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AFTC	Audio Frequency Track Circuits
ARSD College	Atma Ram Sanatan Dharm College, Delhi
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
BTK	Bhiwadi- Tapookara- Khushkhera Complex
CAR	Corridor Alignment Report
CATC	Continuous Automatic Train Control
CBD	Central Business District
CBTC	Communication Based Train Control
CENELAC SIL-4	European Standard – Safety Integrity level four
CNCR	Central National Capital Region
CRC	Consultancy Review Committee
DAMEL	Delhi Airport Metro Express Line
DFC	Dedicated Freight Corridor
DGRA	Delhi-Gurgaon-Rewari-Alwar
DIMTS	Delhi Integrated Multi Model Transport Services
DMIC	Delhi Mumbai Industrial Corridor
DMRC	Delhi Metro Rail Corporation Limited
DPR	Detailed Project Report
DTC	Delhi Transport Corporation
DTS	Data Transmission System
EMU	Electro-motive Units
HVAC	Heating, Ventilation and Air Conditioning
IR	Indian Railways
ISBT	Inter State Bus Terminus
KMP	Kundli-Manesar-Palwal
LMV	Light Motor Vehicle
MBIR	Manesar-Bawal Investment Region
MOU	Memorandum of Understanding
MOUD	Ministry of Urban Development

MRTS	Mass Rapid Transit System
NATM	New Austrian Tunnelling Method
NCR	National Capital Region
NCRPB	National Capital Region Planning Board
NCRTC	National Capital Region Transport Corporation
NCTD	National Capital Territory Delhi
NDLS	New Delhi Railway Station
NH	National Highway
NZM	Nizamuddin
OCC	Operations Control Centre
OFC	Optical Fibre Cable
PHPDT	Peak Hour Peak Direction Trips
RDSO	Research Design and Standards Organisation
Rajiv Chowk (G)	Rajiv Chowk (Gurgaon)
RFID	Radio Frequency Identification Device
ROW	Right of Way
RRTS	Regional Rapid Transit System
SDH	Synchronous Digital Hierarchy
SEZ	Special Economic Zones
SH	State Highway
SNB	Shahjahanpur – Neemrana – Behror – Complex
TO	Train Operator
TOD	Transit Oriented Development
TSS	Traction Sub Station
UMTC	Urban Mass Transit Company Limited

1. Introduction

1.1. Study Background

The National Capital Region Planning Board (NCRPB), in order to enhance the connectivity within the National Capital Region, has proposed to connect the Urban, industrial (SEZs/industrial parks), regional and sub-regional centers through a Regional Rapid Transit System (RRTS). The Integrated Transportation Plan 2032 has identified eight rail based rapid transit corridors to enhance the efficacy of the transportation system in the NCR (Figure 1-1) in addition to providing other facilities including road network enhancements.

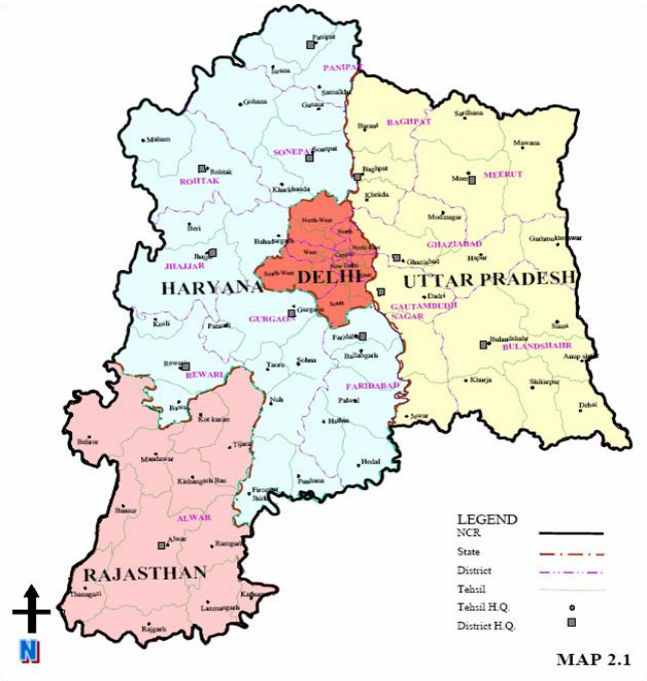


Figure 1-1 National Capital Region

The eight identified RRTS corridors are:

1. Delhi – Gurgaon – Rewari – Alwar [DGRA - Project Corridor]
2. Delhi – Ghaziabad – Meerut
3. Delhi – Sonipat – Panipat
4. Delhi – Faridabad – Ballabhgarh – Palwal
5. Delhi – Bahadurgarh – Rohtak
6. Delhi – Shahadra – Baraut
7. Ghaziabad – Khurja
8. Ghaziabad – Hapur

The proposed RRTS corridors are shown in Figure 1-2

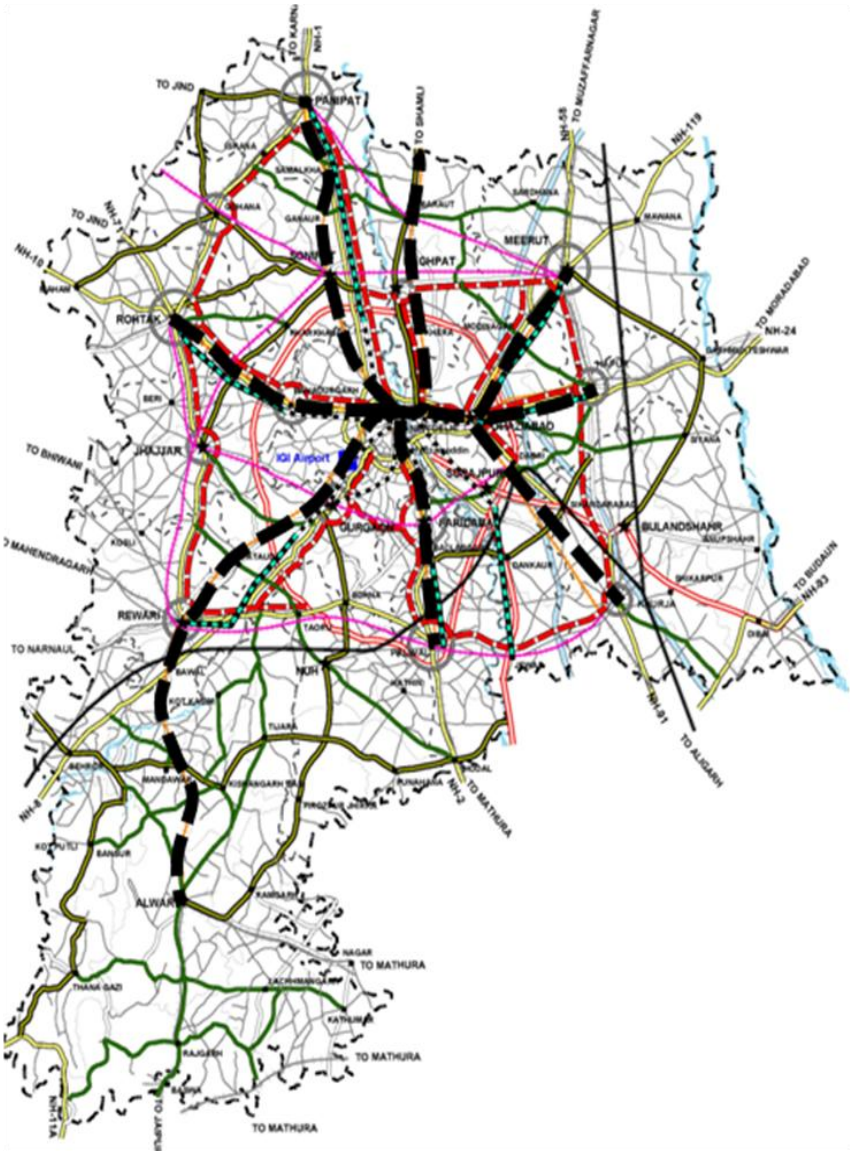


Figure 1-2 National Capital Region and Proposed RRTS corridors

The Feasibility Report on the Delhi –Alwar RRTS corridor was submitted on 27.09.2011 and was approved as per the minutes of the Consultants Review Committee (CRC) meeting held on 14.10.2011. Minutes of the meeting is attached as Annexure 1.

