai Metropolitan Region Development Authority (MMRDA) incorporated under the Companies Act, 1956 to implement this project. **Figure 19-5** gives the funding pattern of Mumbai Metro Line 1. Line 1 is now operational. There are some issues with the concessionaire and the implementation mechanism for Line 2 is being revisited.

FIGURE 19-5 FUNDING PATTERN OF MUMBAI METRO LINE 1

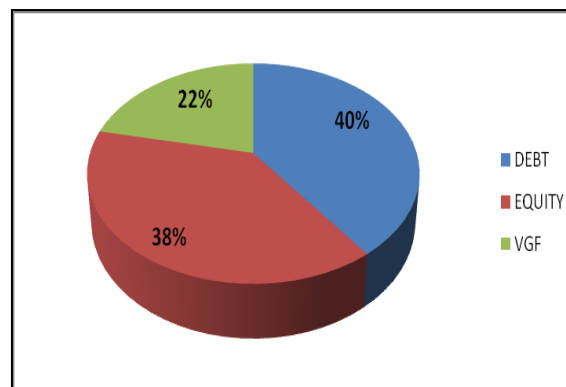


EXHIBIT 19-5 PPP IN O&M ACTIVITIES IN BANGALORE METRO

Bangalore Metro Rail Corporation Ltd (BMRCL) has signed a memorandum of understanding (MoU) with the Embassy Group to build the Kadubeesanahalli Metro station. Embassy Group will pay Rs 100 Crore to BMRCL in installments. The group is the first corporate to sign the agreement under the public-private partnership scheme.

The station, to be located just outside the Embassy Tech Village on the Outer Ring Road, will be on the recently approved 17-km North-South Metro corridor linking Silk Board Junction with Krishnarajapuram.

The construction will be done in accordance with the façade designs and specifications approved by BMRCL. The period of concession and permission granted to Embassy Group will be for 30 years starting from the date of commencement of commercial operations and could be extended further on mutual terms. The agreement mandates that the group will maintain Kadubeesanahalli Metro station, including housekeeping and maintenance, along with all the equipment, according to specifications laid down by the corporation.

The partnership also means the group will be entitled to utilize the pre-determined spaces for advertisements. Embassy can also use the leasable retail space measuring approximately 3,000 sq. ft at the Metro station. Embassy will also have the advantage of leveraging the linear zone of 250 metres around the Kadubeesanahalli Metro station.

EXHIBIT 19-6 PPP IN O&M ACTIVITIES IN LUCKNOW METRO - AFC

LMRC has tied up with M/s HDFC Bank for Fare Collection System and Provision of Allied Banking Application for Phase I (21 stations of North South Corridor of the project) . The Bank was offered two options for partnership

Option 1 – Annual royalty payable by bidder to LMRC (including provisions of TVMs and RCTMs)

Option 2 – Annual royalty payable by bidder to LMRC (excluding provisions of TVMs and RCTMs)

The Royalty Shall increase by 20% on completion of every 3 years on an compounding basis.

M/s HDFC Bank opted for Option 2 i.e. Annual Royalty payable by Bidder to LMRC (excluding provisions of TVMs and RCTMs). HDFC Bank pays Rs. 1000 as Annual Royalty under option 2 to LMRC. While opting for option 2, following cost is being incurred by HDFC Bank in discharging the obligation.

Annual Manpower Cost (including dress) – Rs. 101.17 Lakh

Annual Cash Management Charges – Rs. 53.4 Lakh

Annual Maintenance Charges – Rs. 3.00 Lakh

Total - Rs. 157.54 Lakh

The above cost will be increased by approx 9% annually considering the inflation and other cost.

EXHIBIT 19-7 PPP IN O&M ACTIVITIES IN KOCHI METRO - AFC

Kochi Metro Rail Limited (KMRL) has signed a public-private partnership (PPP) pact with Axis Bank for the automated fare collection (AFC) system. Under the agreement, investment for the entire funding required for the AFC system will be undertaken by Axis Bank, which will also maintain it for 10 years. The bank will pay a royalty of Rs 209 Crore over the next 10 years for the right to be KMRL's partner in this endeavour. In return, Axis Bank will get the right to issue co-branded cards, which will function as a smart card as well as a ticket, to the users of the metro. In addition to this, 0.2 per cent of Axis Bank's gross revenue, from the utilisation of this card outside KMRL's ecosystem in various mercantile outlets and internet transactions, will also accrue to KMRL over the next 10 years.

The AFC system is a critical core component of any metro system. It includes complex hardware and software installed at entry points of metro stations as well as buses and boats. It uses radio frequency identification devices (RFID) to collect fares from the users. In such a system, the metro ticket can be in the form of a co-branded card or an NFC-enabled smart phone or a 'patch' on a mobile device or any other surface with NFC stickers or QR code, or even as a paper-coupon. The smart card can be linked with any bank account of the user, in any bank.

KMRL is planning a 'click and collect' system whereby the commuter will be able to order goods and services using this card, which can be delivered at all metro stations. It is also planning to start a drive for including a variety of local and national goods and services that can be accessed using the KMRL - Axis Bank co-branded card. In addition to the co-branded card, the bank will also develop a mobile app, which can be used for ticketing as well as e-commerce. This initiative is unique in that it is for the first time that 'open-loop' smart cards are being introduced in the metro system.

