



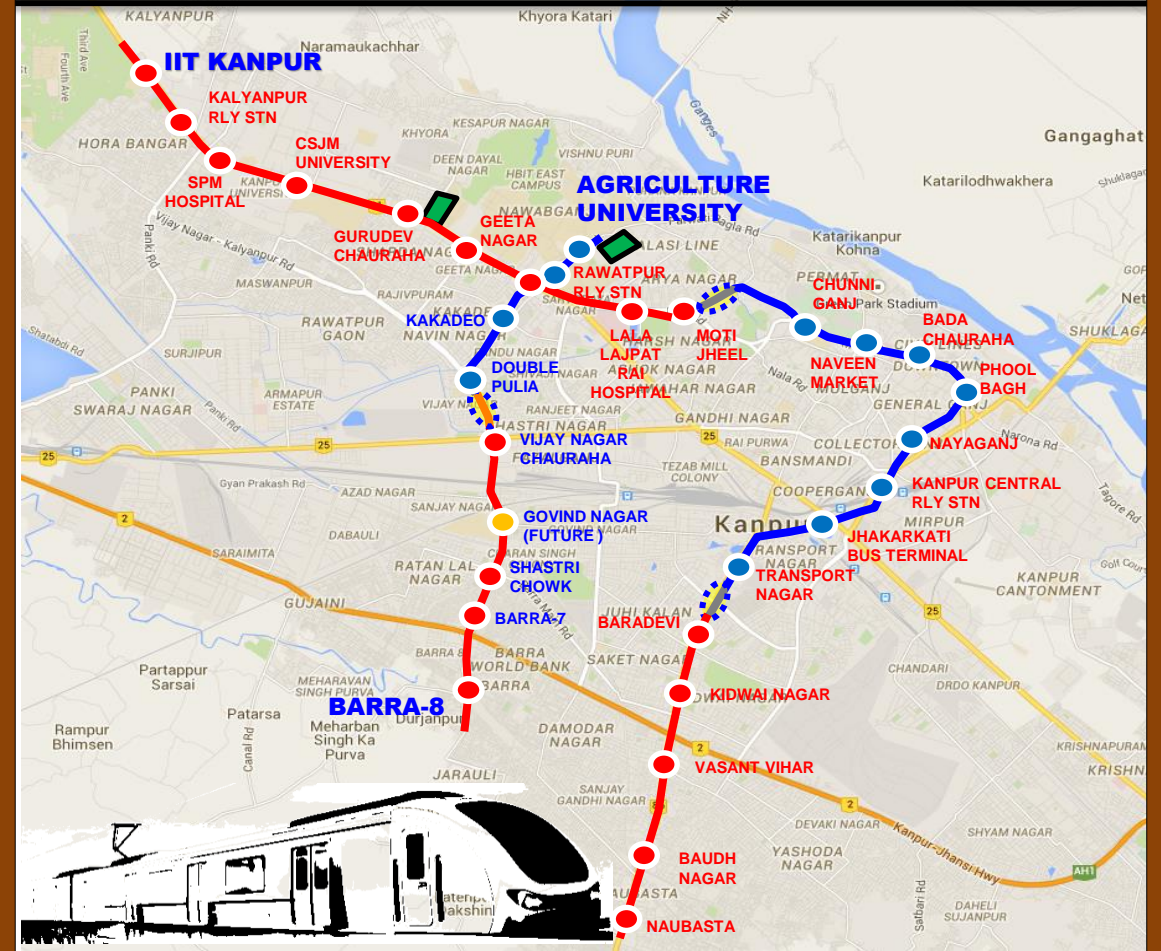
Government of Uttar Pradesh
through
Kanpur Development Authority



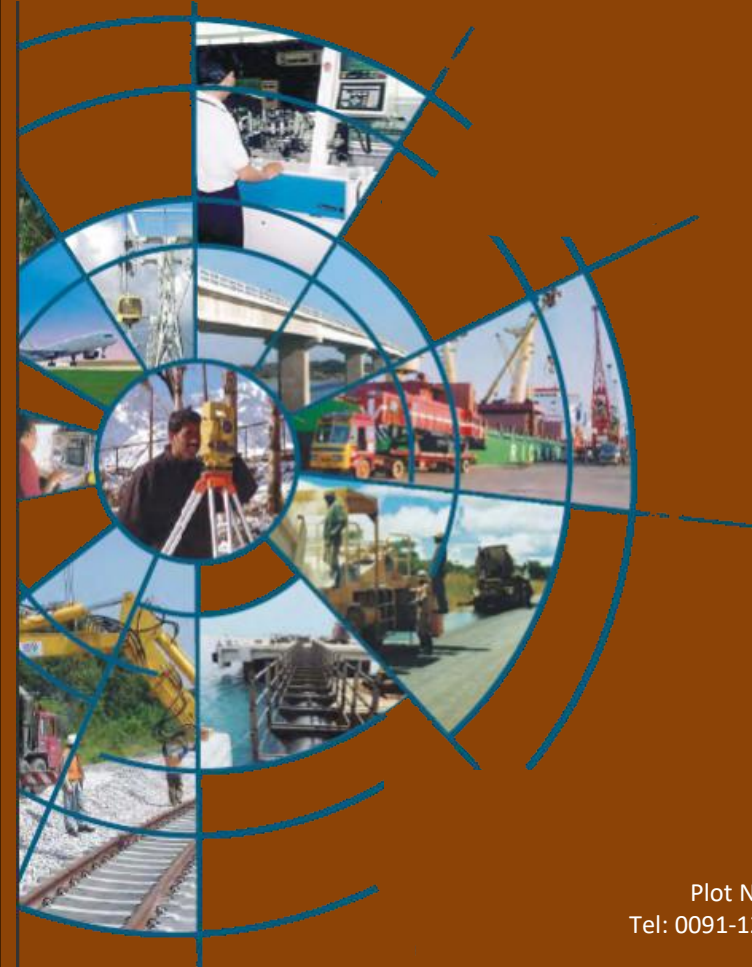
Coordinated by
Lucknow Metro Rail Corporation



**SUPPLEMENTARY DOCUMENT TO
 DETAILED PROJECT REPORT FOR
 RAIL BASED MASS TRANSIT SYSTEM
 IN KANPUR**



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 Kanpur as a long-term solution to meet the transportation demands of the most populous city of Uttar Pradesh. Kanpur Development Authority (KDA) 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/Aath-7-18-15 Metro/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 Kanpur is one of the very old industrial and densely populated city 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 Kanpur Metro with 6-Car train configuration - similar to that of Lucknow, Pune, Chennai, Bangalore Metro and Ahmedabad Phase-I has been proposed. According to the geographical structure of Kanpur, there are 12 stations in 13.0 km underground section, which is 41% of the total length (32.4 km) and the balance 19.4 km is elevated section with 19 stations.

- 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 Kanpur 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, adopting GIS (Gas Insulated Sub-station) to conventional sub-station for RSS and reducing the number of rolling stock to be procured at this stage have also been considered to bring down the cost of Kanpur 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 Kanpur Metro comes down from 156 coaches to 117 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.

To serve the catchment areas fully, 4-5 entry/exits have been proposed at stations in Kanpur Metro project DPR. Generally, 2-3 entry/exits are provided in other Metro project. 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 optimised for Kanpur Metro Project in line with benchmarking exercise by MoHUA.

For Corridor-2, five elevated stations have been planned in a length of about 4 Km. Govind Nagar elevated station is now proposed as future station and cost has been reduced at this stage. This can be added later depending on the traffic pattern in the catchment.

For Corridor-1, it was desired to review the requirement of Nayaganj underground station by NATM. Several International case studies have been referred for inter-station spacing of MRTS stations in urban centres. In view of the above, very dense commercial and residential areas in its immediate catchment and substantially higher boarding/ alighting passenger forecasts, Nayaganj station is proposed to be retained. However, to reduce the cost, it is now proposed to be constructed by 'cut & cover' method based on similar experience for Hussainganj Underground Metro station of Lucknow Metro. Resultant cost savings have been incorporated accordingly.

1.7.3 Land:

Corridor-1 includes about 1.70 Hectare of private land identified for the purpose of parking cum property development. The cost of this item alone is about ₹ 221 Crore. The land cost has been reduced by removing the private lands identified for parking cum property development at this stage.

The areas of Govt. as well as Private land have also been optimised. Land for Polytechnic Depot has been reduced to 16.2 Ha in place of 21.9 Ha. Land for Naubasta Depot on 6.75 Ha has been removed at this stage on account of reduction in rolling stock to be procured initially. This depot can also be constructed later when additional rolling stock is procured and the provision for cost of depot has been considered along with procurement of rolling stock in future. 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, numbers 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 216 to 102 and the number of Lifts from 116 to 102.

1.7.6 Automatic Fare Collection (AFC) system:

AFC system for Kanpur 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. There are three RSS proposed for both the corridors, out of which, to reduce the cost, earlier proposed 2 number of 220 kV GIS have been considered as conventional type outdoor receiving substation.