The observations and decisions were summarised as follows:-

(i) Consultant should check the alignment at Dharuhera, Rewari and Bawal and modify, if found conflicting with Master Plan.

(ii) Land Cost taken for financial analysis need to be revised based on prevailing rates.

(iii) The amount due as Central Taxes would be treated as interest free subordinate debt to be shared between the Central and the State Government. The State Taxes shall be waived off/reimbursed by the States.

(iv) Contribution of project cost should not be taken as 12.5%. It is equity contribution just to form the company. It should be decided on the basis of length of RRTS corridor in the State and benefits thereon.

(v) Committee approved the Feasibility Report and directed to release the payment. The Committee directed to submit the addendum on Feasibility Report after incorporating the above suggestions.

1.2. Scope of the Addendum Report

This Addendum to the Feasibility Report addresses the points as directed by the CRC tabulated below

S. No.	Decisions	Inclusion in the Addendum
1	Consultant should check the alignment at Dharuheda, Rewari and Bawal and modify, if found conflicting with Master Plan.	The changes in the alignment suggested by the Govt. of Haryana have been discussed with Sr. Town Planner, Gurgaon and District Town Planner, Rewari on 09.11.2011, and further with Sh. S.S. Dhillon, Financial Commissioner and Pricipal Secretary, Town and Country Planning alongwith other officers of Govt. of Haryana on 22.11.2011, and the suggested alignment is marked on the key map in Figure 1-3. It was also decided in these meetings that Rajiv Chowk and MBIR stations, approved earlier, may be deleted. Kherki Dhaula station will be added between the meeting points of NPR and SPR at NH-8.

S. No.	Decisions	Inclusion in the Addendum
		Thus, there is a suggested change of around 35 kms in the alignment (kindly refer letter No. UMTC/GPG/RRTS/NCRPB/144 dated 22.12.11 and letter No. UMTC/GPG/RRTS/NCRPB/146 dated 26.12.11 attached as Annexure 2. However, no directions have been received from NCRPB on the work involving the change in alignment in Haryana and ***hence this report contains the financial analysis and work based on the RRTS alignment approved by the CRC and Task Force on 17.03.11 and 29.06.11 respectively.***
2	Land Cost taken for financial analysis need to be revised based on prevailing rates.	The Circle rates have been collected and included in the land cost calculations in the costing in Chapter 3
3	The amount due as Central Taxes would be treated as interest free subordinate debt to be shared between the Central and the State Government. The State Taxes shall be waived off/reimbursed by the States.	This has been considered in the revised Financial Analysis in Chapter 4
4	Contribution of project cost should not be taken as 12.5%. It is equity contribution just to form the company. It should be decided on the basis of length of RRTS corridor in the State and benefits thereon.	This has been rectified. The state wise contribution of project cost would be decided by NCRTC as per the minutes of meeting held on 14.10.11.

This Report contains the revised Financial Analysis after including all the necessary changes as discussed in the CRC meeting held on 14.10.11.

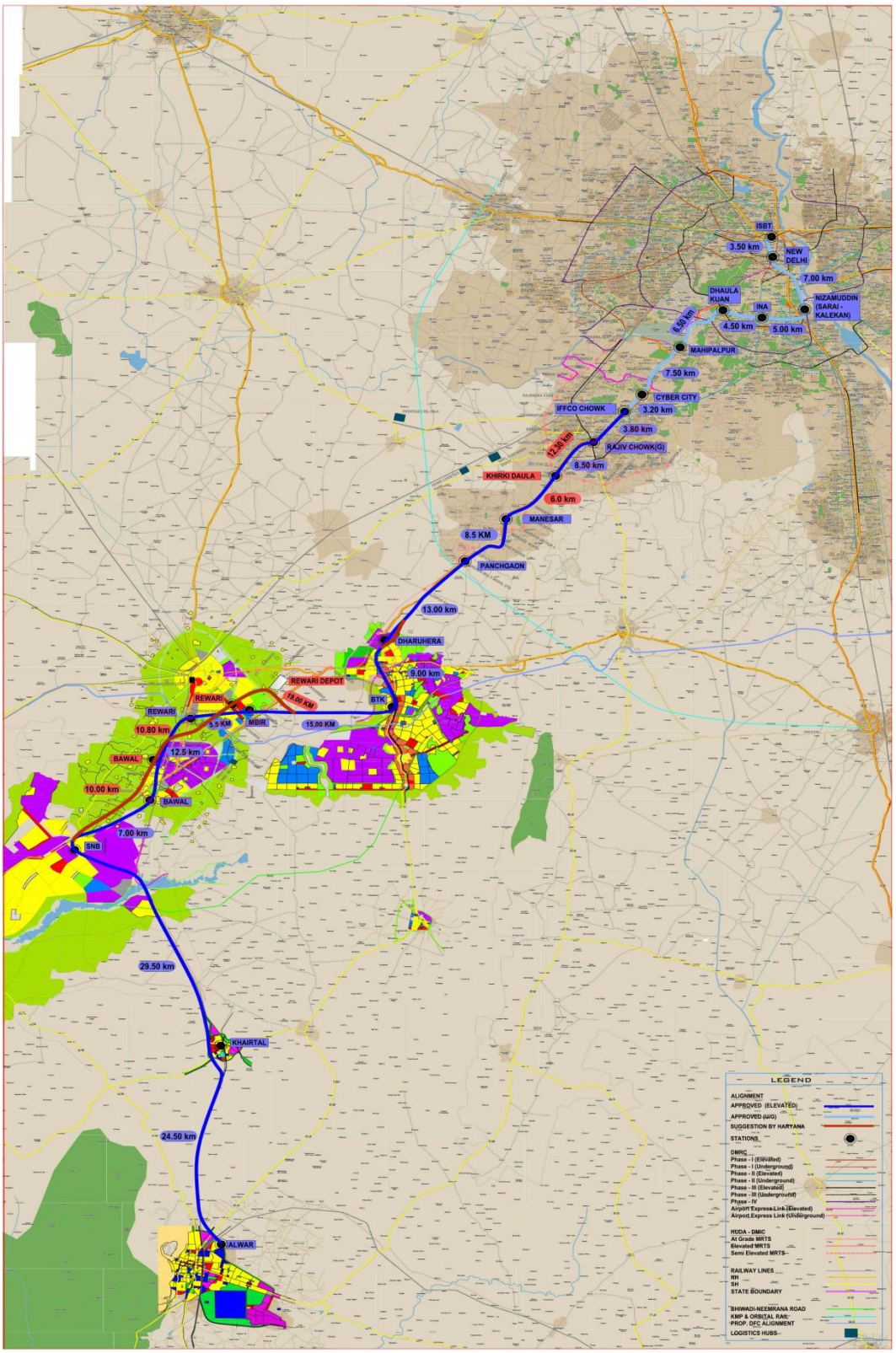


Figure 1-3 Key Map

2. Travel Demand Forecast

2.1. Introduction

The traffic studies for identifying the recommended alignment and forecasting the future traffic for the alignment was carried out based on primary and secondary data collection. The transport planning process primarily consists of development of a set of formulae / equations which are referred as models, enabling forecast of future travel demand and traffic characteristics. It is not just one model but a series of interlinked models of varying levels of complexity dealing with different facets of travel demand. Planning variables at zonal level, such as population, employment, land use and transit oriented development have been made use of in the transport demand analysis.