19.5.5 Equity Sharing Model (SPV Model) for Agra Metro

Under this model, a Special Purpose Vehicle (SPV) will be set up as a joint venture between Central Government and Government of Uttar Pradesh for the implementation of the project and for its subsequent Operation & Maintenance. As per the prevalent practice, Central Government contributes 20% of the project cost excluding land and state taxes as its equity contribution. An equal amount will be contributed by State Government aggregating the total equity to 40%. In addition to equity, GoUP will also fund the cost of land and state taxes. During Stake holder consultations, it was agreed that local bodies in the city would contribute **Rs. 200 Crore** towards funding of the metro in the city. Remaining amount shall be arranged as soft loan from funding agencies.

The funding pattern developed under this model (SPV) is placed in **Table 19-18**. Equity Cash Flows (after repayment of JICA Step Loan and excluding cost towards hedging of exchange rate risk) is placed at Annexure 1.

TABLE 19-18 FUNDING PATTERN UNDER EQUITY SHARING MODEL (SPV)

Particulars	Amount (Rs in Cr)	% Share
Equity by GoI	1162	15.85%
Equity by Govt. of UP	1162	15.85%
SD for CT by Govt. of UP	304	4.15%
SD for CT by GoI	304	4.15%
Contribution by Local Bodies	200	2.73%
Soft Loan from bilateral/multilateral funding agencies	4199	57.27%
Total Cost	7331	100.00%
SD for land and R&R by Govt. of UP	424	-
State Taxes towards Completion Cost	508	-
IDC for JICA Step Loan @0.1% & Front End Fee @0.2%	14	
Total Cost	8277	-

19.5.6 Public Private Partnership – DBFOT with VGF for Agra Metro

In this model, the private firm may be responsible for designing, building, operating and maintaining of the entire project. Government of Uttar Pradesh will bear the cost towards land including R&R and state taxes irrespective of the model of PPP. The metro rail being a social sector project not many private parties are available to bid for such a project. Besides quite expectedly the private operator may demand assured rate of return in the range of 16% to 18% or a comfort of guaranteed ridership.

The operation period by a private entity is considered as 30 years, Debt : Equity ratio for all financing by private entity is considered as 70:30, with long term cost of debt as 12% p.a. The Private Partner will develop the infrastructure with its own funds and funds raised from lenders at its risk (that is, it will provide all or the majority of the financing). The Private Partner is also responsible for operating (supply and running of rolling stock) and managing the infrastructure life cycle (assuming life-cycle cost risks) for a specified number of years. To carry out these tasks, the Private Partner, will usually create an SPV.

The bid parameter in such projects is either Premium (as percentage of revenues) if the funds coming from users are sufficient to cover O&M expenses and long-term maintenance with a surplus that can then be used as a source to repay the financing of the construction of the asset, and where no Bidder is offering a Premium, bidding parameter is the Grant required (as per VGF scheme of Government of India). The Grant/ Premium is computed for a target pre-tax equity IRR of private entity as 18%.

Based on above, the funding pattern without additional income from PD is provided in **Table 19-19**. Equity Cash Flows to Concessionaire is provided in **Annexure 19.2**.

TABLE 19-19 FUNDING PATTERN UNDER PPP – BOT WITH VGF

Particulars	Amount (Rs in Cr)	% Share
VGF by GoI	1290	17.60%
VGF by GoUP	1290	17.60%
Equity by Concessionaire	1425	19.44%
Concessionaire's Debt @ 12% p.a.	3326	45.37%
Total	7331	100.00%
Land by GoUP	424	
State Taxes by GoUP	508	
IDC	748	
Total	9011	

19.5.7 Grant by the Central Government – Supply of System and O&M by Private Participation

Under this model, Government of Uttar Pradesh will bear the cost towards land including R&R and state taxes. Central Government shall provide a grant of 10% and post-construction of civil assets by State Government the Private Partner installs the system (signalling and electrical assets), procures rolling stock and operates and maintains all these assets.

The State Government collects all the revenue and pays the Private Partner a monthly/ annual payment for operations and maintenance of the system. The remuneration given could comprise of a fixed fee and a variable component, which would depend on the quality of service provided and the fixed fee is computed for a target pre-tax equity IRR of private entity as 18% which will be financed through the revenue generated in the project. For our analysis, a fixed fee escalated at long-term WPI i.e. 4% p.a. is considered. Equity Cash Flows to Private Partner is provided in Annexure 3. Based on above, the funding pattern is provided in **Table 19.20**.

TABLE 19-20 FUNDING PATTERN UNDER GRANT BY THE CENTRAL GOVERNMENT MODEL

Particulars	Amount (Rs in Cr)	% of Contribution
Capital Contribution by GOI	733	10.00%
Capital Contribution by GoUP	4399	60.00%
Equity by Concessionaire	660	9.00%
Concessionaire's Debt @ 12% p.a.	1540	21.00%
Total	7331	100.00%
Land by GoUP	424	
State Taxes by GoUP	508	

Particulars	Amount (Rs in Cr)	% of Contribution
IDC	320	
Total	8740	

The total fund contribution of GoI & GoUP under various alternatives excluding land and state taxes is tabulated in **Table 19-21**.