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 Kanpur 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 Kanpur Metro project is reworked as under:

- i) Corridor-1 – Rs. 7659.63 crore
- ii) Corridor-2 - Rs. 3249.04 crore

Total Cost - Rs. 10908.67 crore

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

- FIRR: 8.89%
- EIRR: 18.48%

17. DETAILED PROJECT COST ESTIMATES

17.1 CAPITAL COST ESTIMATE

17.1.1 Coverage

Cost estimate for Kanpur 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. The two depots are planned in the State Govt. land. The land for parking / property development has been primarily planned on State Govt. land. The summary of land requirement for Corridor - I & II 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	Alignment / Stations etc	0.12	0.92	0.0054
	Casting Yard	0	6.0	0
	Total	0.12	6.92	0.0054
State Govt	Alignment / Stations etc	3.16	4.64	1.22
	Depot	16.20	0	5.21
	Parking cum PD	56.81	0	0
	Casting Yard	0	10.26	0
	RSS	0.60	0	0
	Ancillary buildings & Misc.	0.20	0.10	0.10
	Total	76.97	15.00	6.53
Private	Alignment / Stations etc	0.53	0	0.95
	Ancillary buildings & Misc.	0.1	0	0.1
	Total	0.63	0	1.05
Squatters	Transport Nagar UG Station	0	0	0.7
Grand Total		77.72	21.92	8.29

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

Ownership	Purpose	Permanent Land	Temporary Land	Structures (Floor area)
Central Govt	Alignment / Stations etc	0	0	0
	Casting Yard	0	0	0
	Total	0	0	0
State Govt	Alignment / Stations etc	0.36	2.4	0.8
	Depot	12.5	0	0.06
	Parking cum PD	6.76	0	0
	Casting Yard	0	6.5	0
	RSS	0.3	0	0
	Ancillary buildings & Misc.	0.1	0.1	0.1
	Total	20.02	9.0	0.96
Private	Entry Exit at Shastri Chowk, Ancillary buildings, Temples & Misc.	0.12	0	0.12
	Total	0.12	0	0.12
Squatters	After CNB-DLI railway tracks at Dada Nagar UG Station	0	0	0.3
Grand Total		20.14	9.0	2.38

- b) Rate of Central Govt. land (North Central Railway) 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) Efforts have been made to provide parking for maximum possible stations. Moreover, to make the project financially viable, property development has been proposed on 63.57 Ha (including Depot) land pieces identified in consultation with KDA in State Govt. land. Land for PD includes approx. 40 Ha land of Samaj Kalyan Vibhag. Moreover, in line with DPR for Lucknow Metro, cost of State Govt. 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. It is pointed out that relocation of certain structures (5.2 Ha floor area of structures of Polytechnic College, Fire station at Chunniganj, residential building No. R-9 for Agriculture depot) is a condition precedent for dismantling the old structures and clearing the land piece for taking up of construction activities related to Kanpur Metro. 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) Rehabilitation & relocation of squatters occupying Govt. land at Transport Nagar metro station location (mostly G+0 warehouses) and at Dada Nagar Railway crossing (mostly residential brick buildings G+0 / G+1 / G+2) will be essential to have clear land for taking up of Metro construction activities. Cost of structures required for relocation of squatters is adopted as Rs. 8000/- per sqm.
- j) The total cost of Land works out to be **Rs. 247.57 Crore** for Corridor-I and **Rs. 99.56 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
2.4	Elevated Section (Special Span -34m+45m+34m = 113m)	Each	14.84
3.0	Station Buildings		
3.1	Underground Station incl. EM works, VAC etc. by Cut & Cover		
a	Underground Station- Structural Civil works including Architectural Finishes	Each	130.80
b	Underground Station- EM works etc.	Each	24.425

Item No.	Item	Unit	Rates (Rs. In Crore)
c	Underground Station- ECS & TVS etc.	Each	26.00
3.2	Elevated Station Buildings		
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	26.00
b	Elevated station - EM Works etc.	Each	4.44
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	102.48
b	EM works + Machinery & Plant + General Works	LS	65.58
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.	14.00
6.2	Elevated section including SCADA	R. Km.	10.24
6.3	For Depot	Track Km.	4.00
6.4	For 220 kV GIS & and 220 kV cable/transmission line in RSS	Each	65.10
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.		
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		

Item No.	Item	Unit	Rates (Rs. In Crore)
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 PROPOSED 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: IIT KANPUR – NAUBASTA

Total Length = 23.785 Km, From = (-) 450m to 23335m, UG = 8.621 Km & ELEV = 15.164 Km,

Depot Entry = 0.70Km

Stations = 22 No's, Elevated = 14 No's, U/G by Cut & cover = 8 No's.

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

S.N.	Item	Unit	Rate	Qty.	Amount
1.0	Land				
a	Central Govt. Land -Permanent (without Solatium)	Ha	38.50	0.12	4.62
b	Central Govt. Land -Temporary	Ha	1.32	6.92	9.13

S.N.	Item	Unit	Rate	Qty.	Amount
c	Central Govt. Structures- Permanent	Ha	25.00	0.0054	0.14
d	State Govt. Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	5.50	20.16	110.88
e	State Govt. Land -Permanent (for Parking cum PD)	Ha	0.00	56.81	0.00
f	State Govt. Land -Temporary	Ha	1.32	15.00	19.80
g	State Govt. Structures -Permanent	Ha	4.00	6.53	26.12
h	Private Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., including Solatium)	Ha	86.00	0.63	54.48
j	Private Structure - Permanent including Solatium as per LARRA	Ha	16.00	1.05	16.80
k	Cost of Structures for rehabilitation of squatters at Transport Nagar	Ha	8.00	0.70	5.60
	Sub Total (1)				247.57
2.0	Alignment and Formation				
2.1	Underground section by T.B.M excluding station length (265m each)	R. Km.	125.00	6.05	755.63
2.2	Underground section by cut & cover for Ramp	R. Km.	122.52	0.54	65.67
2.3	Elevated section excluding viaduct length in station	R. Km.	37.04	12.98	480.71
2.4	Elevated Section (Special Span -34m+45m+34m = 113m)	Each	14.84	2.00	29.68
2.5	Entry to Depot	R. Km.	37.04	0.70	25.93
	Sub Total (2)				1357.61
3.0	Station Buildings				
3.1	Underground Station (265 m length) incl. EM works, VAC etc. by Cut & Cover				
a	Underground Station- Structural Civil works including Architectural Finishes	Each	130.80	8.00	1046.40
b	Underground Station- EM works etc.	Each	24.425	8.00	195.40
c	Underground Station- ECS & TVS etc.	Each	26.00	8.00	208.00
3.2	Elevated Station Buildings				
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	26.00	14.00	364.00
b	Elevated station - EM Works etc.	Each	4.44	14.00	62.16
3.3	Lifts & Escalators (Elevated and UG stations)				
a	Lifts	Each	0.47	74.00	34.78
b	Escalators	Each	0.73	74.00	54.02
	Sub Total (3)				1964.76
4.0	Maintenance Depot including OCC building				
a	Civil works	LS			102.48
b	EM works + Machinery & Plant + General	LS			65.58

S.N.	Item	Unit	Rate	Qty.	Amount
	Works				
	Sub Total (4)				168.06
5.0	P-Way				
5.1	Ballastless track for elevated & underground Section	Route Km.	7.00	23.785	166.50
5.2	Ballasted track for Depot	Track Km.	3.50	5.55	19.43
5.3	Ballastless track for entry to Depot	Route Km.	7.00	0.70	4.90
	Sub Total (5)				190.82
6.0	Traction & power supply incl. OHE, ASS etc. Excl. lifts & Escalators				
6.1	UG Section	R. Km.	14.00	8.62	120.69
6.2	Elevated section including SCADA	R. Km.	10.24	15.16	155.28
6.3	For Depot	Track Km.	4.00	5.55	22.20
6.4	For 220 kV GIS & and 220kV cable / transmission line in RSS	Each	65.10	1.00	65.10
	Sub Total (6)				363.27
7.0	Signalling and Telecom etc				
7.1	Signalling	R. Km.	6.75	23.785	160.55
7.2	Telecommunication	Per Station	5.00	22.00	110.00
7.3	Automatic fare collection	through PPP			
	Sub Total (7)				270.55
8.0	Environment and R & R incl. Hutments etc.				
a	Environmental Cost	As per details given in Chapter 15			25.80
b	R & R				2.99
	Sub Total (8)				28.79
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	23.785	71.36
b	Electrical Works	R. Km.	3.00	23.785	71.36
	Sub Total (9)				142.71
10.0	Capital Expenditure on Security				
a	Civil works	Per Station	0.30	22.00	6.53
b	EM works	Per Station	0.07	22.00	1.56
	Sub Total (10)				8.10
11.0	Staff Quarters				
a	Civil works	R. Km.	1.31	23.785	31.05

S.N.	Item	Unit	Rate	Qty.	Amount
b	EM works	R. Km.	0.32	23.785	7.54
	Sub Total (11)				38.59
12.0	Capital Expenditure on Inter modal integration including Footpath for pedestrians	Per Station	3.00	22.00	66.00
13.0	Rolling Stock	Each	8.00	87.00	696.00
14.0	Total of all items except Land				5295.26
15.0	General Charges including Design charges, incl. Metro Bhawan Building (Civil+EM works) @ 5% on all items except land				264.76
16.0	Total of all items including G. Charges				5560.02
18.0	Contingencies @ 3 % on all items except land				166.80
19.0	Gross Total including Contingencies (excluding Land Cost)				5726.82
20.0	Gross Total including Contingencies (including Land Cost)				5974.39
21.0	Central GST & Basic Customs duty				512.43
22.0	State GST				424.46
23.0	Total Cost including Taxes & Duties				6911.28

TABLE 17.5: CAPITAL COST ESTIMATE CORRIDOR-2
CORRIDOR - 2: AGRICULTURE UNIVERSITY - BARRA 8

Total Length = 8.60 Km, From = (-) 750m to 7850m, UG = 4.410 Km & ELEV = 4.19 Km,

Depot Entry = 0.70 Km

Stations = 8 No's, Elevated = 4 No's, U/G by Cut & cover = 4 No's, Future Station = 1 No.