The finalised Alignment as approved by the CRC and Task Force consists of the following stations:-

ISBT Kashmere Gate - New Delhi Railway Station – Sarai Kale Khan (Nizammuddin) – INA – Dhaula Kuan – Mahipalpur – Cyber City – IFFCO Chowk - Rajiv Chowk (G) – Manesar – Panchgaon – Dharuhera – BTK – MBIR – Rewari – Bawal – SNB – Khairthal – Alwar.

The traffic forecast has been carried out for this alignment taking into account the influence on RRTS traffic due to the connectivity of the zones connected by the DAMEL and the DMRC Gurgaon Line. The details of the travel demand and traffic characteristics have been provided in the sections below.

2.2. Results

The alignment is shown in **Figure 2-1**. The ridership results are presented in the following sub sections.

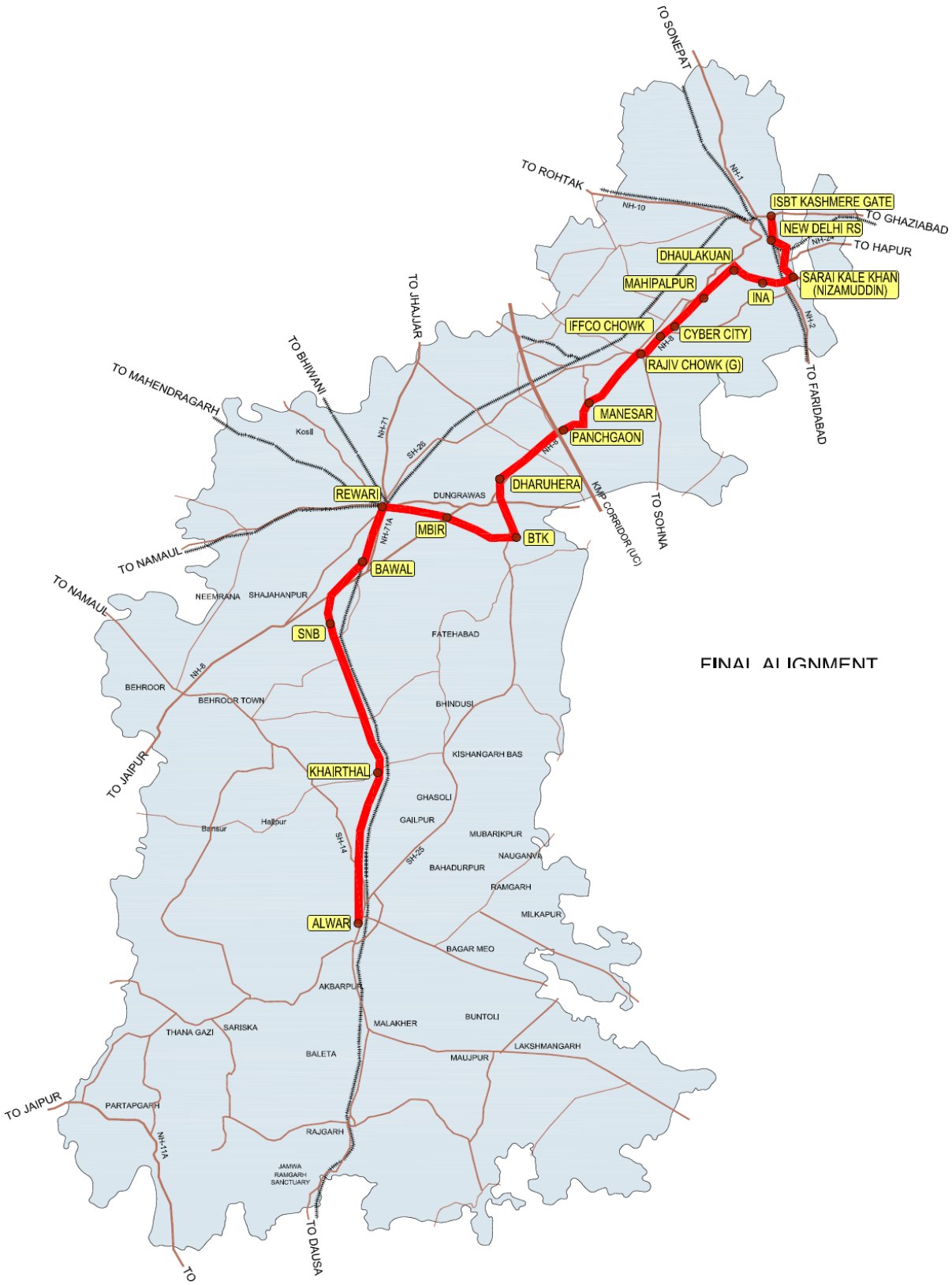


Figure 2-1 – Final alignment

The peak hour candidate trips and diverted trips for 2016, 2021, 2031 and 2041 with TOD are presented in Table 2-1.

Table 2-1: Peak Hour Candidate trips, diverted trips

Mode	Peak Hour Candidate trips	Peak Hour Diverted Trips
2016	979738	69920
2021	1247178	91321
2031	1515061	125593
2041	1798448	151135

2.3. Station wise Boarding and Alighting

The daily ridership on the proposed corridor will have an important impact on the feasibility of the project since the revenue generation will depend mostly on the number of people using the facility; this has been forecast by detailed model development and calibration. The daily boarding and alighting at each station is considered to be equal.

The daily boarding-alighting on RRTS for the various horizon years are given in Table 2-2.

Table 2-2: Daily Boarding/Alighting for various stations in RRTS

S.No	Station Name	2016	2021	2031	2041
1	ISBT Kashmere Gate	20390	24540	33095	44340
2	New Delhi RS	26030	32855	42495	54280
3	Sarai Kale Khan (Nizamuddin)	38000	44520	66395	84950
4	INA	24955	31275	47545	55515
5	Dhaulakuan	6000	9270	10140	11565
6	Mahipalpur	66035	87320	131110	145720
7	Cyber City	58210	83760	114145	125675
8	IFFCO Chowk	44760	44655	57535	67105
9	Rajiv Chowk (G)	25285	47105	57035	67145
10	Manesar	46765	61085	87410	96520
11	Panchgaon	24785	34290	38715	44440
12	Dharuhera	29375	33995	40680	45000
13	BTK	59395	76510	93535	115185
14	MBIR	24625	28865	34960	48050
15	Rewari	68000	99795	140735	161165
16	Bawal	62980	82240	135835	167035
17	SNB	38805	46915	61205	93305
18	Khairthal	18615	23155	32150	39285
19	Alwar	15320	20340	30690	44380
	Total	698330	912490	1255410	1510660

2.4. Final summary

Ridership summary for the RRTS is presented in Table 2-3.