TABLE 19-21 COMPARISON OF THREE IMPLEMENTATION MODELS (Rs. Crore)

Particulars	Equity sharing model	BOT with VGF model	Grant by Central Govt model
Contribution by GoI	1466	1290	733
Contribution by GoUP (excluding land & State Taxes)	1466	1290	4557
Sub-Total	2933	2580	5290
Land & State Taxes by GoUP	932	932	932
Total	3864	3512	6221
Present Value @8% of Operating Cash Flow to Public Entity (Revenue less Expenses)	8235	0	5474

It can be seen from the above table that the contribution of Governments under SPV model is slightly more than VGF model. However, in VGF model, the entire revenues for the Concession Period are accruing to the Private Partner with no return on Government's contribution. Also, in the VGF model the risk of revenue is with Private Partner which may not be in its control due to control of Government on tariff policies. Therefore, the actual VGF quoted by Private Partner may increase substantially to mitigate the Revenue risk.

Accordingly, it is proposed the project may be implemented on SPV Model.

As per new Metro Rail Policy 2017, it is essential to explore private participation either for complete provisioning of metro rail or for some unbundled components of operations and maintenance costs of metro rail. Accordingly, under SPV model for implementation of Agra Metro project following activities have been identified for private participation:

- i) Private participation in Automatic Fare System by completely outsourcing operation of Ticket Operating Machines (TOMs), Ticket Vending Machines (TVMs) and Card Recharge Machines including Smart Cards provisions and Merchant Acquirer functions on similar lines as Lucknow Metro.
- ii) Maintenance contracts with System suppliers for Rolling Stock and Signalling systems in place of in house maintenance.
- iii) Station Civil and E&M maintenance and parking management.
- iv) Exploring long term lease of Elevators at Metro Stations

ANNEXURE 19.1: CASH FLOWS TO SPV - EQUITY SHARING MODEL

Year			Capital Cost	Revenue	O&M & additional Cost	Cash Flow before debt	Loan Opening Balance	Withdrawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Cash flow after debt
2020	-	21	871	0	0	-871	0	0	0	0	0	0	-871
2021	-	22	1,594	0	0	-1,594	0	0	0	0	0	0	-1,594
2022	-	23	1,812	0	0	-1,812	0	722	0	0	0	722	-1,091
2023	-	24	2,281	0	0	-2,281	722	2,281	2	0	0	3,005	0
2024	-	25	1,196	559	247	-883	3,005	1,196	4	0	0	4,205	313
2025	-	26	0	631	264	367	4,205	0	4	0	4	4,205	363
2026	-	27	0	682	283	399	4,205	0	4	0	4	4,205	395
2027	-	28	0	770	304	467	4,205	0	4	0	4	4,205	462
2028	-	29	0	833	325	507	4,205	0	4	0	4	4,205	503
2029	-	30	0	1,062	357	705	4,205	0	4	0	4	4,205	701
2030	-	31	0	1,281	391	890	4,205	0	4	210	4	3,994	676
2031	-	32	0	1,601	1,106	495	3,994	0	4	210	4	3,784	281
2032	-	33	0	1,655	471	1,184	3,784	0	4	210	4	3,574	970
2033	-	34	0	1,790	505	1,285	3,574	0	3	210	3	3,364	1,071
2034	-	35	0	1,862	541	1,320	3,364	0	3	210	3	3,153	1,107
2035	-	36	0	2,013	581	1,432	3,153	0	3	210	3	2,943	1,219
2036	-	37	0	2,081	623	1,457	2,943	0	3	210	3	2,733	1,244
2037	-	38	0	2,250	669	1,581	2,733	0	3	210	3	2,523	1,368
2038	-	39	0	2,325	718	1,607	2,523	0	2	210	2	2,313	1,394
2039	-	40	0	2,514	771	1,743	2,313	0	2	210	2	2,102	1,531
2040	-	41	0	2,598	828	1,770	2,102	0	2	210	2	1,892	1,558
2041	-	42	0	2,810	1,288	1,522	1,892	0	2	210	2	1,682	1,310
2042	-	43	0	2,872	960	1,912	1,682	0	2	210	2	1,472	1,700
2043	-	44	0	3,072	1,033	2,039	1,472	0	1	210	1	1,261	1,827
2044	-	45	0	3,154	3,175	-21	1,261	0	1	210	1	1,051	-232
2045	-	46	0	3,373	1,196	2,177	1,051	0	1	210	1	841	1,966
2046	-	47	0	3,448	1,288	2,160	841	0	1	210	1	631	1,949
2047	-	48	0	3,688	1,387	2,301	631	0	1	210	1	420	2,090
2048	-	49	0	3,769	1,493	2,276	420	0	0	210	0	210	2,066

Year			Capital Cost	Revenue	O&M & additional Cost	Cash Flow before debt	Loan Opening Balance	Withdrawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Cash flow after debt
2049	-	50	0	4,031	1,608	2,423	210	0	0	210	0	0	2,213
TOTAL			7,755	56,725	22,411	26,559	68,898	4,199	69	4,205	63	68,898	26,490