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

S. No.	Item	Unit	Rate	Qty.	Amount
1.0	Land				
a	State Govt. Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., without Solatium)	Ha	5.50	13.26	72.92
b	State Govt. Land -Permanent (for Parking cum PD)	Ha	0.00	6.76	0.00
c	State Govt. Land -Temporary	Ha	1.32	9.00	11.88
d	State Govt. Structures -Permanent	Ha	4.00	0.96	3.84
e	Private Land -Permanent (for Alignment, Depot, RSS, Ancillary Bldgs., Misc., including Solatium)	Ha	55.00	0.12	6.60
f	Private Structure - Permanent including Solatium as per LARRA	Ha	16.00	0.12	1.92
g	Cost of Structures for rehabilitation of squatters at Dada Nagar	Ha	8.00	0.30	2.40

S. No.	Item	Unit	Rate	Qty.	Amount
	Sub Total (1)				99.56
2.0	Alignment and Formation				
2.1	Underground section by T.B.M excluding station length (265m each)	R. Km.	125.00	3.15	393.75
2.2	Underground section by cut & cover for Ramp	R. Km.	122.52	0.20	24.50
2.3	Elevated section excluding viaduct length in station	R. Km.	37.04	3.26	120.82
2.4	Elevated Section (Special Span - 34m+45m+34m = 113m)	Each	14.84	1.00	14.84
2.5	Elevated Section (Special Span - 75m+105m+75m = 255m)	Each	32.82	1.00	32.82
2.7	Entry to Depot (UG by cut & cover)	R. Km.	122.52	0.70	85.76
	Sub Total (2)				672.50
3.0	Station Buildings				
3.1	Underground Station (265 m length) incl. EM works, lifts, escalators, VAC etc. by Cut & Cover				
a	Underground Station- Structural Civil works including Architectural Finishes	Each	130.80	4.00	523.20
b	Underground Station- EM works etc	Each	24.425	4.00	97.70
c	Underground Station- ECS & TVS works etc	Each	26.000	4.00	104.00
3.3	Elevated Station Buildings				
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	26.00	4.00	104.00
b	Elevated station - EM Works etc.	Each	4.44	4.00	17.76
3.3	Lifts & Escalators (Elevated and UG stations)				
a	Lifts	Each	0.47	28.00	13.16
b	Escalators	Each	0.73	28.00	20.44
	Sub Total (3)				880.26
4.0	Maintenance Depot				
a	Civil works	LS			40.09
b	EM works + Machinery & Plant + General Works	LS			25.10
	Sub Total (4)				65.19
5.0	P-Way				
5.1	Ballastless track for elevated & underground Section	Route Km.	7.00	8.60	60.20
5.2	Ballasted track for Depot	Track Km.	3.50	3.94	13.79
5.3	Ballastless track for entry to Depot	Route Km.	7.00	0.70	4.90
	Sub Total (5)				78.89
6.0	Traction & power supply incl. OHE, ASS etc. Excl. lifts & Escalators				

S. No.	Item	Unit	Rate	Qty.	Amount
6.1	UG Section	R. Km.	14.00	4.41	61.74
6.2	Elevated section including SCADA	R. Km.	10.24	4.19	42.91
6.3	For Depot	Track Km.	4.00	3.94	15.76
	Sub Total (6)				120.41
7.0	Signalling and Telecom etc				
7.1	Signalling	R. Km.	6.75	8.60	58.05
7.2	Telecommunication	Per Station	5.00	8.00	40.00
7.3	Automatic fare collection	Through PPP			
	Sub Total (7)				98.05
8.0	Environment and R & R incl. Hutments etc.				
a	Environmental Cost	As per details given in Chapter 15			14.78
b	R & R				2.35
	Sub Total (8)				17.13
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	8.60	25.80
b	Electrical Works	R. Km.	3.00	8.60	25.80
	Sub Total (9)				51.60
10.0	Capital Expenditure on Security				
a	Civil works	Per Station	0.30	8.00	2.38
b	EM works	Per Station	0.07	8.00	0.57
	Sub Total (10)				2.94
11.0	Capital Expenditure on Inter modal integration including Footpath for pedestrians	Per Station	3.00	8.00	24.00
12.0	Rolling Stock	Each	8.00	30	240.00
13.0	Total of all items except Land				2250.97
14.0	General Charges incl. Design charges, @ 5% on all items except land				112.55
15.0	Total of all items including G. Charges				2363.52
17.0	Contingencies @ 3 % on all items except land				70.91
18.0	Gross Total including Contingencies (excluding Land Cost)				2434.43
19.0	Gross Total including Contingencies (including Land Cost)				2533.98
20.0	Central GST & Basic Customs duty				217.92
21.0	State GST				179.27

S. No.	Item	Unit	Rate	Qty.	Amount
22.0	Total Cost including Taxes & Duties				2931.17

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	4.84	22.00	106.48
2.0	AFC for Corridor-2	Per Station	4.84	9.00	43.56
3.0	Total of AFC				150.04
4.0	General Charges @ 5%				7.50
5.0	Total including GC				157.54
6.0	Contingencies @ 3 % on all items including GC				4.73
7.0	Total including GC & Contingencies				162.27
8.0	Central GST & Basic Customs duty				20.50
9.0	State GST				14.70
10.0	Total Cost including Taxes & Duties				197.46

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	821.30	12.69	23.32	23.32	59.32	34.49	34.49	68.99	128.31
	Elevated	536.31	0.00	0.00	0.00	0.00	32.18	32.18	64.36	64.36
2	Station Buildings									
	Underground station-civil works	1046.40	16.17	29.71	29.71	75.58	43.95	43.95	87.90	163.48
	Underground station-EM works	435.69	11.22	20.62	20.62	52.45	13.07	13.07	26.14	78.59
	Elevated station - civil works	364.00	0.00	0.00	0.00	0.00	21.84	21.84	43.68	43.68
	Elevated station-EM works	118.67	1.22	2.25	2.25	5.71	5.70	5.70	11.39	17.11
3	Depot including OCC Buildings									
	Civil works	102.48	1.58	2.91	2.91	7.40	4.30	4.30	8.61	16.01
	EM and M&P works	65.58	0.68	1.24	1.24	3.16	7.34	7.34	14.69	17.85
4	P-Way	190.82	7.86	14.45	14.45	36.75	2.29	2.29	4.58	41.33
5	Traction & power supply									
	Traction and power supply	363.27	7.48	13.75	13.75	34.99	13.08	13.08	26.16	61.14
6	S and T Works									
	S & T	270.55	11.15	20.48	20.48	52.11	4.87	4.87	9.74	61.85
7	R & R hutments	2.99	0.00	0.00	0.00	0.00	0.18	0.18	0.36	0.36
8	Misc.									
	Civil works	71.36	0.00	0.00	0.00	0.00	4.28	4.28	8.56	8.56
	EM works	71.36	0.00	0.00	0.00	0.00	9.99	9.99	19.98	19.98
9	Security									

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	6.53	0.00	0.00	0.00	0.00	0.39	0.39	0.78	0.78
	EM works	1.56	0.00	0.00	0.00	0.00	0.22	0.22	0.44	0.44
10	Staff quarters									
	Civil works	31.05	0.00	0.00	0.00	0.00	1.86	1.86	3.73	3.73
	EM works	7.54	0.00	0.00	0.00	0.00	1.06	1.06	2.11	2.11
12	Intermodal Integration	66.00	0.00	0.00	0.00	0.00	3.96	3.96	7.92	7.92
13	Rolling stock	696.00	17.92	32.93	32.93	83.79	31.32	31.32	62.64	146.43
14	Rent on Temporary Land	28.93	0.00	0.00	0.00	0.00	2.60	2.60	5.21	5.21
15	General Charges	264.76	0.00	0.00	0.00	0.00	23.83	23.83	47.66	47.66
16	Total	5563.16	87.97	161.65	161.65	411.27	262.81	262.81	525.62	936.89
	Total taxes & Duties							SAY		936.89

TABLE 17.9: TAXES AND DUTIES FOR CORRIDOR-2

(Rs. In Crores)

S. No.	Description	Total cost	Taxes and duties							Total Taxes & Duties
			Basic Customs Duty	IGST (CGST portion)	IGST (SGST portion)	Total Customs Duty	CGST	SGST	Total GST	
1	Alignment & Formation									
	Underground	504.02	7.79	14.31	14.31	36.41	21.17	21.17	42.34	78.74
	Elevated	168.48	0.00	0.00	0.00	0.00	10.11	10.11	20.22	20.22
2	Station Buildings									
	Underground station-civil works	523.20	8.08	14.85	14.85	37.79	21.97	21.97	43.95	81.74
	Underground station-EM works	216.63	5.58	10.25	10.25	26.08	6.50	6.50	13.00	39.08
	Elevated station - civil works	104.00	0.00	0.00	0.00	0.00	6.24	6.24	12.48	12.48
	Elevated station-EM works	36.43	0.38	0.69	0.69	1.75	1.75	1.75	3.50	5.25
3	Depot									
	Civil works	40.09	0.62	1.14	1.14	2.90	1.68	1.68	3.37	6.26
	EM and M&P works	25.10	0.26	0.48	0.48	1.21	2.81	2.81	5.62	6.83
4	P-Way	78.89	3.25	5.97	5.97	15.20	0.95	0.95	1.89	17.09
5	Traction & power supply									
	Traction and power supply	120.41	2.48	4.56	4.56	11.60	4.33	4.33	8.67	20.27
6	S and T Works									
	S & T	98.05	4.04	7.42	7.42	18.89	1.76	1.76	3.53	22.42
7	R & R hutments	2.35	0.00	0.00	0.00	0.00	0.14	0.14	0.28	0.28
8	Misc.									
	Civil works	25.80	0.00	0.00	0.00	0.00	1.55	1.55	3.10	3.10
	EM works	25.80	0.00	0.00	0.00	0.00	3.61	3.61	7.22	7.22
9	Security									
	Civil works	2.38	0.00	0.00	0.00	0.00	0.14	0.14	0.29	0.29