Table 2-3: Ridership for various Horizon Years (Realistic Scenario)

Description	2016	2021	2031	2041
Peak Hour Candidate Trips	979738	1247178	1515061	1798448
Peak Hour Diverted Trips	69920	91321	125593	151135
Daily Ridership on RRTS	698330	912490	1255410	1510660
Maximum sectional load	13792	15646	21817	25775

The rolling stock requirement and the train operation plans for the horizon years have been worked out on the basis of this above data. The revenue generation has also been worked out based on the above figures.

3. Cost Estimates

3.1. INTRODUCTION

Project Cost estimates for the RRTS Delhi-Gurgaon-Rewari-Alwar corridor as mentioned below have been prepared covering civil, electrical, signaling and telecommunication works, rolling stock, environmental protection, rehabilitation, considering 25KV AC traction at January 2012 price level, both for Capital and Operation & Maintenance costs.

While preparing cost estimates, various items have generally been grouped under three major heads on the basis of:-

- Route km length of alignment
- No. of units of that item
- Item being independent entity

All items related to alignment, whether in underground or elevated or at grade construction, permanent way OHE, signaling and telecommunication, have been estimated on rate per route km/km basis. Route km cost for underground alignment construction, excludes station lengths. Station lengths (320m) have to be done by tunneling technique. The rates adopted for underground stations include cost of civil structures and architectural finishes. Similarly, cost of elevated and at grade stations includes civil work for station structures, architectural finishes, platform roofing, etc. Provisions for electrical and mechanical works, air conditioning, lifts, escalators, etc, have been worked out separately. These rates do not include cost of permanent way, O.H.E., power supply, signalling and telecommunication, automatic fare collection (AFC) installations, for which separate provisions have been made in the cost estimates. Similarly, for other items like Rolling stock, Traction & Power, tunnel ventilation, etc, costs have been summed up separately. In remaining items, viz. land, utility diversions, rehabilitation, etc the costs have been assessed on the basis of each item taken as an independent entity.

The overall Capital Cost for the corridor at January 2012 price level works out to Rs.24600 crores including the cost of rolling stock for the induced traffic, excluding applicable Taxes & Duties but including cost of land. Taxes and duties have been added @20% of the cost (excluding land cost) for working out the financial viability. The base rates of Delhi Metro Phase III estimate of January 2011 have been adopted, which have been suitably modified for the RRTS infrastructure and have been escalated further for one year@ 5% per annum.

Details and methodology of arriving at these costs are discussed in the following paragraphs.

3.2. Civil Engineering Works

Land requirements have been kept to the barest minimum and worked out on area basis. Acquisition of private land has been minimized as far as possible.

For underground alignment, no land is proposed to be acquired permanently, except small areas for locating entry/ exit structures, ventilation shafts, traffic integration etc. Elevated alignment is proposed to be located on the road verge, side of roads and wherever, this is outside the road alignment, minimum land area about 15m wide is proposed for acquisition for the piers and the service road. Land will be required at stations locations.

The land proposed for Transit Oriented Development (TOD) has been reduced to 377 hectares in the Haryana and Rajasthan stations from an earlier estimate of 518 hectares, this has been done based on the discussions with Haryana Govt on 22.11.2011 and subsequent discussions to minimize land acquisition.

Cost of Govt. land is based on the rate presently being charged by the concerned authorities, such as L&DO, MCD, DDA, etc. and circle rates for the rest of the areas.

Provision for cost of land required for resettlement and rehabilitation has been made in the cost estimates.

In addition to the lands required permanently, some areas of land (mainly Govt.) are proposed to be taken over temporarily for construction yards.

3.3. Permanent Way

For underground and elevated alignment ballastless track and for depot, ballasted track is proposed. Rates adopted are based on the DPR cost of similar works in Phase-III DMRC MRTS duly updated to the price level of January 2012,

3.4. Utility Diversions, Environmental Protection, Miscellaneous Other Works

Provisions have been made to cover the cost of utility diversions, miscellaneous road works involved, road diversions, road signages etc. and environmental protection works on lump sum basis.

3.5. Rehabilitation and Resettlement

Provisions have been made on fair assessment basis, to cover cost of relocation of Jhuggies, Shops, residential houses on private land etc.

Provision for barracks for CISF including security equipment and Quarters for O&M staff has been made in the cost estimates.

3.6. Traction and Power Supply

Provision has been made to cover the cost of O.H.E., Auxiliary sub stations, receiving substations, service connection charges, SCADA and miscellaneous items, on route km basis separately for underground alignment, elevated and at-grade section as the requirements are different and costs are more for underground section.

Provisions towards cost of lifts, escalators for underground and elevated stations have been made in the cost estimates. Rates are based on the DPR cost of similar works in Phase-III DMRC MRTS duly updated to the price level of January 2012. Provision for mid section shaft is made separately.

3.7. Signalling And Telecommunication Works

Rates are based on the DPR cost of similar works in Phase-III DMRC MRTS duly updated to the price level of January 2012. These rates include escalation during

manufacturing and supply of equipment and their installation at site. Lump sum Cost of Platform Screens Doors (PSD) for the underground stations has also been added in the estimate.

3.8. Automatic Fare Collection

Adopted rates are based on the DPR cost of similar works in Phase-III DMRC MRTS duly updated to the price level of January 2012

3.9. Rolling Stock

Adopted rates are based on the DPR cost of similar works in Phase-III DMRC MRTS and DAMEL rolling stock cost duly updated to the price level of January 2012 considering likely increase due to increase in coach dimensions (24mx3.66m) and the operating speed.

3.10. General Charges and Contingencies

Provision @3% has been made towards general charges on all items, except cost of land, which also includes the charges towards Detailed Design Charges (DDC), etc. Provision for contingencies @3% has been made on all items including general charges.

3.11. Capital Cost

The overall Capital cost for these corridors estimated at January 2012 price level, based on the above considerations works out to Rs.24600/- crores.

Table 3-1 shows the Cost Break up for the RRTS corridor

Table 3-1: Cost Break up

S.No.	Item	Unit	Rate based on DMRC Rates of Ph-III of Jan. 2011 escalated @5% for 2012 (in Crore)	Qty.	Amount (in Crore)
1.0	**Land**				