ANNEXURE 19.2: EQUITY CASH FLOWS TO CONCESSIONAIRE IN DBFOT WITH VGF MODEL

Year			Capital Cost	Revenue	O&M Cost	Cash Flow before debt	Equity Withdrawn	Loan Opening Balance	With drawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Equity Cash Flow
2019	-	20	659	0	0	-659	659	0	0	0	0	0	0	-659
2020	-	21	1113	0	0	-1113	766	0	347	44	0	0	391	-766
2021	-	22	1021	0	0	-1021	0	391	1021	155	0	0	1567	0
2022	-	23	1284	0	0	-1284	0	1567	1284	264	0	0	3116	0
2023	-	24	674	559	247	-361	0	3116	674	285	0	0	4074	0
2024	-	25	0	631	264	367	0	4074	0	244	0	244	4074	122
2025	-	26	0	682	283	399	0	4074	0	234	170	234	3905	-5
2026	-	27	0	770	304	467	0	3905	0	224	170	224	3735	73
2027	-	28	0	833	325	507	0	3735	0	214	170	214	3565	124
2028	-	29	0	1062	357	705	0	3565	0	204	170	204	3395	332
2029	-	30	0	1281	391	890	0	3395	0	194	170	194	3226	527
2030	-	31	0	1601	1106	495	0	3226	0	183	170	183	3056	142
2031	-	32	0	1655	471	1184	0	3056	0	173	170	173	2886	841
2032	-	33	0	1790	505	1285	0	2886	0	163	170	163	2716	952
2033	-	34	0	1862	541	1320	0	2716	0	153	170	153	2546	998
2034	-	35	0	2013	581	1432	0	2546	0	143	170	143	2377	1120
2035	-	36	0	2081	623	1457	0	2377	0	132	170	132	2207	1155
2036	-	37	0	2250	669	1581	0	2207	0	122	170	122	2037	1289
2037	-	38	0	2325	718	1607	0	2037	0	112	170	112	1867	1325
2038	-	39	0	2514	771	1743	0	1867	0	102	170	102	1698	1472
2039	-	40	0	2598	828	1770	0	1698	0	92	170	92	1528	1509
2040	-	41	0	2810	1288	1522	0	1528	0	81	170	81	1358	1271
2041	-	42	0	2872	960	1912	0	1358	0	71	170	71	1188	1671
2042	-	43	0	3072	1033	2039	0	1188	0	61	170	61	1019	1808
2043	-	44	0	3154	3175	-21	0	1019	0	51	170	51	849	-241

Year			Capital Cost	Revenue	O&M Cost	Cash Flow before debt	Equity Withdrawn	Loan Opening Balance	With drawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Equity Cash Flow
2044	-	45	0	3373	1196	2177	0	849	0	41	170	41	679	1967
2045	-	46	0	3448	1288	2160	0	679	0	31	170	31	509	1960
2046	-	47	0	3688	1387	2301	0	509	0	20	170	20	340	2111
2047	-	48	0	3769	1493	2276	0	340	0	10	170	10	170	2096
2048	-	49	0	4031	1608	2423	0	170	0	0	170	0	0	2253
TOTAL			4751	56725	22411	29563	1425		3326	3804	4074	3056		25446
Equity IRR														18.00%

ANNEXURE 19.3: EQUITY CASH FLOWS TO PRIVATE ENTITY IN FIXED FEE MODEL

Year			Capital Cost	Revenue (Fixed Fee)	O&M Cost	Cash Flow before debt	Equity Withdrawn	Loan Opening Balance	Withdrawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Equity Cash Flow
2019	-	20	198	0	0	-198	198	0	0	0	0	0	0	-198
2020	-	21	415	0	0	-415	415	0	0	0	0	0	0	-415
2021	-	22	544	0	0	-544	47	0	496	63	0	0	560	-47
2022	-	23	684	0	0	-684	0	560	684	123	0	0	1367	0
2023	-	24	359	668	247	63	0	1367	359	133	0	0	1859	63
2024	-	25	0	668	264	404	0	1859	0	112	0	112	1859	292
2025	-	26	0	695	283	412	0	1859	0	107	77	107	1782	227
2026	-	27	0	722	304	419	0	1782	0	102	77	102	1704	239
2027	-	28	0	751	325	426	0	1704	0	98	77	98	1627	251
2028	-	29	0	781	357	424	0	1627	0	93	77	93	1549	254
2029	-	30	0	813	391	421	0	1549	0	88	77	88	1472	256
2030	-	31	0	845	1106	-261	0	1472	0	84	77	84	1394	-422
2031	-	32	0	879	471	408	0	1394	0	79	77	79	1317	252
2032	-	33	0	914	505	409	0	1317	0	74	77	74	1239	258
2033	-	34	0	951	541	409	0	1239	0	70	77	70	1162	262
2034	-	35	0	989	581	408	0	1162	0	65	77	65	1084	265
2035	-	36	0	1028	623	405	0	1084	0	60	77	60	1007	267
2036	-	37	0	1069	669	400	0	1007	0	56	77	56	930	267
2037	-	38	0	1112	718	394	0	930	0	51	77	51	852	266
2038	-	39	0	1157	771	386	0	852	0	46	77	46	775	262