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	0.57	0.00	0.00	0.00	0.00	0.08	0.08	0.16	0.16
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	24.00	0.00	0.00	0.00	0.00	1.44	1.44	2.88	2.88
13	Rolling stock	240.00	6.18	11.36	11.36	28.89	10.80	10.80	21.60	50.49
14	Rent on Temporary Land	11.88	0.00	0.00	0.00	0.00	1.07	1.07	2.14	2.14
15	General Charges	112.55	0.00	0.00	0.00	0.00	10.13	10.13	20.26	20.26
16	Total	2360.62	38.65	71.03	71.03	180.70	108.24	108.24	216.49	397.19
	Total taxes & Duties							SAY		397.19

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	247.57	99.56	347.13
2	Alignment and Formation	1357.61	672.50	2030.11
3	Station Buildings incl. Civil works, EM works, ECS, TVS, Lift, escalators & Architectural Finishes etc	1964.76	880.26	2845.02
4	Depot including civil, EM, Machinery & plants, general works & OCC building	168.06	65.19	233.25
5	P-Way for main line, depot and depot connectivity	190.82	78.89	269.71

S. No.	Item	Corridor-1	Corridor-2	Total Amount
6	Traction & power supply for main line and depot incl. OHE, ASS, GIS etc.	363.27	120.41	483.68
7	Signalling and Telecom. etc.	270.55	98.05	368.60
8a	Environment	25.80	14.78	40.58
8b	R & R incl. Hutments etc.	2.99	2.35	5.34
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	142.71	51.60	194.31
10	Capital Expenditure on Security including civil and EM works	8.10	2.94	11.04
11	Staff Quarters including civil, electrical works	38.59	0.00	38.59
12	Capital Expenditure on Inter modal integration including Footpath for pedestrians	66.00	24.00	90.00
13	Rolling Stock	696.00	240.00	936.00
14	Total of all items except Land	5295.26	2250.97	7546.23
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)	264.76	112.55	377.31
16	Total of all items including G. Charges	5560.02	2363.52	7923.54
17	Contingencies @ 3 %on all items except land	166.80	70.91	237.71
Gross Total including Contingencies (excluding Land Cost)		5726.82	2434.43	8161.25
Gross Total including Contingencies (including Land Cost)		5974.39	2533.98	8508.37
Central GST & Basic Customs duty		512.43	217.92	730.35
State GST		424.46	179.27	603.73
Total Cost including Taxes & Duties		6911.28	2931.17	9842.45
Completion Cost		7659.63	3249.04	10908.67

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, 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	
1	Land	698.42	135.67	834.08	247.57	99.56	347.13	486.95
2	Alignment and Formation	1644.54	709.87	2354.42	1357.61	672.50	2030.11	324.30
3	Station Buildings incl. Civil works, EM works, ECS, TVS, Lift, escalators & Architectural Finishes etc	2764.14	1202.88	3967.02	1964.76	880.26	2845.02	1122.00

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	
4	Depot including civil, EM, Machinery & plants, general works & OCC building	232.78	148.02	380.80	168.06	65.19	233.25	147.55
5	P-Way for main line, depot and depot connectivity	271.24	104.99	376.23	190.82	78.89	269.71	106.52
6	Traction & power supply for main line and depot incl. OHE, ASS, GIS etc.	589.70	253.20	842.90	363.27	120.41	483.68	359.22
7	Signalling and Telecom. etc.	469.96	175.12	645.08	270.55	98.05	368.60	276.48
8a	Environment	25.80	14.78	40.58	25.80	14.78	40.58	0.00
8b	R & R incl. Hutments etc.	2.99	2.35	5.34	2.99	2.35	5.34	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	192.17	69.48	261.65	142.71	51.60	194.31	67.34
10	Capital Expenditure on Security including civil and EM works	8.09	3.31	11.39	8.10	2.94	11.04	0.35
11	Staff Quarters including civil, electrical works	112.59	19.45	132.05	38.59	0.00	38.59	93.46
12	Capital Expenditure on Inter modal integration including Footpath for pedestrians	126.28	54.07	180.35	66.00	24.00	90.00	90.35
13	Rolling Stock	1270.62	423.54	1694.16	696.00	240.00	936.00	758.16
14	Total of all items except Land	7710.89	3181.07	10891.96	5295.26	2250.97	7546.23	3345.73
15	General Charges incl. Design charges, including Metro Bhawan, (Civil+EM works) @ 5% on all items except land	322.01	137.88	459.89	264.76	112.55	377.31	82.58
16	Total of all items including G. Charges	8032.90	3318.95	11351.85	5560.02	2363.52	7923.54	3428.31
17	Contingencies @ 3 % on all items except land	240.99	99.57	340.56	166.80	70.91	237.71	102.85
Gross Total including Contingencies (excluding Land Cost)		8273.89	3418.52	11692.41	5726.82	2434.43	8161.25	3531.16
Gross Total including Contingencies (including Land Cost)		8972.31	3554.18	12526.49	5974.39	2533.98	8508.37	4018.12
Central GST & Basic Customs duty		777.23	318.89	1096.12	512.43	217.92	730.35	365.77
State GST		621.23	256.09	877.32	424.46	179.27	603.73	273.59
Total Cost including Taxes & Duties		10370.77	4129.16	14499.93	6911.28	2931.17	9842.45	4657.48
Completion Cost		12949.34	5193.49	18142.83	7659.63	3249.04	10908.67	7234.16

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 year 2020. The estimated staff cost is Rs. 83.83 Cr. for corridor 1 and Rs. 30.30 Cr. for corridor 2 for the inception year i.e. 2024.

17.6.2 Maintenance Expenses

Maintenance expenses are taken @ Rs. 1.65 Crores/km in the year 2017. Maintenance cost for Kanpur Metro corridors would be Rs. 47.82 Crores for corridor 1 and Rs. 17.28 Cr for corridor 2 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. 75.76 crores in year 2024, Rs. 139.69 crores in 2031, Rs. 271.94 crores in 2041 for IIT Kanpur to Naubasta

corridor and Rs. 37.53 Crores in year 2024, Rs. 69.03 crores in 2031, Rs. 129.33 crores in 2041 for Agriculture University to Barra-8 corridor.

17.6.4 Additional Investment

Since ridership materialization in the initial years of operation is less than projected, the provision for 70% of the estimated number of rakes has been made initially. The remaining 30% of the rakes will be purchased in the year 2031.

Also, to cater to increased traffic demand, additional investment will have to be made for purchase of additional coaches. The additional investment in the year 2031 works out to **Rs. 541.79 Crores** for purchase of 45 additional coaches for IIT Kanpur to Naubasta Corridor and **Rs. 216.72 Crores** for 18 additional coaches for Agriculture University to Barra-8 corridor in year 2031.

An investment of **Rs. 704.47 Crores** would be required for purchase of 48 additional coaches in the year 2041 (Rs 528.35 crores for 36 additional coaches for IIT Kanpur to Naubasta Corridor and Rs 176.12 crores for 12 additional coaches for Agriculture University to Barra-8 corridor). These additional investments have been worked out considering an escalation factor of 2% per annum. No escalation has been considered till the start of construction period.

The future station (Govind Nagar in Corridor-2) & minor depot (Naubasta for Corridor-1) shall be constructed on attainment of 100% ridership and purchase of additional rolling stock. The cost for future station & minor depot is given in **TABLE 17.12 & TABLE 17.13**.

TABLE 17.12: ADDITIONAL COST OF FUTURE STATION (GOVIND NAGAR IN CORR-2)

S. No.	Item	Unit	Rate	Qty.	Amount
1.0	Elevated Station Buildings				
a	Elevated station - Civil Works including Viaduct and Architectural Finishes	Each	20.81	1.00	20.81
b	Elevated station - EM Works etc.	Each	4.44	1.00	4.44
2.0	Lifts & Escalators				
a	Lifts	Each	0.47	3.00	1.41
b	Escalators	Each	0.73	3.00	2.19
3.0	Telecommunication	Per Station	5.00	1.00	5.00
4.0	Capital Expenditure on Security				
a	Civil works	Per Station	0.30	1.00	0.30
b	EM works	Per Station	0.07	1.00	0.07
5.0	Capital Expenditure on Inter modal integration incl. Footpath for pedestrians	Per Station	3.00	1.00	3.00
14.0	Total of all items				37.22

S. No.	Item	Unit	Rate	Qty.	Amount
15.0	General Charges including Design charges @ 5% on all items				1.86
16.0	Total of all items including G. Charges				39.08
18.0	Contingencies @ 3 % on all items incl. GC				1.17
19.0	Gross Total including GC & Contingencies				40.26
21.0	Central GST & Basic Customs duty				2.92
22.0	State GST				2.63
23.0	Total Cost including Taxes & Duties				45.81

TABLE 17.13: ADDITIONAL COST OF MINOR DEPOT (CORR-1)

S. No.	Item	Amount
1.0	Land for Depot	37.13
2.0	Viaduct for Depot entry	18.52
3.0	Maintenance depot	
a.	Civil Works	21.00
b.	E&M Works	15.00
4.0	P-way	
a.	Pway for Depot	14.00
b.	Pway for Depot entry	3.50
5.0	Traction	
a.	Traction in depot	16.00
b.	Traction for Depot Entry	5.12
6.0	Total excluding Land	93.14
7.0	General Charges including Design charges @ 5% on all items	4.66
8.0	Total of all items including G. Charges	97.80
9.0	Contingencies @ 3 % on all items incl. GC	2.93
10.0	Gross Total including GC & Contingencies	137.86
11.0	Central GST & Basic Customs duty	9.70
12.0	State GST	8.07
13.0	Total Cost including Taxes & Duties	155.63

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.