S.No.	Item	Unit	Rate based on DMRC Rates of Ph-III of Jan. 2011 escalated @5% for 2012 (in Crore)	Qty.	Amount (in Crore)
1.1	Land in Delhi State required for underground stations for integration with DMRC, RRTS and Northern Railway; exit and entry for underground station and ventilation shafts	Hect.	varies from 164 Cr. to 300 Cr. per ha	2.00	413.00
1.2	Land in Haryana required for elevated station including TOD elevated section between Cyber City and Bawal and Depot at MBIR.	Hect.	2.20 Cr. (Avg.)	334	731.00
1.3	Land in Rajasthan required for elevated station with TOD, elevated station between Bawal-SNB to Alwar and Depot and Alwar.	Hect.	0.7 Cr. (Avg.)	309	218.00
1.4	Temporary land for casting yard, working spares.	Hect.	0.50	225	113.00
	Sub Total (1.0)				**1475.00**
2.0	**Alignment and Formation**				
2.1	Underground section - Tunneling by TBM	R. Km	166.00	36	6049.04
	Elevated viaduct section	R. Km	32.55	141	4589.55
	Special span	R. Km	31.00	1.00	31.00
	Civil Work for mid section ventilation shaft	Each	3.00	20	60.00
	Sub Total (2.0)				**10729.59**
3.0	**Important Bridges**				
	Length of Sahibi River = 0.700 km	Nos.	30.00	1.00	30.00
	Sub Total (3.0)				**30.00**
4.0	**Station Buildings;**				
4.1 (a)	Underground Station	Each	178.24	7.00	1248.00
(b)	Underground Terminal Station	Each	250.00	1.00	250.00
4.2	Elevated Station (including finishes)				
(a)	Way side station	Each	37.80	9.00	340.20
(b)	Terminal station	Each	40.32	2.00	80.64
4.3	Interchange facilities at interchange station viz ISBT, New Delhi, Sarai Kale Khan, Dhaula Kuan, Mahipalpur, Cyber City & IFFCO Chowk	Each	10.00	7.00	70.00
	Sub Total (4.0)				**1988.84**
5.0	**E & M Works**				

S.No.	Item	Unit	Rate based on DMRC Rates of Ph-III of Jan. 2011 escalated @5% for 2012 (in Crore)	Qty.	Amount (in Crore)
5.1	Underground station (E&M, Lifts, Escalators, DG Sets, UPS, TVS, ECS etc.)	Each	58.00	8.00	464.00
5.2	Elevated station (E&M, Lifts, Escalators, DG Sets etc.)	Each	6.86	11	75.00
5.3	Mid section ventilation shafts	Each	6.00	20	120.00
	Sub Total (5.0)				**659.00**
6.0	**Depot**				
	Depot of Sarai Kalekhan, MBIR and Alwar (including Civil Works, E&M, P&M, Track works, OHE etc.)	L.S.			200.00
	Sub Total (6.0)				**200.00**
7.0	**Permanent Way**				
	Ballast less/Ballasted Track for elevated, underground and at grade alignment	R. Km	6.80	183	1245.00
	Sub Total (7.0)				**1245.00**
8.0	**Traction and Power**				
	Traction and power supply including OHE ASS etc.				
	Underground section	R. Km			
	Elevated & Grade section	R. Km			
	Sub Total (8.0)				**846.00**
9.0	**Signalling and Telecom**				
9.1	Signalling	R. Km	10.22	183.00	1781.00
9.2	Telecom	Each	4.58	19.00	87.00
9.3	Auto Fare Collection				
9.3.1	Underground station	Each	3.11	8.00	25.00
9.3.2	Elevated Station	Each	3.11	11.00	33.00
9.4	PSD at Station	L.S.			20.00
	Sub Total (9.0)				**1946.00**
10.0	**Rolling Stock (BG)**	Each	13.60	264	3590.00
	Sub Total (10.0)				**3590.00**
11.0	**Utilities**				
11.1	Misc. utilities, other Civil works, such as median, road signages, Electrical & Telecom utilities.	L.S.			150.00

S.No.	Item	Unit	Rate based on DMRC Rates of Ph-III of Jan. 2011 escalated @5% for 2012 (in Crore)	Qty.	Amount (in Crore)
11.2	Service roads	Km	1.10	70	77.00
	Sub Total (11.0)				**227.00**
12.0	R&R including Hutments and road restoration etc.	L.S.			200.00
	Sub Total (12.0)				**200.00**
13.0	Barracks for CISF including security equipments and staff quarters for ORM staff.	L.S.			40.00
	Sub Total (13.0)				**40.00**
14.00	Special noise & vibration reduction treatment	L.S.			**50.00**
	Sub Total (14.0)				**50.00**
15.00	Total of all item except land				21751.43
16.00	General charges including design charges @3% on all items except land.				653.00
17.00	Total including General Charges.				22404.43
18.00	Total cost including of land cost.				23879.43
19.00	Contingencies @3%.				716.00
	Gross Total				**24595.43**

4. Financial Analysis

4.1. Introduction

Full recovery of capital investment from public transport systems has usually remained elusive considering the huge investments required. Thus higher emphasis is given to operational sustainability for this kind of projects. Such capital intensive projects hugely affect socio economic dynamics at the regional level and therefore necessity of such projects could be justified through Socio-Economic Cost benefit analysis which is discussed separately in the chapter on the same.

This chapter attempts to estimate the extent of financial viability and operational sustainability of proposed RRTS project. It discusses inputs and estimations related to project cost, means of finance, revenues, and operations cost. Alternative implementation formats including PPP formats are also analyzed and discussed.

4.2. Analysis Period and Sequence

It is expected that the project construction period would be five years upto Dec 31, 2016. The operations are expected to begin under this assumption on Jan 1, 2017. The period of operations used for the purpose of financial analysis is 30 years thereafter upto 2046. The revenues, expenses, taxes, profits and cashflow are calculated for this time window.

The financial analysis for RRTS begins with analysis of the project in totality without considering the implementation model and agency. The discussion proceeds with estimations of project cost, various streams of revenue, Operation and maintenance cost and analysis of operational viability and returns of the project.

At the end of above analysis, various implementation models for the project are discussed. Suitable model for development and implementation is recommended taking the pros and cons of each model in to consideration.

4.3. Project cost

The summary of estimated project cost used for financial analysis is presented in Table 4-1.

Table 4-1: Summary of project cost

Particular	Total (*Rs. Crore*)
Land	1475
Government land	*1317*
Private Land	*159*
Aggregate Project Cost except land	21751
Total Project Cost with Land	**23227**
General Charges inc. Design (3% on all items except land)	653
Total with General Charges	**23879**
Contingency on all items at 3%	716
Project Cost with Contingency	**24596**

Source: As per Project cost estimates

The above cost does not include tax on project goods and interest during construction. These are introduced subsequently in the analysis as per the requirement of the context. However project cost is escalated due to inflation during construction period as follows.

Estimated construction period is around five years. Construction is expected to end on December 2016. The project cost is escalated to account for increase in construction cost over the period. The table 4-2 shows the escalated project cost over five years. The project cost is escalated at 6% pa considering average growth in Wholesale Price Index published by Government of India.

Table 4-2: Phasing of Project cost with escalation

Construction Phasing (*Rs. Crore*)	2012 10%	2013 20%	2014 30%	2015 30%	2016 10%	Total 100%
Project Cost (Un-escalated)	2460	4919	7379	7379	2460	24596
Project Cost (Escalated)	2607	5527	8788	9315	3291	29529
Tax on Project Goods	231	489	777	824	291	2611
Total	2838	6016	9565	10139	3583	32141

Source: Author's estimations

The applicable combined taxes from Central and State Governments are estimated to be around 20% of the total hard cost. The tax rates are adopted on the basis of tax rates estimated in other metro rail projects in India. However as per clause 3.3 of the MOU which is signed between MOUD, NCPRB and State Govt. of Delhi (GNCT), Rajasthan, Haryana and Uttar Pradesh, the Central taxes for RRTS project would be considered as interest free subordinate debt while State Govt. Taxes would be waived off/reimbursed. Thus, the above calculation includes only applicable Central taxes at around 10% on the hard cost arrived at by excluding land cost, general and design charges and contingencies. The tax amount considered as sub-debt from the Government would be repaid in a shared manner to the Central and State Government. As per the MOU, the land cost would also be considered as interest free subordinate debt from the state Governments. However such arrangements are considered in the discussion on the implementation models in the later part.