Year			Capital Cost	Revenue (Fixed Fee)	O&M Cost	Cash Flow before debt	Equity Withdrawn	Loan Opening Balance	Withdrawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Equity Cash Flow
2039	-	40	0	1203	828	375	0	775	0	42	77	42	697	256
2040	-	41	0	1251	1288	-37	0	697	0	37	77	37	620	-152
2041	-	42	0	1301	960	342	0	620	0	33	77	33	542	232
2042	-	43	0	1353	1033	321	0	542	0	28	77	28	465	215
2043	-	44	0	1407	3175	-1767	0	465	0	23	77	23	387	-1868
2044	-	45	0	1464	1196	267	0	387	0	19	77	19	310	171
2045	-	46	0	1522	1288	234	0	310	0	14	77	14	232	143
2046	-	47	0	1583	1387	197	0	232	0	9	77	9	155	110
2047	-	48	0	1646	1493	153	0	155	0	5	77	5	77	71
2048	-	49	0	1712	1608	104	0	77	0	0	77	0	0	27
TOTAL			2199	28487	22411	3877	660		1540	1714	1859	1394		1804
Equity IRR														18.00%

20. ECONOMIC ANALYSIS

20.1. APPROACH AND METHODOLOGY FOR ECONOMIC ANALYSIS

The DPR Chapter has been modified due to revision in projects costs and revenues incorporating comments and observations received from the Stakeholders. During the consultations, it was decided that it generally takes 4-5 years to achieve the estimated ridership on a new mass transit system. Accordingly, 70% of the projected ridership has been assumed for first 5 years and then gradual increase of 10% every year for next 3 years. O&M costs have been revised accordingly. The economic benefits that will accrue to the society have also been reduced in the same proportion.

The economic appraisal has been 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. In the analysis, the cost and benefit streams arising under the above project scenarios 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. The annual streams of project costs and benefit have been compared over the analysis period of 30 years to estimate the net cost / benefit and to calculate the economic viability of the project in terms of EIRR & ENPV.

20.1.1 Evaluation Assumptions

The key assumptions used in the evaluation are listed in **Table 20.1**.

TABLE 20.1: KEY EVALUATION ASSUMPTIONS

Parameter	Assumption
Price Level	November '2017
Construction period	2019-2024
First year of operation of MRTS	2024
Daily to annual factor	340

20.1.2 Development of With and Without Metro Scenario

The ‘Without Project Scenario’ is essentially the present condition but it includes existing and committed transport infrastructure proposals that will be constructed in the near future. The ‘Without Project Scenario’ includes the existing road network

and improvements that are likely to be implemented within the next few years, except for the mass transit system corridors being considered in this study.

The Without Project Scenario provides a baseline for comparing travel benefits in both 'with and without project scenarios' for Metro System. Accordingly, transport demand analysis for metro system in both scenarios has been carried out.

The mode-wise passenger trips for the horizon years have been worked out and shown in **Table 20.2**.

The introduction of mass rapid transit system in the Study Area will help in reducing vehicular traffic on the road thereby contributing to relieving traffic congestion along proposed corridors, reduction in accidents and larger environmental savings.

TABLE 20.2: MODE-WISE TRIPS IN WITH & WITHOUT PROJECT SCENARIOS IN HORIZON YEARS

SN	Mode	Trips in 'Without Project Scenario' (in lakh)				Trips in 'With Project Scenario' (in lakh)			
		2021	2031	2041	2051	2021	2031	2041	2051
1	Car	4.2	5.3	6.3	7.9	4.1	5.1	6.2	7.7
2	2-Wheelers	16.4	18.8	22.7	28.3	15.2	17.3	20.9	26.1
3	Auto Rickshaw	1.1	1.4	1.7	2.1	1.1	1.2	1.5	1.9
4	Bus/ Shared Auto	8.8	10.5	12.6	15.8	4.4	5.0	5.5	6.9
5	MRTS	-				5.7	7.4	9.2	11.5
Total		30.5	36.0	43.4	54.2	30.5	36.0	43.4	54.2

20.2. ESTIMATION OF ECONOMIC COST OF MRTS

The project cost comprises capital cost and operation & maintenance cost. The Cost components considered for the purpose of this exercise include:

- Capital cost of infrastructure (civil engineering, land, track, power supply, traction system, signaling & telecommunications, etc.) and rolling stock.
- Operating cost of MRTS
- Maintenance and Replacement costs

Table 20.3 summarizes the estimated financial cost to economy. The cost at 2017 prices is estimated at Rs. 6470 Crore including Rs 418 Crore as land and R&R cost.

TABLE 20.3: FINANCIAL COST OF METRO - CAPITAL AND O&M (RS. IN CRORE) AT 2017 PRICES

Cost Component	Metro
Construction Cost Including land and R&R	6470
Taxes and Duties	1001
O&M Costs	
• 2024	191
• 2031	214
• 2041	233

The economic costs of the capital works and annual operation and maintenance costs have been calculated from the financial cost estimates by excluding:

- Price contingencies/price escalations
- Import duties and taxes
- Sunk costs
- Interest payment, principal payment and interest during construction period

The economic costs have been derived from financial costs using following shadow price factor (**Table 20.4**) for each component to take care of the distortions brought by above factors. **Table 20.5** gives the economic costs of MRTS - Capital and O&M.