The replacement cost for the IIT Kanpur to Naubasta corridor works out to be **Rs. 1870.27 Crores** and **Rs 731.99 Crores** for Agriculture University to Barra-8 corridor. 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 Kanpur MRTS is indicated in **TABLE 17.14** and **TABLE 17.15**

TABLE 17.14: OPERATION AND MAINTENANCE COSTS CORRIDOR-I

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	83.83	47.82	75.76	207.41	
2025	91.37	50.21	80.78	222.36	
2026	99.59	52.72	86.02	238.33	
2027	108.55	55.36	91.58	255.49	
2028	118.32	58.13	97.49	273.94	
2029	128.97	61.04	110.33	300.34	
2030	140.58	64.09	124.38	329.05	
2031	153.23	67.29	139.69	360.21	541.79
2032	167.02	70.65	156.53	394.20	Addition of 45 coaches
2033	182.05	74.18	166.50	422.73	
2034	198.43	77.89	177.11	453.43	
2035	216.29	81.78	188.38	486.45	
2036	235.76	85.87	200.33	521.96	
2037	256.98	90.16	212.98	560.12	
2038	280.11	94.67	226.48	601.26	
2039	305.32	99.40	240.72	645.44	
2040	332.80	104.37	255.87	693.04	
2041	362.75	109.59	271.94	744.28	528.35
2042	395.40	115.07	289.59	800.06	Addition of 36 coaches
2043	430.99	120.82	308.27	860.08	
2044	469.78	126.86	328.18	924.82	1,870.27
2045	512.06	133.20	349.18	994.44	Replacement of 25% of Elec. & 50% S&T assets
2046	558.15	139.86	371.48	1069.49	
2047	608.38	146.85	395.27	1150.50	
2048	663.13	154.19	420.42	1237.74	
2049	722.81	161.90	447.14	1331.85	

TABLE 17.15: 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	30.30	17.28	37.53	85.11	
2025	33.03	18.14	40.00	91.17	
2026	36.00	19.05	42.58	97.63	
2027	39.24	20.00	45.32	104.56	
2028	42.77	21.00	48.22	111.99	
2029	46.62	22.05	54.56	123.23	
2030	50.82	23.15	61.48	135.45	
2031	55.39	24.31	69.03	148.73	216.72
2032	60.38	25.53	77.03	162.94	Addition of 18 coaches
2033	65.81	26.81	81.60	174.22	
2034	71.73	28.15	86.45	186.33	
2035	78.19	29.56	91.59	199.34	
2036	85.23	31.04	97.02	213.29	
2037	92.90	32.59	102.75	228.24	
2038	101.26	34.22	108.87	244.35	
2039	110.37	35.93	115.29	261.59	
2040	120.30	37.73	122.11	280.14	
2041	131.13	39.62	129.33	300.08	176.12
2042	142.93	41.60	137.61	322.14	Addition of 12 coaches
2043	155.79	43.68	146.38	345.85	
2044	169.81	45.86	155.71	371.38	731.99
2045	185.09	48.15	165.55	398.79	Replacement of 25% of Elec. & 50% S&T assets
2046	201.75	50.56	176.00	428.31	
2047	219.91	53.09	187.13	460.13	
2048	239.70	55.74	198.90	494.34	
2049	261.27	58.53	211.41	531.21	

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. O&M costs have also been revised accordingly.

The financial analysis of Kanpur MRTS project has been carried out for the two MRTS corridors combined. 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 Kanpur MRTS.

19.1.1 Capital Cost

The Construction cost of the metro corridors at Nov' 2017 prices is estimated at Rs. 7918Crore. The cost of land is estimated at Rs. 347Crore. The cost of R&R together with contingency is estimated to be Rs 243 Cr. The total cost of project including land & R&R cost is estimated at Rs. 8508 Crore. The Central GST,duties and State GST amount to Rs. 1334Crore. The capital cost components at Nov'17 prices are given in **Table 19.1**.

TABLE 19.1:CAPITAL COSTS (Nov'2017 Prices) (Rs. in Crore)

Cost Component	Corridor I	Corridor II	Total
Construction Cost excluding land, R&R	5724	2432	8156
Land Cost	248	100	347
R & R incl. Hutments	3	2	5
Construction Cost Including land & R&R	5974	2534	8508
Taxes	937	397	1334
Central Taxes and Duties	512	218	730
State GST	424	179	604
Total Cost with Land & Taxes	6911	2931	9842
Total Cost with Land &Central Taxes only	6487	2752	9239

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. 9421Crore and withcentral taxes it is estimated at Rs 10235 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, R&R costshave not been escalated assuming that 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 238 Crore 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	9421
With Central Taxes	10235
With both Central and State taxes	10909

19.1.3 Phasing of Construction

Considering the elevated and underground lengths of MRTS network, it is expected that the construction of Kanpur metro will take 5 yearsand the operation will start from5thyear onwards. **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 19-4YEAR WISE FUND REQUIREMENTS WITHOUT TAXES (Rs. in Crore)

Year	Completion Cost	Land and R&R Cost	Total Completion Cost
2020-2021	816	176	992
2021-2022	1,710	176	1,887
2022-2023	2,242		2,242
2023-2024	2,821		2,821
2024-2025	1,479		1,479
Total	9,068	352	9,421

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

Year	Completion Cost	Land and R&R Cost	Taxes	Total Completion Cost
2020-2021	816	176	133	1,125
2021-2022	1,710	176	280	2,167
2022-2023	2,242		368	2,610
2023-2024	2,821		463	3,285
2024-2025	1,479		243	1,723
Total	9,068	352	1488	10,909

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

Year	Completion Cost	Land and R&R Cost	Central Taxes	Total Completion Cost
2020-2021	816	176	73	1,065
2021-2022	1,710	176	153	2,040
2022-2023	2,242		201	2,443
2023-2024	2,821		254	3,075
2024-2025	1,479		133	1,613
Total	9,068	352	815	10235

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 Kanpur Metro project, this has been considered as 35 persons per route km. The average salary of the staff is assumed to be 7.12 lakhs per annum for the year 2017. The maintenance expenses for the Kanpur project have been considered as Rs. 1.65 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 Kanpur 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 Kanpur Metro project for the year 2024 i.e. the inception year has been calculated as 40% and 37% respectively.

Several measures have been proposed for the Kanpur 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 to reduce the number of breakdowns for smooth operation of 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 activities like ticketing, crowd control, housekeeping etc.

➤ **O&M Cost Estimates**

Based on above principles, O&M Cost for Kanpur 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. 293 Crore. The total O&M cost in the year 2031 is estimated at Rs. 509 Crore. The Table also gives the requirement of Additional and Replacements costs as well.

➤ **Additional & Replacement Costs**

To cater to increased traffic demand additional Rolling Stock would be required. Additional investment of **Rs. 1103 Crore** in the Year 2031 and **Rs. 704 Crore** in Year 2041 has been estimated. The replacement cost for the corridors is estimated to be **Rs. 2602 Crore** in the year 2044.

The additional cost of **Rs 1103 Crore** include **Rs 759 Crore** towards additional rolling stock and **Rs 345 Crore** towards completion costs (including contingencies and taxes) of a future station and 2nd depot at Naubasta 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	114.13	65.10	113.29	292.52	
2025	124.40	68.35	120.78	313.53	
2026	135.59	71.77	128.60	335.96	
2027	147.79	75.36	136.90	360.05	
2028	161.09	79.13	145.71	385.93	
2029	175.59	83.09	164.89	423.57	
2030	191.40	87.24	185.86	464.50	
2031	208.62	91.60	208.73	508.95	1103
2032	227.40	96.18	233.56	557.14	
2033	247.86	100.99	248.09	596.94	
2034	270.16	106.04	263.56	639.76	
2035	294.48	111.34	279.97	685.79	
2036	320.99	116.91	297.35	735.25	
2037	349.88	122.75	315.73	788.36	
2038	381.37	128.89	335.35	845.61	
2039	415.69	135.33	356.02	907.04	
2040	453.10	142.10	377.98	973.18	
2041	493.88	149.21	401.27	1044.36	704.47
2042	538.33	156.67	427.20	1122.20	
2043	586.78	164.50	454.65	1205.93	
2044	639.59	172.72	483.89	1296.20	2602.26
2045	697.15	181.35	514.74	1393.24	
2046	759.90	190.42	547.47	1497.79	

Year	Staff Cost	Maintenance Expenses	Energy Charges	Total O&M Cost	Additional Rolling Stock / Replacement Cost
2047	828.29	199.94	582.40	1610.63	
2048	902.83	209.93	619.32	1732.08	
2049	984.08	220.43	658.55	1863.06	

19.2 MEANS OF FINANCE

The Revenue for Kanpur 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 Kanpur metro system has been estimated at 9.44 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	9.44 (6.61*)
2031	10.8
2041	13.5

*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 8.45 km. The trip length distribution is given in **Table 19-9**.

TABLE 19-9 TRIP LENGTH DISTRIBUTION

Trip Length (Km)	% Distribution
0-1	3.9%
1-2	9.3%
2-6	33.2%
6-9	17.2%
9-13	14.0%



Trip Length (Km)	% Distribution
13-17	5.7%
>17	16.7%
Total Trips (Km)	100%

➤ 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 Kanpur Metro also. Assuming fare revision of 5 % every 2nd year, fare structure for Kanpur 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 KANPUR METRO FOR HORIZON YEARS

Year		Fare in Rs.						
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

Year		Fare in Rs.						
From	To	0-1	1-2	2-6	6-9	9-13	13-17	>17
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

19.2.2 Non Fare Box Revenue

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

- Advertisement
 - In stations,
 - On trains
 - Outside Stations
 - 10% of total revenue generated above has been assumed as extra advertisement for rest of Advt. possibilities
- 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 rate 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 & train	2000 / sqm / month in 2018	5% every year
Kiosk rentals	667 per sqm / 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 Lakh / 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/ month for entire track length; 50000/ month in underground section	10% every 2 year
Telecom Tower license fee	15000 / month for elevated stations	10% every 2 year

Advertising in stations is proposed at following locations with areas as mentioned in **Table 19-13**.