It can be seen that there is an increase of around 31% in the aggregate project cost by the end of the construction period.

Estimations related to revenue and O&M expenses are discussed further.

4.4. Estimations of Operations and Maintenance Cost

The Operation and Maintenance (O&M) cost for RRTS is segregated into five components like 1) Staff Salary 2) Repair and Maintenance expenses 3) Administrative expense 4) Replacement Expenses 5) Energy Expenses 4). The O&M cost for RRTS is calculated mainly using cost of similar metro type rail systems.

Staff salary

Staff requirement is considered to be 35 persons per km. Thus total estimated staff required for RRTS would be thus 6300 persons. Following is the estimate of the breakup of the staff requirement and estimated salary, shown in table 4-3.

Table 4-3: Break up of Staff and Salary

Designation	No. of persons required	Annual Remuneration CTC basis (Rs. Lakh)	Total remuneration (Rs crore)
CEO	1	50	0.50
Vice Presidents	10	24	2.40
Dept. Heads	40	12	4.80
Middle level	320	10	32.00
Technician/Supervisory Level	1300	5	65.00
Others	4629	2.5	115.73
Total	**6300**		**220.43**

Source: Discussion with Manpower agencies regarding prevailng remuneration levels in similar kind of jobs.

The above remuneration levels are at 2011 prices. These are escalated over 6 years for equivalent levels in 2017. The growth under this head is estimated to be 9% pa.

Repair and Maintenance Expenses

Repair and Maintenance Expenses including cost of inventory for RRTS are expected to be around Rs. 0.9 crore per km. The cost is escalated at 6% pa.

Administrative Expenses

Administrative expenses are estimated in table 4-4.

Table 4-4: Administrative Expenses

Admin Expenses	Rs Crore
Insurance, legal, stationary, telephone, security, vehicle hire & maintenance, land license fee, loss on asset etc. (Rs lakh Cost per km)	25.00
Above Cost in Rs. Crore for RRTS	45.00
Travelling and conveyance etc pa. Rs crore	1.00
Misc pa (Rs crore)	5.00
Total	**51.00**

Source: Author's Estimations

Replacement Expenses

The replacement costs are calculated based on 10% replacement for project goods after 20 years of operations. The project goods which will be required replacement are shown in table 4-5:

Table 4-5: Project goods to be considered for replacement

Project Goods	Cost (Rs. crore)
E & M Works	659
Permanent Way	1245
Traction and Power	846
Signaling and Telecom	1947
Utilities	227
Special noise & vibration reduction treatment	50
Total	**4974**

In addition to above rolling stock would be purchased and replaced periodically as shown in table 4-6.

Table 4-6: Purchase of rolling stock

	2021	2031	2041
Number of units (Cumulative)	318	396	477
Number of units (Incremental)	54	78	81
Estimated Cost Per Unit (Rs Crore)	24	44	78
Purchase of Rolling stock (Rs. Crore)	1315	3402	6327

Source: As per the rolling stock requirement calculated for the project.

The cost for rolling stock at the beginning of operations is already included in the project cost. Purchase Cost for rolling stock units for the future years are obtained by escalating existing prices.

Energy Expenses

The energy expenses are a product of units of electricity consumed for traction and buildings and the per unit cost of consumption. Table 4-7 shows the estimated consumption of electricity for the entire system of 180 kms.

Table 4-7: Energy Expenses

Unit Consumption (Crore Units pa)	2016	2021	2031	2041
For Traction	53.04	63.22	79.66	94.96
For Auxiliary	14.18	14.18	19.31	19.31
Total	**67.22**	**77.4**	**98.97**	**114.27**

Source: As per the estimated energy consumption pattern

The unit price for electricity for RRTS is estimated to be a concessional rate of Rs. 4/ unit. The tariffs are envisaged to increase 5% annually during the projection period.

Following is the summary of estimated O&M expenses over the next 30 years shown in table 4-8.

Table 4-8: Summary of O&M expenses

Sr. No	Particular	2017	2021	2031	2036	2041	2046
		Rs .in Crore					
1	Staff Salaries	220	311	737	1133	1744	2683
2	Repair & Maintenance Exp	162	205	366	490	656	878
3	Energy Expenses						
	Unit Consumption (Unit crore)	67	77	99	99	114	114
	Unit Price (Rs. Unit)	5.36	6.21	9.63	11.70	14.22	18.15
	Total Energy Expenses	360	480	953	1158	1625	2074
4	Admin Expenses	51	64	115	154	206	276
5	Replacement in Equipment /Addition of Rolling Stock	0	1315	3402	1595	6327	0
	Total	**794**	**2376**	**5573**	**4212**	**10558**	**5911**

Source: Author's Estimations

It can be seen that staff salary and energy expenses are the significant contributors to O&M costs. The replacement in equipment and addition to rolling stock takes place only at certain intervals, which happen to be the years mentioned above.

4.5. Estimations of Revenue

Urban transit projects lead to a number of benefits to users of the system. The benefits are both direct and indirect in nature. Direct benefits include availability of transit service, opportunities for advertising at transit stations, and opportunities to provide products/services through kiosks/outlets at stations. Indirect benefits arise from association with the project through proximity or through significant positive externalities. The following table 4-9 shows the nature of benefit and their value capturing possibilities.

Table 4-9: Revenue Capture Instruments for different benefits associated with RRTS Project

Nature of Benefit	Revenue Capture Instrument	Status of capture
Direct	• Fare Box • Advertising • License Fees from station assets	Captured in terms of fare, advertisement revenue and license fee from kiosks, stalls and other assets
Proximate	• Increase in business next to stations • Real Estate Development Rights arising from ToD. • Rise in property value around stations	Captured from property development near stations for TOD
Indirect	• Economic Development on the corridor • Less congestion for road users • Improvement in air quality • Availability of more public space • Reduction in use of fossil fuels	Captured from revenue from carbon credits. Cess on Property Transaction and Cess on VAT in the states also considered.

Source: Author's Analysis

It can be seen in the above table that direct benefits play a major role in revenue generation while indirect benefits are relatively difficult to capture. Capturing indirect benefits often require concerted action not only at the project level but assume the cooperation and action from institutions involved such as local bodies, regional Government and members of the public receiving the indirect benefits. This is so since indirect benefits follow from non-excludability (meaning it is difficult to exclude those who do not pay for receiving the benefits).

The principal source of revenue for the project is fare revenue. However since such revenue would be insufficient for recovery of capital in a project of this magnitude, property development near the stations in the spirit of developing Transit Oriented Development (TOD) is proposed. This income supports the fare income in a significant manner, though is phased over a long period of time given that development will happen along the corridor only gradually. Further, it has been attempted to capture value from proximity benefits through carbon credits.

The sources of revenue for the project are the following: 1) fare box collection 2) Income from TOD 3) advertisement fees, 4) license fees from stalls within the station premises and 5) sale of Carbon Credit (CC). Estimations related to fare box collection

is discussed first. It is expected that commercial operation would start from 1st January, 2017. Revenue is thus projected for next 30 years therafter.

Fare box collection

Following table 4-10 shows passenger traffic forecast upto 2046 with realistic, optimistic and pessimistic scenarios.