TABLE 20.4: FACTORS USED FOR CONVERTING PROJECT COSTS TO ECONOMIC COSTS

S. No	Item	Factor
1	Capital Cost	0.83
2	Operations & Maintenance Cost	0.87

TABLE 20.5: ECONOMIC COSTS OF MRTS – CAPITAL AND O&M (RS IN CRORE)

Cost Component	Metro
Construction Cost Including land and R&R	5370
O&M Costs	
• 2024	166
• 2031	186
• 2041	202

20.3. ECONOMIC BENEFITS OF MRTS

Agra Metro will yield tangible and non-tangible savings due to equivalent reduction in road traffic and certain socio-economic benefits. **Table 20.6** gives reduced passenger trips due to Agra Metro.

**TABLE 20.6: REDUCED PASSENGER TRIPS DUE TO AGRA MRTS
 (Trips in Lakh)**

Mode	Reduced pass Trips Due to Agra Metro		
	2024	2031	2041
Car	0.12	0.14	0.18
2W	1.15	1.54	1.82
Bus /Shared Auto	4.5	5.65	7.21
Auto	0.01	0.03	0.03
MRTS	5.7	7.4	9.2

The introduction of MRTS will result in reduction in number of mini buses, IPT, usage of private vehicles, air pollution and increase in the speed of road-based vehicles. This, in turn, will result in significant social benefits due to reduction in fuel consumption, vehicle operating cost and travel time of passengers. Reduction in

accidents, pollution and road maintenance costs are the other benefits to the society in general. The benefit stream includes:

- Savings in Capital and operating cost (on present congestion norms) of carrying the total volume of passenger traffic by existing modes in case MRTS project is not taken up.
- Savings in operating costs of different modes due to de-congestion including those that would continue to use the existing transport network even after the MRTS is introduced.
- Savings in time of commuters using the MRTS over the existing transport modes because of faster speed of MRTS.
- 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 MRTS.
- Savings in road infrastructure and development costs that would be required to cater to increase in traffic, in case MRTS is not introduced.

The 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

20.3.1 Input Parameters

Inputs used for Economic analysis have been collected from primary and secondary data sources. Vehicle Operating cost (VOC) and Value of Travel Time (VOT) are the two important parameters of Economic Analysis.

Vehicle Operating Cost (VOC): VOC is a function of speed, road roughness, carriageway, width/capacity, rise and fall per unit. The VOC unit cost have been taken from the “Manual on Economic Evaluation of Highway Projects in India, 2009” by the Indian Road Congress (IRC). The VOC has been adjusted for Agra according to the traffic, road conditions, fuel cost in the city as recommended in the manual.

Table 20.7 gives the mode wise VOC to estimate benefits accruing to the society from the project.

TABLE 20.7: MODE WISE VOC FOR AGRA

Mode	VOC* Rs /Km
Car	8.10
2w	3.59
Auto	6.48
Bus	19.30

**Source IRC SP 30 (2009) Values brought to 2017 level using factor of 5%*

Value of Travel Time (VOT): VOT is another important parameter of Economic Analysis. It refers to the cost of time spent on transport. It includes costs of both work and non-work trips. Mode wise value of time has also been taken from IRC SP 30 (2009) Values brought to 2017 level using factor of 5%. The value of travel time for MRTS passengers has been taken as that of deluxe bus. **Table 20.8** gives the mode wise VOT to estimate benefits accruing to the society from the project.

TABLE 20.8: MODE WISE VOT FOR AGRA MRTS

Mode	Value of Travel Time**Passenger/ Hour
Car	85
2w	40
Shared Auto	40
Bus	40
Metro	64

**Source IRC SP 30 (2009) Values brought to 2017 level using factor of 5%*

Other operational parameters required to assess the savings in VOC and VOT, accidents, pollution for the system in year 2041 is presented in **Table 20.9**.

TABLE 20.9: MODE WISE OPERATIONAL PARAMETERS – METRO

Mode	Average Lead KM	Veh-KM/ Day	Average Speed (Km/Hr)*		Occupancy
			Without MRTS	With MRTS	
Bus	7	100	16	20	30
Car	8	25	22	25	3.1
2wh	6	20	23	30	1.4
Auto	4	70	18	23	3

Source: RITES Field Studies 2015, Derived from Transport Demand model*

Other benefits that will accrue to the society include reduction in emission, savings due to reduction in accidents. The input for the benefit estimation from these parameters includes the emission factors by vehicle category as given by CPCB (**Table**

20.10), vehicle and accident statistics (Table 20.11) and cost of accidents (Table 20.12).