TABLE 19-13 ADVERTISING AREA

S. N.	Place of Advertisement	Area of Advertising (in Sqm)
1	Under Ground Stations Advt. (14 Stations)	11,425
2	Elevated Stations Advt. (19 Stations)	12,008
3	10% Extra Advertisement for rest of Advt. possibilities (i.e. total advertisement revenues including Train wrap 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 19-14 NON-FARE BOX REVENUE

Revenue Stream	Total Revenues (in Rs. Crore)		
	2024-25	2031-32	2041-42
Advertisement Receipts	89.4	125.7	205.9
Rentals from Kiosks	1.6	2.2	3.7
Parking Receipts	22.4	31.5	77.0
Film Shooting	0.3	0.5	0.8
Telecom Cable & Tower (License fees)	1.8	2.4	4.0
Total	115.5	162.5	291.5

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

Source of Revenue	2024	2031	2041
Fare Box Revenue	834	1655	2644
Non Fare Box Revenue	116	163	292
Total Revenue	949	1817	2936

19.3 OPERATIONAL VIABILITY/FINANCIAL INTERNAL RATE OF RETURN (FIRR)

The FIRR for the project with capital costs including central taxes and revenue from fare box and non fare box sources works out to be **8.89%** 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	8.46%	8.07%	9.34%	9.83%
Ridership	9.45%	10.06%	8.15%	7.44%

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)
- Public Private Partnership (PPP)
- Grant by the Central Government

Figure 19-1 presents the implementation models graphically.



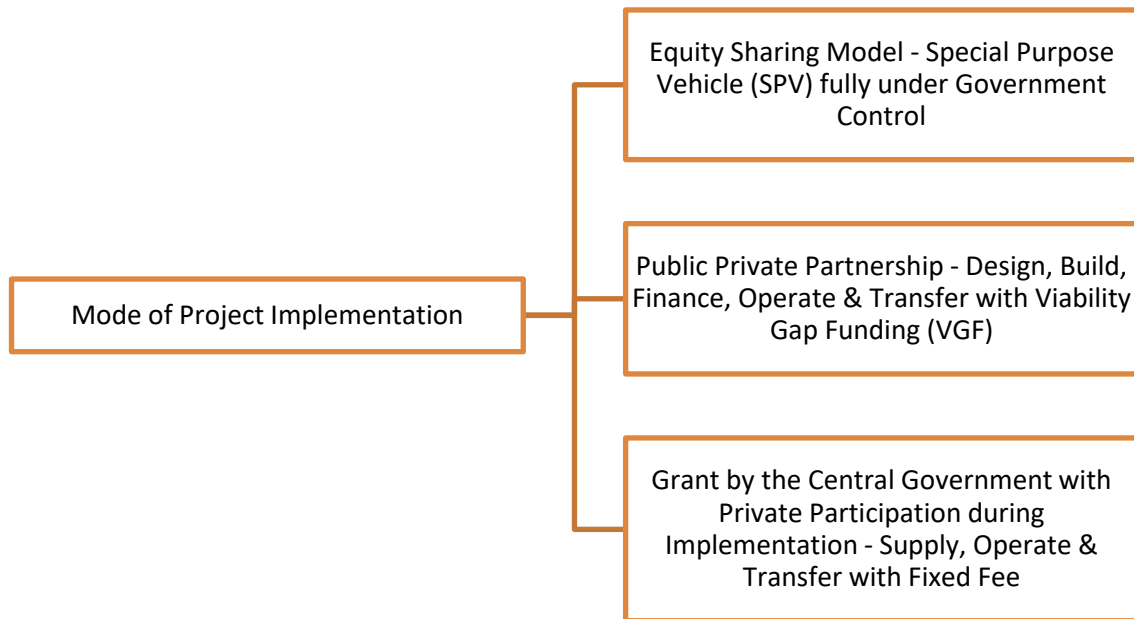
TABLE 19-17 KANPUR MRTS FIRR WITH CENTRAL TAXES (RS. IN CRORE)

Year			Nov' 2017, Price Level	Completion Cost	land cost & R&R	Central Taxes	Total Project Completion Cost	Fare Box Revenue	Revenue from Adv & PD	Gross Revenue	O&M Cost	Additional Capital	Operational Surplus
2020	-	21	816	816	176	73	1,065	0	0	0			-1,065
2021	-	22	1,631	1,710	176	153	2,040	0	0	0			-2,040
2022	-	23	2,039	2,242	0	201	2,443	0	0	0			-2,443
2023	-	24	2,447	2,821	0	254	3,075	0	0	0			-3,075
2024	-	25	1,223	1,479	0	133	1,613	834	116	949	293	0	-956
2025	-	26						892	121	1,014	314	0	700
2026	-	27						910	127	1,037	336	0	701
2027	-	28						973	134	1,107	360	0	747
2028	-	29						992	140	1,133	386	0	747
2029	-	30						1,213	147	1,361	424	0	937
2030	-	31						1,391	155	1,546	464	0	1,082
2031	-	32						1,655	163	1,817	509	1,103	205
2032	-	33						1,692	171	1,863	557	0	1,306
2033	-	34						1,817	179	1,996	597	0	1,399
2034	-	35						1,858	207	2,066	640	0	1,426
2035	-	36						1,996	218	2,213	686	0	1,528
2036	-	37						2,041	228	2,270	735	0	1,534
2037	-	38						2,192	240	2,432	788	0	1,643
2038	-	39						2,242	252	2,494	846	0	1,648
2039	-	40						2,407	264	2,672	907	0	1,765
2040	-	41						2,462	278	2,740	973	0	1,767



Year			Nov' 2017, Price Level	Completion Cost	land cost & R&R	Central Taxes	Total Project Completion Cost	Fare Box Revenue	Revenue from Adv & PD	Gross Revenue	O&M Cost	Additional Capital	Operational Surplus
2041	-	42						2,644	292	2,936	1,044	704	1,187
2042	-	43						2,697	306	3,003	1,122	0	1,881
2043	-	44						2,888	321	3,210	1,206	0	2,004
2044	-	45						2,946	370	3,316	1,296	2,602	-583
2045	-	46						3,155	388	3,543	1,393	0	2,150
2046	-	47						3,218	407	3,626	1,498	0	2,128
2047	-	48						3,447	428	3,875	1,611	0	2,264
2048	-	49						3,516	449	3,965	1,732	0	2,233
2049	-	50						3,765	472	4,237	1,863	0	2,374
Total			8,156	9,068	352	815	10,235	55,846	6,573			62,419	22,580
												IRR %	8.89

FIGURE 19-1 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 contributes 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 & 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 are to be borne by state with Private sector participation.

These models have been explored for implementation of Kanpur 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 Kanpur 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 GoI, 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 19-2 APPROVED FUNDING PATTERN OF DELHI AIRPORT LINE

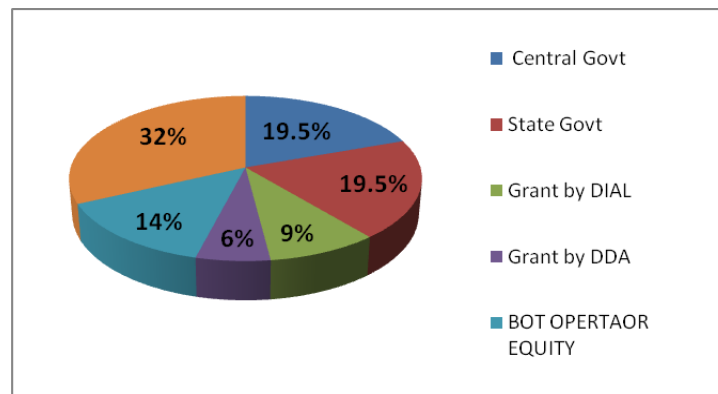


EXHIBIT 19-2 HYDERABAD METRO UNDER PPP MODEL

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 19-3 FUNDING PATTERN OF HYDERABAD METRO

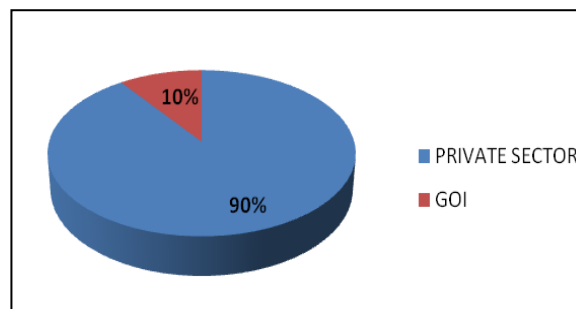


EXHIBIT 19-3 GURGAON METRO UNDER PPP MODEL

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.*

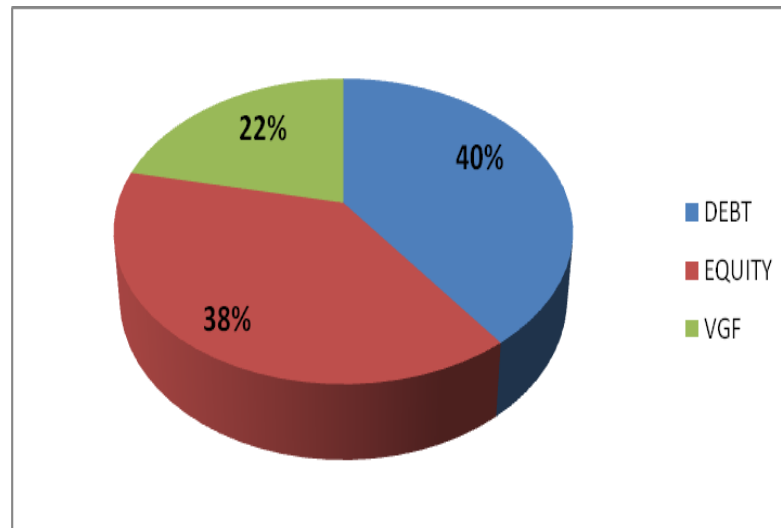
FIGURE 19-4 FUNDING PATTERN OF MUMBAI METRO LINE 1

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 endeavor. 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 Kanpur 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. 350 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 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

Particulars	Amount (Rs in Cr)	% Share
Equity by Gol	1569	15.88%
Equity by Govt. of UP	1569	15.88%
SD for CT by Govt. of UP	407	4.12%
SD for CT by Gol	407	4.12%
Contribution by Local Bodies	350	3.54%
Soft Loan from bilateral/multilateral funding agencies	5580	56.46%
Total Cost	9883	100%
SD for land and R&R by Govt. of UP	352	-
State Taxes towards Completion Cost	673	-
IDC for JICA Step Loan @0.1% & Front End Fee @0.2%	19	-
Total Cost	10927	-

19.5.6 Public Private Partnership – DBFOT with VGF for Kanpur 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). 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 2**.