Table 4-10: Projected daily traffic

Daily Traffic (In lakh)					
Scenarios	**2016**	**2021**	**2031**	**2041**	**2046**
Realistic	6.99	9.12	12.55	15.10	16.27
Optimistic	8.06	10.38	14.18	16.98	18.30
Pessimistic	5.96	7.78	10.69	12.79	13.78

Source: Traffic Demand Analysis for RRTS

Average trip length is estimated to be shown in table 4-11;

Table 4-11: Average trip length

Year	2016	2021	2031	2041
Average Trip Length (km)	27.42	25.96	27.69	28.78

Source: Traffic Demand Analysis for RRTS

The average trip length is increasing over time as the passengers are estimated to commute for longer distance.

Estimation of Fares

A mix of distance based flat and distance based increasing fares are adopted. In order to determine the fares, fare fixation principles have been evolved as follows:

1) Affordability to the users
2) Sustainability of the system
3) Competitiveness with the other modes of transport on the similar route
4) Flexibility for revision

Table 4-12 shown the comparison of fares for competing transportation facilities.

Table 4-12: Fare comparison

Average fares (Rs. /Pax)@								
Stages	**DMRC**	**DTC**	**IR AC chair**	**IR Third AC 3T**	**IR Second Sleeper**	**RSRTC (Ac Service)**	**HSRTC (Ac Service)**	**Proposed Fares for RRTS**
Base fare	**8**	**5**	-	-	-	-	-	**15**
0-10	12	5	-	-	-	-	-	15
10-20	16	10	-	-	-	-	-	20
20-30	20	15	-	-	-	44	34	31
30-40			-	-	-	-	-	38
40-50			-	-	-	-	-	50
50-60			-	-	-	96	75	61
60-70			-	-	-	-	-	72
70-80			-	-	-	131	102	83
80-90			-	-	-	-	-	94
90-100			-	-	-	166	129	105
100-110			240*	210	120	-	-	116
110-120			-	210	120	-	-	127
120-130			-	-	-	219	170	138
130-140			-	-	-	-	-	149
140-150			-	-	-	-	-	160
150-160			-	-	-	271	211	171
160-170			-	-	140	-	-	182
170-180			-	-	140	-	-	193

Source: Fares of different systems and analysis

@ The fares considered above are average fares calculated for respective distance slabs

**These are Shatabdi Rates. Normal AC Chair Car Rates are Rs.165.*

The proposed fares for RRTS are maintained higher than Delhi Metro Rail and DTC buses to discourage shorter or within the city trips. The rates would be slightly higher than the IR's sleeper class but lower than IR's AC chair and 3 tier AC trains and AC services of RSRTC and HSRTC.

Proposed RRTS could compensate higher rates through faster, frequent and comfortable services in comparison with IR sleeper class and RSRTC buses. All the above transportation systems cater to the middle and long distance trips which is the target passenger segment for RRTS.

Fare Revision

The fare revision formula adopted for the RRTS is based on international practice in urban transport systems of relating the fares to the consumer's own inflation rather than input costs[1]. The fares for RRTS are thus revised biennially, indexed with Wholesale Price Index (WPI). The proposed formula for fare revision is placed below.

Revised Fare = Base Fare +[100% of Base Fare *% change of Consumer Price Index*(1-efficiency factor)]

Using the historical growth rate in WPI over last 8 years, fare is estimated to be rising at 6.5% over the projection period. Insertion of efficiency factor is optional and can be around 5%. The fare box revenue is calculated using fares applicable per passenger according to average trip length. Such fares are applied on the daily passenger traffic.

It is estimated that 60% of the daily commuters would be pass holders. It is expected that the number of pass holders would not be as high as in a metro situation since this is a regional service. Approx 25% concession on fare is taken for the pass holders[2]. Following table 4-13 is the estimated fare box collection.

Table 4-13: Estimated fare revenue

Particular	2017	2021	2031	2041	2046
Daily Passenger (In lakh)	7.37	9.12	12.55	15.10	16.27
Daily pass holders (In Lakh)	4.42	5.47	7.53	9.06	9.76
Daily revenue from Non Pass holders (Rs. Crore)	1.38	2.19	5.66	12.78	17.72
Daily revenue from Pass holders (Rs. Crore)	1.55	2.47	6.37	14.38	19.93
Daily fare box collection (Rs. Crore)	**2.93**	**4.66**	**12.03**	**27.17**	**37.65**
Annual fare box collection (Rs. Crore)	**995**	**1583**	**4090**	**9237**	**12801**

Source: Author's Estimation

Estimations for property development through Transit Oriented Development principles are discussed further.

[1] The Singapore MRT System indexes fares revisions to changes in Consumer Price Index and in Wage index in equal proportion. It also uses an indexation factor of 1.5%.
[2] The concession of 25% to pass holders is provided in Airport Express Link project (i.e New Delhi Railway station to Delhi Airport). Similar concession rate is adopted for analysis in RRTS project.

Revenue from property development

As discussed earlier, in order to promote Transit Oriented Development (TOD), development of property along the corridor or at nodes is envisaged by acquisition of land in advance. Such development contributes to a compact city and regional development. Commuters travel from homes to workplaces through an integrated transit system (mix of main and feeder transportation systems). It reduces the travel demand in other part of the city as the origin and destinations are located on the same transport corridor. It results into dense city/region/corridor which is a better proposition as far as urban planning is concerned.

TOD property would be developed and sold on the nodes/stations of the proposed RRTS. It would be a mix of office- retail and residential spaces. Following table shows proposed TOD on RRTS corridor which is proposed to be developed on different stations.

Table 4-14: Estimated TOD

Sr. No.	Station Location	BUA (Sq.mtr)		
		Commercial	Residential	Total
1	ISBT Kashmere Gate	28672	0	28672
2	New Delhi	0	0	0
3	Nizamuddin /ISBT Sarai KaleKhan	28672	0	28672
4	INA	28672	0	28672
5	Dhaulakuan	0	0	0
6	Mahipalpur	28672	0	28672
7	Cyber City	0	0	0
8	IFCCO Chowk	0	0	0
9	Rajiv Chowk	28672	0	28672
10	Manesar	142016	0	142016
11	Panchgaon	519008	0	519008
12	Dharuhera	293216	174496	467712
13	MBIR	179200	224000	403200
14	Rewari	672672	226688	899360
15	Bawal	134400	224000	358400

Sr. No.	Station Location	BUA (Sq.mtr)		
		Commercial	Residential	Total
16	BTK	204064	201600	405664
17	SNB	787360	883904	1671264
18	Khairthal	349216	0	349216
19	Alwar	169792	143808	313600
	Total	**3594304**	**2078496**	**5672800**
	Total (in Lakh)	**35.94**	**20.78**	**56.73**

Source: Estimation based on availability of land at different nodes and potential for development

It can be seen that the TOD is proposed mostly outside the NCR region. Around 29% of the total BUA is envisaged in SNB station followed by Rewari station (16%). Around 25% of the total BUA is jointly proposed at Panchgoa, Dharuhera and MBIR stations. Combined proportion of office and retail space in total TOD is 63% while rest is residential development.

It is understood from published sources that in 2011 combined demand for commercial and residential space in NCR was around 10 lakh sq.mtr while supply was around 6 lakh sq.mtr. The demand for 2012 is estimated to be higher than the previous year, though the actual demand would depend on the possible economic post recovery from a double dip global recession. Around 80% of the total NCR demand is anticipated from Gurgaon region alone. Considering the above the aggregate real estate demand in NCR and surrounding region for next 15-20 years can be estimated to be around 300-400 lakh sq. mtr. Owing to proposed DMIC, accessibility of Western ports and Industrial development, the Gurgaon demand is likely to spill over the proposed RRTS corridor.