TABLE 20.10: MODE WISE EMISSION FACTORS (GRAM/KM)

Vehicle Type/ Pollutant	CO	HC	NOX	PM	CO2
2-wheeler	1.4	0.7	0.3	0.05	28.58
Auto	2.45	0.75	0.12	0.08	77.89
Cars (incl. cabs)	1.39	0.15	0.12	0.02	139.52
Bus (incl. BRT)	3.72	0.16	6.53	0.24	787.72
Treatment Cost (Rs. /ton)	1,00,000	1,00,000	1,00,000	1,00,000	500

Source: Appraisal guidelines for Metro Rail Project Proposals MoHUA, GOI 2017

TABLE 20.11: ROAD ACCIDENTS IN AGRA

Year	Registered Vehicles	Total Accidents	Fatal Accidents
2013	825085	1021	500
2014	883060	971	522
2015	945487	1007	532
2016	1012749	1062	492

Source: Year-wise Statistics on Road Accidents in Agra, Traffic Police, 2017

TABLE 20.12: COST OF ACCIDENTS

Type of Accident	Accident Cost (Rs.)	
	(2004 prices)*	(2017 prices)**
Cost of fatal accident	437342	824674
Cost of major accident	64256	121164
Cost of damage to Two wheelers	2286	18410
Cost of damage to Car	9763	61883
Cost of damage to buses in road accidents	32818	4311

Source: *Appraisal guidelines for Metro Rail Project Proposals MoHUA, GOI 2017

**derived using escalation factor of 5%

20.3.2 Estimation of Project Benefits

The methodology adopted to quantify benefits that will accrue to the society owing to implementation of the Metro project include:

- Travel Time Savings- Travel time savings will accrue on two accounts:
 - Travel Time Savings for passenger trips that are shifted to MRTS from other modes due to higher speed of MRTS project as compared to 'Without' project scenario.
 - Travel Time Savings for trips remaining on road due to reduction in congestion due to shift on metro leading to fewer vehicles on roads.
 - Passenger Time Savings = Time Savings of Modal Shift passenger + Time savings of passenger travelling on other mode.

- Time Savings of Modal Shift Passengers = (Time spent by Modal shift Passengers on Metro Rail Project - Time spent by Modal Shift diverted passenger on alternate transport mode in do nothing scenario) X Value of Passenger time.
- Time Savings of Passengers travelling on other modes = (Time spent by Passengers Travelling on other mode in With Project Scenario - Time spent by passengers travelling on other mode in do nothing scenario) X Value of Passenger time.
- Savings in Vehicle Operating Cost - Shifting of passenger trips from road to MRTS will result in lesser vehicles on roads resulting in saving in VOC. Savings in VOC will also accrue on two accounts:
 - VOC savings of mode wise vehicle trips which have shifted from road to MRTS.
 - VOC savings due to reduced congestion on roads of vehicles trips remaining on road.

The VOC savings have been calculated by multiplying the unit VOC cost with the number of vehicle kms saved for the particular vehicle category. $VOC \text{ savings} = VOC [Rs. /km] \times \text{Vehicle kms saved [km]}$. The VOC savings are calculated for the vehicle types and then added.

The difference of cost in “with” and “without” project is taken with respect to difference in speed of traffic, to estimate savings in Vehicle Operating Cost due to reduced congestion.

- Accident Reduction-These savings are also based on reduction in no of vehicles on roads due to shift of passengers of different modes on MRTS.
 - Reduction in fatal and injury accidents due less no of vehicles on roads.
 - Savings in damage cost to vehicles involved in accidents.
 - Based on trends of last 3 year data of vehicles and relationship with fatal and damage accidents data, the reduction in no of accidents is estimated for reduced no of vehicles on roads due to modal shift of passengers. Reduced number of fatal and damage accidents are then multiplied by the cost of accident to arrive at savings due to metro.
- Savings from Pollution Reduction - The reduction in no of vehicles on roads due to shift of passengers of different modes on MRTS.
 - Absence of vehicles on road due to modal shift passengers on MRTS will save pollution from modes that would have continued on road in "without MRTS scenario"
 - Savings from pollution are estimated by using the following method

Vehicle Km saved = [No. of Trips shift to Metro from other mode] x [Average Lead of the mode]

Total Volume of Pollutant= [Volume of Pollutant released per km] x [Daily vehicle km saved]

Annual Treatment Cost = [Volume of pollutant] x [Treatment cost/ton]

- Savings in Road Infrastructure Maintenance
 - With less no of vehicles on roads, expenditure on road maintenance is expected to go down. In the absence of data, a lump-sum expenditure of Rs. 50 Cr/ year has been assumed.

Following above methodology socio-economic benefits of Agra metro have been estimated in monetary terms. Following factors have been used for converting project benefits to economic costs (**Table 20.13**).

TABLE 20.13: FACTORS FOR CONVERTING PROJECT BENEFITS IN TERM OF ECONOMIC COST

S. No	Item	Factor
1	Savings in Capital & Operating Cost of Buses	0.9
2	Savings in Capital & Operating cost of Private Vehicles	0.9
3	Savings in Passenger Time	1.0
4	Savings in VOC	0.9
5	Savings in Accident Costs	0.9
6	Savings in Pollution Costs	1.0
7	Infrastructure Maintenance Cost Savings	0.87

With input from above tables, the accrued project benefits for the Agra in the horizon year 2041 has been summarized in **Table 20.14**.