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

Particulars	Amount (Rs in Cr)	% of Contribution
VGF by GoI	1977	20.00%
VGF by GoUP	2117	21.42%
Equity by Concessionaire	1707	17.27%
Concessionaire's Debt @ 12% p.a.	4082	41.31%
Total	9883	100.00%
Land by GoUP	352	
State Taxes by GoUP	673	
IDC	490	
Total	11399	

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 (signaling 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 CENTRAL GOVERNMENT MODEL

Particulars	Amount (Rs in Cr)	% of Contribution
Capital Contribution by GOI	988	10.00%
Capital Contribution by GoUP	5930	60.00%
Equity by Concessionaire	889	9.00%

Particulars	Amount (Rs in Cr)	% of Contribution
Concessionaire's Debt @ 12% p.a.	2075	21.00%
Total	9883	100.00%
Land by GoUP	352	
State Taxes by GoUP	673	
IDC	249	
Total	11158	

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 (SPV)	BOT (VGF) MODEL	GRANT BY CENTRAL GOVT MODEL
Contribution by GoI	1977	1977	988
Contribution by GoUP (excl land & State Taxes)	1977	2117	5930
Sub-Total	3953	4094	6918
Land & State Taxes by GoUP	1026	1026	1026
Total	4979	5119	7944
Present Value @8% of Operating Cash Flow to Public Entity (Revenue less Expenses)	9856	0	5470

It can be seen from table that the contribution of Governments under SPV model is less than that of VGF and Grant By Central Govt model. Moreover, under the VGF model, the entire revenues for the Concession Period are accruing to the Private Partner with no return on Government's contribution. Accordingly, it is proposed that 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 Kanpur Metro project following activities have been identified for private participation:

- i) PPP 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 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	1,065	0	0	-1,065	0	0	0	0	0	0	-1,065
2021	-	22	2,040	0	0	-2,040	0	0	0	0	0	0	-2,040
2022	-	23	2,443	0	0	-2,443	0	892	0	0	0	893	-1,551
2023	-	24	3,075	0	0	-3,075	893	3,075	2	0	0	3,970	0
2024	-	25	1,613	949	293	-956	3,970	1,613	5	0	0	5,587	657
2025	-	26	0	1,014	314	700	5,587	0	6	0	6	5,587	695
2026	-	27	0	1,037	336	701	5,587	0	6	0	6	5,587	695
2027	-	28	0	1,107	360	747	5,587	0	6	0	6	5,587	742
2028	-	29	0	1,133	386	747	5,587	0	6	0	6	5,587	741
2029	-	30	0	1,361	424	937	5,587	0	6	0	6	5,587	932
2030	-	31	0	1,546	464	1,082	5,587	0	5	279	5	5,308	797
2031	-	32	0	1,817	1,612	205	5,308	0	5	279	5	5,029	-79
2032	-	33	0	1,863	557	1,306	5,029	0	5	279	5	4,749	1,021
2033	-	34	0	1,996	597	1,399	4,749	0	5	279	5	4,470	1,115
2034	-	35	0	2,066	640	1,426	4,470	0	4	279	4	4,191	1,142
2035	-	36	0	2,213	686	1,528	4,191	0	4	279	4	3,911	1,244
2036	-	37	0	2,270	735	1,534	3,911	0	4	279	4	3,632	1,251
2037	-	38	0	2,432	788	1,643	3,632	0	3	279	3	3,352	1,361
2038	-	39	0	2,494	846	1,648	3,352	0	3	279	3	3,073	1,365
2039	-	40	0	2,672	907	1,765	3,073	0	3	279	3	2,794	1,482
2040	-	41	0	2,740	973	1,767	2,794	0	3	279	3	2,514	1,485
2041	-	42	0	2,936	1,749	1,187	2,514	0	2	279	2	2,235	905
2042	-	43	0	3,003	1,122	1,881	2,235	0	2	279	2	1,956	1,599
2043	-	44	0	3,210	1,206	2,004	1,956	0	2	279	2	1,676	1,723
2044	-	45	0	3,316	3,898	-583	1,676	0	2	279	2	1,397	-864
2045	-	46	0	3,543	1,393	2,150	1,397	0	1	279	1	1,117	1,869
2046	-	47	0	3,626	1,498	2,128	1,117	0	1	279	1	838	1,848
2047	-	48	0	3,875	1,611	2,264	838	0	1	279	1	559	1,984
2048	-	49	0	3,965	1,732	2,233	559	0	0	279	0	279	1,953
2049	-	50	0	4,237	1,863	2,374	279	0	0	279	0	0	2,095
TOTAL			10,235	62,419	26,989	25,194	91,468	5,580	91	5,587	84	91,468	25,103



ANNEXURE 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	Withdrawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Equity Cash Flow	
2020	- 21	871	0	0	-871	853	0	18	2	0	0	20	-853
2021	- 22	1358	0	0	-1358	853	20	504	66	0	0	590	-853
2022	- 23	1220	0	0	-1220	0	590	1220	193	0	0	2003	0
2023	- 24	1535	0	0	-1535	0	2003	1535	324	0	0	3862	0
2024	- 25	805	949	293	-148	0	3862	805	349	0	0	5017	0
2025	- 26	0	1014	314	700	0	5017	0	301	0	301	5017	399
2026	- 27	0	1037	336	701	0	5017	0	288	209	288	4808	204
2027	- 28	0	1107	360	747	0	4808	0	276	209	276	4599	262
2028	- 29	0	1133	386	747	0	4599	0	263	209	263	4390	274
2029	- 30	0	1361	424	937	0	4390	0	251	209	251	4181	477
2030	- 31	0	1546	464	1082	0	4181	0	238	209	238	3972	634
2031	- 32	0	1817	1612	205	0	3972	0	226	209	226	3763	-230
2032	- 33	0	1863	557	1306	0	3763	0	213	209	213	3554	883
2033	- 34	0	1996	597	1399	0	3554	0	201	209	201	3345	990
2034	- 35	0	2066	640	1426	0	3345	0	188	209	188	3136	1029
2035	- 36	0	2213	686	1528	0	3136	0	176	209	176	2927	1143
2036	- 37	0	2270	735	1534	0	2927	0	163	209	163	2717	1162
2037	- 38	0	2432	788	1643	0	2717	0	151	209	151	2508	1284
2038	- 39	0	2494	846	1648	0	2508	0	138	209	138	2299	1301
2039	- 40	0	2672	907	1765	0	2299	0	125	209	125	2090	1430
2040	- 41	0	2740	973	1767	0	2090	0	113	209	113	1881	1445
2041	- 42	0	2936	1749	1187	0	1881	0	100	209	100	1672	877
2042	- 43	0	3003	1122	1881	0	1672	0	88	209	88	1463	1584
2043	- 44	0	3210	1206	2004	0	1463	0	75	209	75	1254	1720
2044	- 45	0	3316	3898	-583	0	1254	0	63	209	63	1045	-855
2045	- 46	0	3543	1393	2150	0	1045	0	50	209	50	836	1891
2046	- 47	0	3626	1498	2128	0	836	0	38	209	38	627	1881
2047	- 48	0	3875	1611	2264	0	627	0	25	209	25	418	2030



Year			Capital Cost	Revenue	O&M Cost	Cash Flow before debt	Equity Withdrawn	Loan Opening Balance	Withdrawn	Interest	Principal Repayment	Interest Repayment	Closing Balance	Equity Cash Flow
2048	-	49	0	3965	1732	2233	0	418	0	13	209	13	209	2011
			0	4237	1863	2374	0	209	0	0	209	0	0	2165
TOTAL			5789	62419	26989	29640	1707		4082	490	0	0		29640
													Equity IRR	18.00%