TABLE 20.14: ECONOMIC BENEFITS OF AGRA MRTS -2041

S.No	Benefits	Metro	
		Amount	% Share
1	Travel Time Savings	1160	59
2	Savings in Vehicle Operating Cost	733	37
3	Savings from Accident , Pollution & Road maintenance Reduction	74	4
	Total	1967	100

It is clear from the table that the system benefits are mainly come from saving of travel time by MRTS and road passengers (59%), VOC savings (37%), and Environmental benefit from emission reduction, accident reduction and road maintenance cost (together 4%).

20.4. EIRR FOR 30 YEARS

For deriving the values of economic indicators (EIRR, ENPV), cost and benefit stream for the system has been constructed in terms of money value. *In the initial years benefits stream, the benefits have been reduced in the same proportion as that of reduction in ridership till the year 2031 when the ridership stabilizes.*

The Toolkit on Finance and Financial Analysis 2013 by MoHUA, suggests that ENPV can be calculated on social cost of capital or government security rate. Accordingly, ENPV for Agra MRTS have been calculated on both the rates.

Metro Rail Policy 2017 prescribes 14% as acceptable EIRR rate for metro project, same has been considered as the social cost of capital. The government security rate in December '2017 is 7.2%. Accordingly, ENPV for Agra MRTS has been calculated based on these rates. The summary of the ENPV, EIRR and Cost Benefit ratio is presented in **Table 20.15**. The cost and benefit streams for Agra MRTS is presented in **Table 20.17**.

TABLE 20.15 ECONOMIC RETURN PARAMETERS OF AGRA MRTS

S.No	Parameter	Metro
1	EIRR	17.32%
2	ENPV - Social cost of capital @14% - Government Security Rate@ 7.2%	1128 7050

20.5. OUTCOME ON ECONOMIC VIABILITY

The project has EIRR more than 14%, indicating that the benefits to the society are more than the social cost of capital of 14%. It also meets the acceptable norm of MOUD. Thus the project is economically viable and should be implemented.

20.5.1 Sensitivity Analysis

The sensitivity analysis has been carried out to see the impact of change in critical parameters in the range of 5% to 15% on EIRR and is presented in **Table 20.16**.

TABLE 20.16: SENSITIVITY ANALYSIS

S. No.	Factor	Range		
		5%	10%	15%
1	Cost overruns due to delay or other factors	16.68%	16.08%	15.52%
2	Increase in Maintenance Cost	17.22%	17.11%	17.01%
3	Reduction in Ridership	17.02%	16.72%	16.41%
4	Reduction in benefits	16.54%	15.73%	14.90%
5	Combination of reduction in benefits and increase in cost	15.91%	14.57%	13.26%

TABLE 20.17: COST AND BENEFIT STREAM FOR METRO SYSTEM (IN CRORE)

Units: Rs in Crores

YEAR	MRTS COSTS			SAVINGS					NET CASH FLOW
	CAPITAL	O&M	TOTAL	TIME	VOC	POL & ACC	ROAD INFRASTRUCTURE	TOTAL	
2020-21	676	0	676	0	0	0	0	0	-676
2021-22	1178	0	1178	0	0	0	0	0	-1178
2022-23	1256	0	1256	0	0	0	0	0	-1256
2023-24	1507	0	1507	0	0	0	0	0	-1507
2024-25	753	166	920	528	425	15	30	999	79
2025-26	0	167	167	542	428	15	30	1015	848
2026-27	0	168	168	555	447	15	30	1048	880
2027-28	0	169	169	569	458	16	30	1074	905
2028-29	0	169	169	584	470	16	30	1100	931
2029-30	0	175	175	684	550	20	35	1288	1114
2030-31	0	180	180	789	635	22	39	1485	1305
2031-32	0	186	186	939	622	25	44	1630	1443
2032-33	299	192	491	963	638	25	44	1670	1179
2033-34	0	193	193	987	654	26	44	1711	1518
2034-35	0	194	194	1012	671	27	44	1753	1559
2035-36	0	195	195	939	622	25	44	1630	1434

Units: Rs in Crores

YEAR	MRTS COSTS			SAVINGS					NET CASH FLOW
	CAPITAL	O&M	TOTAL	TIME	VOC	POL & ACC	ROAD INFRASTRUCTURE	TOTAL	
2036-37	0	196	196	961	637	25	44	1666	1470
2037-38	0	197	197	983	651	26	44	1703	1506
2038-39	0	198	198	1005	666	26	44	1742	1543
2039-40	0	199	199	1029	682	27	44	1781	1581
2040-41	0	200	200	1052	698	28	44	1821	1620
2041-42	0	202	202	1160	733	30	44	1967	1765
2042-43	179	204	383	1187	750	31	44	2012	1628
2043-44	0	205	205	1214	768	31	44	2057	1851
2044-45	0	207	207	1242	785	32	44	2103	1896
2045-46	502	209	710	1271	803	33	44	2151	1440
2046-47	0	210	210	1300	822	34	44	2199	1989
2047-48	0	212	212	1330	841	34	44	2249	2037
2048-49	0	213	213	1361	860	35	44	2300	2086
2049-50	0	215	215	1392	880	36	44	2352	2137
								EIRR	17.32%
								ENPV@14%	1128
								ENPV@7.2%	7050