ANNEXURE 3: EQUITY CASH FLOWS TO PRIVATE ENTITY IN GRANT BY CENTRAL GOVERNMENT 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
2020	- 21	267	0	0	-267	267	0	0	0	0	0	-267
2021	- 22	559	0	0	-559	559	0	0	0	0	0	-559
2022	- 23	733	0	0	-733	64	0	669	85	0	755	-64
2023	- 24	922	0	0	-922	0	755	922	166	0	1843	0
2024	- 25	484	854	293	77	0	1843	484	179	0	2506	77
2025	- 26	0	854	314	540	0	2506	0	150	0	2506	390
2026	- 27	0	888	336	552	0	2506	0	144	104	2402	303
2027	- 28	0	923	360	563	0	2402	0	138	104	2297	321
2028	- 29	0	960	386	574	0	2297	0	132	104	2193	338
2029	- 30	0	998	424	575	0	2193	0	125	104	2088	345
2030	- 31	0	1038	464	574	0	2088	0	119	104	1984	350
2031	- 32	0	1080	1612	-532	0	1984	0	113	104	1880	-749
2032	- 33	0	1123	557	566	0	1880	0	107	104	1775	355
2033	- 34	0	1168	597	571	0	1775	0	100	104	1671	366
2034	- 35	0	1215	640	575	0	1671	0	94	104	1566	377
2035	- 36	0	1263	686	578	0	1566	0	88	104	1462	385
2036	- 37	0	1314	735	579	0	1462	0	81	104	1358	393
2037	- 38	0	1366	788	578	0	1358	0	75	104	1253	399
2038	- 39	0	1421	846	576	0	1253	0	69	104	1149	402
2039	- 40	0	1478	907	571	0	1149	0	63	104	1044	404
2040	- 41	0	1537	973	564	0	1044	0	56	104	940	403
2041	- 42	0	1599	1749	-150	0	940	0	50	104	835	-305
2042	- 43	0	1663	1122	540	0	835	0	44	104	731	392
2043	- 44	0	1729	1206	523	0	731	0	38	104	627	381
2044	- 45	0	1798	3898	-2100	0	627	0	31	104	522	-2236
2045	- 46	0	1870	1393	477	0	522	0	25	104	418	347
2046	- 47	0	1945	1498	447	0	418	0	19	104	313	324
2047	- 48	0	2023	1611	412	0	313	0	13	104	209	295
2048	- 49	0	2104	1732	372	0	209	0	6	104	104	261
		0	2188	1863	325	0	104	0	0	104	0	220
TOTAL	2965	36398	26989	6444	889		2075	249	2506			3938
											EIRR%	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

Project horizon comprises of the construction and operation period of the rail based transit project. 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. The key assumptions used in the evaluation are listed in **Table 20.1**.

TABLE 20.1: KEY EVALUATION ASSUMPTIONS

Parameter	Assumptions
Price Level	November '2017
Construction period	2020-2024
First year of operation of MRTS	2024
Daily to annual factor	340

20.1.2 Development of 'With' and 'Without' Scenarios

The development of the two scenario starts with estimating the traffic and the modal share in these scenarios for the system. **Table 20.2** gives the estimated traffic and modal share in different horizon years for Metro. It can be seen that the total estimated demand in the year 2024 is about 39 Lakh which is expected to rise to about 54 Lakh in the year 2041. In the year 2024, rail based transit system is expected to cater to about 9 Lakh trips / day which is expected to rise to about 14 lakh in the year 2041.

TABLE 20.2: ESTIMATED DEMAND AND MODAL SHARE IN 'WITH' AND 'WITHOUT' SCENARIO

Mode	Trips Without Mass Transport System (Lakh)			Trips with Mass Transport System (Lakh)		
	2024	2031	2041	2024	2031	2041
Car	4.23	5.19	6.58	3.96	4.94	6.32
2Wheelers	18.91	23.42	27.86	16.83	20.91	24.4
Auto	1.31	1.61	2.24	1.05	1.5	2.2
Bus/ Shared Auto	14.29	15.41	17.53	7.47	7.48	7.77
MRTS	-	-	-	9.44	10.79	13.51
Total	38.75	45.63	54.21	38.75	45.63	54.21

20.2 ESTIMATION OF ECONOMIC COST OF MRTS

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

The economic costs (**Table 20.3**) have been derived from financial costs using following shadow price factor for each component to take care of the distortions brought by above factors.

TABLE 20.3: 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 20.4 and Table 20.5 give the capital and O&M costs of the MRTS at Nov'17 Price levels in financial and economic terms respectively.

TABLE 20.4: FINANCIAL COSTS OF METRO - CAPITAL AND O&M (RS. IN CRORE)

Cost Component	Metro
Construction Cost Including Land and R&R	8508
Taxes & Duties	1334
O&M Costs	
2024	228
2031	256
2041	279

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

Cost Component	Metro
Construction Cost Including land and R&R	6769
O&M Costs	
2024	198
2031	223
2041	242

20.3 ECONOMIC BENEFITS OF MRTS

Kanpur 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 Kanpur Metro.

TABLE 20.6: REDUCED PASSENGER TRIPS DUE TO KANPUR MRTS

(Trips in Lakh)

Mode	Reduced pass Trips Due to Kanpur Metro		
	2024	2031	2041
Car + Taxi	0.27	0.25	0.26
2W	2.08	2.51	3.46
Bus	1.4	1.58	1.95
Shared Auto	5.7	6.45	7.84
MRTS	9.4	10.8	13.5

Shifting of passenger trips from road to metro would lead to 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 Kanpur 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 KANPUR

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 KANPUR 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	11	150	16	20	40
Car	11	30	25	30	2.4
2wh	7	25	23	28	1.3
Shared Auto	6	80	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 KANPUR

Year	Registered Vehicles	Total Accidents	Fatal Accidents
2013	861,756	1,269	472
2014	950,968	1383	549
2015	1,051,765	1496	625
2016	1,097,141	1451	620

Source: Year-wise Statistics on Road Accidents in Kanpur, 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. $VOC \text{ savings} = VOC \text{ [Rs. /km]} \times \text{Vehicle kms saved [km]}$. 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

$$\text{Vehicle Km saved} = [\text{No. of Trips shift to Metro from other mode}] \times [\text{Average Lead of the mode}]$$

$$\text{Total Volume of Pollutant} = [\text{Volume of Pollutant released per km}] \times [\text{Daily vehicle km saved}]$$

$$\text{Annual Treatment Cost} = [\text{Volume of pollutant}] \times [\text{Treatment cost/ton}]$$
- 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. 60Cr/ year has been assumed.

Following the above methodology socio-economic benefits of Kanpur 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 ECONOMIC COSTS

S. No	Item	Factor
1	Savings in Capital & Operating Cost of Buses	0.83
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 economic benefits for Kanpur Metro in the horizon year 2044-45 have been summarized in **Table 20.14**.

It is clear from the table that benefits are mainly come from VOC savings (52.1%), saving of travel time by MRTS and road passengers (44%), and Environmental benefit from emission reduction, accident reduction and road maintenance cost (together 3.5%).

TABLE 20.14: ECONOMIC BENEFITS OF KANPUR MRTS-2044-45

S.NO	BENEFITS	MRTS	
		Amount (Rs in Cr)	% Share
1	Travel Time Savings	1361	44.4
2	Savings in Vehicle Operating Cost	1594	52.1
3	Savings from Accident, Pollution & Road maintenance Reduction	108	3.5
Total		3063	100

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 to be calculated on social cost of capital or government security rate. Accordingly, ENPV for the system 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 Dec'2017 is 7.2%. Accordingly, ENPV for the system has been calculated based on these rates. The summary of the ENPV and EIRR is presented in **Table 20.15**. The cost and benefit streams for Metro system is presented in **Table 20.17**.

TABLE 20.15: ECONOMIC RETURN PARAMETERS OF KANPUR METRO

S.NO	PARAMETER	Metro
1	EIRR	18.48%
2	ENPV - Social cost of capital @14% - Government Security Rate@ 7.2%	1944 10147

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	17.81%	17.18%	16.59%
2	Increase in Maintenance Cost	18.38%	18.29%	18.19%
3	Reduction in Ridership	18.24%	18.00%	17.75%
4	Reduction in benefits	17.67%	16.84%	15.98%
5	Combination of reduction in benefits and increase in cost	17.02%	15.62%	14.26%



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

Units: Rs in Crores									
YEAR	CAPITAL	RUNNING EXPENSE OF MRTS	TOTAL COSTS	SAVINGS FROM			INFRASTRUCTURE & MAINTENANCE	TOTAL	NET CASH
				VOC	TIME	POL&ACC		SAVINGS	FLOW
								Rs. IN Cr.	
2020-21	677	0	677	0	0	0	0	0	-677
2021-22	1354	0	1354	0	0	0	0	0	-1354
2022-23	1692	0	1692	0	0	0	0	0	-1692
2023-24	2031	0	2031	0	0	0	0	0	-2031
2024-25	1015	198	1213	653	628	24	37	1341	128
2025-26	0	199	199	662	636	24	37	1359	1160
2026-27	0	200	200	671	645	24	37	1376	1176
2027-28	0	202	202	680	653	25	37	1394	1193
2028-29	0	203	203	689	662	25	37	1413	1210
2029-30	0	209	209	798	690	26	43	1557	1348
2030-31	0	216	216	910	787	30	49	1775	1559
2031-32	566	223	789	1115	933	36	54	2138	1349
2032-33	0	230	230	1141	954	37	54	2185	1955
2033-34	0	231	231	1167	1084	42	52	2345	2113
2034-35	0	233	233	1193	1109	43	52	2397	2164
2035-36	0	234	234	1220	1134	43	52	2450	2216
2036-37	0	236	236	1248	1160	44	52	2505	2269
2037-38	0	237	237	1276	1186	45	52	2560	2324
2038-39	0	238	238	1305	1213	47	52	2617	2379
2039-40	0	240	240	1335	1241	48	52	2676	2436
2040-41	0	241	241	1365	1269	49	52	2735	2494
2041-42	319	242	561	1492	1272	52	52	2869	2308
2042-43	0	244	244	1526	1301	54	52	2933	2689



Units: Rs in Crores									
YEAR	CAPITAL	RUNNING	TOTAL	SAVINGS FROM			INFRASTRUCTURE & MAINTENANCE	TOTAL	NET CASH
		EXPENSE	COSTS	VOC	TIME	POL&ACC		SAVINGS	FLOW
		OF MRTS							Rs. IN Cr.
2043-44	0	246	246	1559	1331	55	52	2996	2750
2044-45	629	248	876	1594	1361	56	52	3063	2186
2045-46	0	249	249	1630	1392	57	52	3131	2882
2046-47	0	251	251	1667	1423	58	52	3201	2950
2047-48	0	253	253	1705	1456	60	52	3273	3020
2048-49	0	254	254	1744	1489	61	52	3346	3091
								IRR	18.48%
								ENPV	1944
								ENPV	10147