Given that real estate markets are notoriously unpredictable and forecasting real estate demand is tricky, proposed TOD is estimated to be absorbed in over 20 years after operations on a conservative basis. Experience in other markets such as Navi Mumbai also support the experience of long gestation periods. Further, the proposed project line extends into areas where urban and industrial development is emerging. The real estate market demand thus will too be gradual and phased as one moves from Delhi side towards Alwar.

Thus on an average 2.8 lakh sq. mtrs of built up would available for sale in each year on an average, though actual absorption rates would vary across years. Considering the significant demand-supply gap in NCR and future scenario for development along this corridor, absorption of high volumes of property could be possible, though the phasing, annual abortion and exhaustion of all volumes as envisaged here would depend of a number of macroeconomic, regional and location related developments.

Phasing of construction and Lease of Built Up Area

It has been assumed that property absorption would be in the form of lease by developer since the properties could stand on Government land. However, given complexity arising from long gestation period for recovering capital investment through lease rentals, collection of upfront lease is proposed. Value of upfront lease is equivalent to present value of future lease rentals and hence is almost equivalent to sale values. Upfront lease would also be a preferred model if private sector developers are involved who would like to exit at some point after construction.

A lag of one year is estimated between constructions and leasing of BUA. Thus construction is also phased for 20 years. Maximum absorption occurs in the 6-12 year window after beginning of operations as industrial / urban development catches up with stations where maximum TOD is proposed. The general phasing for construction and lease is thus described below in the graph.

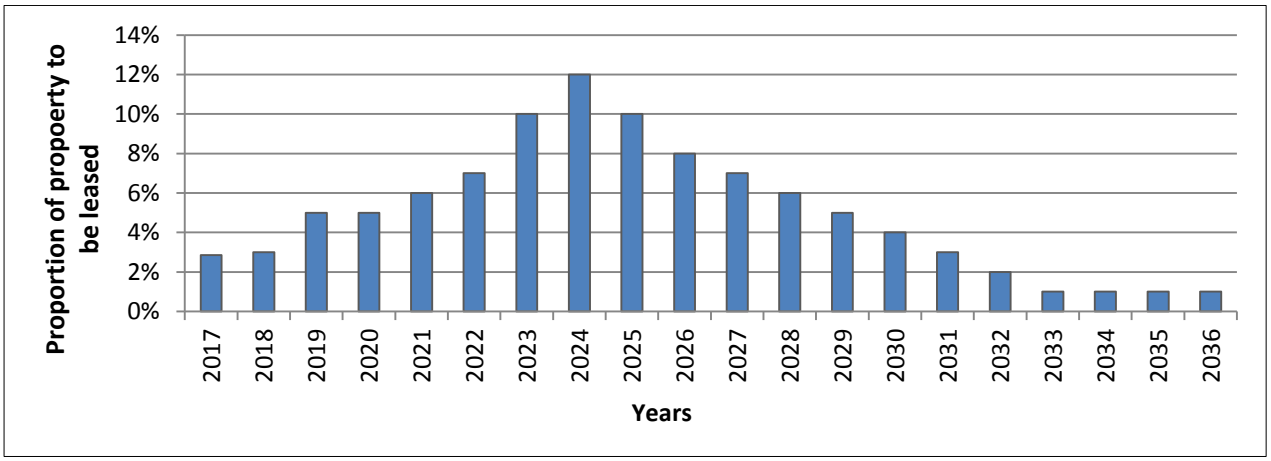


Figure 4-1: Phasing of construction and sale of BUA

Source: Author's Estimation

Construction cost

Properties at RRTS stations at Delhi and Gurgaon as well as Panchgao, Dharuhera and Alwar would be developed initially followed by MBIR and Rewari. Other stations can be developed in later stage within two years of development of above stations. The development would be cascading with spread over the years. Following is the construction cost estimated for TOD development.

Table 4-15: Estimated construction cost for TOD[3]

Construction of	Rs. Crore
Office and retail commercial space	7725
Residential space	4912
Total	**12637**

Source: Author's Estimation

Per units cost for commercial and residential development at 2011 prices is taken 11000/sq.mtr and 12000/ sq.mtr respectively. The cost is further escalated at 6% for future years. The average per unit construction cost for 20 years is calculated to be around Rs.22500/sq.mtr and Rs. 24500/sq. mtr for commercial and residential construction respectively.

Lease rates

As the TOD space is proposed to be leased out against upfront payment lease, it is equated with sale prices of property around the TOD stations. This is based on information available through published sources confirmed though verification with real estate professionals. Following are the estimated upfront lease rates for the TOD.

Table 4-16: Upfront Lease /Sale rates for TOD

Station Location	Upfront sale rates for 2011 (Rs./sq.mtr)	
	Commercial	Residential
ISBT Kashmere Gate	263620	0
New Delhi	263620	0
Nizamuddin /ISBT Sarai Kale Khan	263620	0
INA	263620	0

[3] Rates of Construction have been adopted based on discussion with developers.

Station Location	Upfront sale rates for 2011 (Rs./sq.mtr)	
	Commercial	Residential
Dhaulakuan	210896	0
Mahipalpur	210896	0
Cyber City	80700	0
IFCCO Chowk	80700	
Rajiv Chowk	80700	0
Manesar	72397	37385
Panchgaon	57917	29908
Dharuhera	50678	26170
MBIR	51402	26543
Rewari	54587	28188
Bawal	43438	22431
BTK	43438	22431
SNB	65157	33647
Khairthal	28959	14954
Alwar	36198	22431

Source: TOI Property Supplement, JLL Report, Magic Bricks.com, discussions and estimation as discussed.

The rates are considered to be increased by 10% pa. New Delhi and Gurgaon rates are used as guiding factor for sale rates at other TOD stations whenever published or reliable sources are not available. Rates for some locations are decided based on discussion with market players for suitable estimations.

The above rates are estimated to increase by 12% over the projection period in anticipation of the proposed development. Infact the prices along the DMRC corridor have already doubled. Following is the estimated net revenue from Property Development.

Table 4-17: Revenue from sale of Property

Particular (Rs. Crore)	2017	2021	2031	2036	
Commercial	844	2842	4594	2753	**82871**
Residential	229	758	1176	691	**21581**
Total	**1073**	**3600**	**5770**	**3444**	**104452**

Source: Author's Estimations

Revenue from Advertisement and Stall licensing

Revenue from advertisement is possible through display space at the stations and on the elevated corridor. Based on standard station design, available advertisement space at each RRTS station and along the corridor has been worked out as follows on an aggregate basis for all stations:

Table 4-18: Estimated Advertisement Space: Aggregate for all Stations

Sr. No	Types of advertisement	Units	Total for all stations
1	Hoardings at Platform Area	Sq.mtr	2380
2	Hoardings at Entry Area	Sq.mtr	684
3	Glow Cubes	*Nos.*	2624
4	Kiosks	*Nos.*	38
5	LED Displays	*Nos.*	76
6	Ad on Trains	Sq.mtr	6143
7	Ad on Tickets / Smart Cards	*Nos .Lakh Daily in 2017*	2.95
8	Hoardings at Parking lots	Sq.mtr	389
9	Ad on Lifts	Sq.mtr	291
10	Ad on Escalators	Nos.	38
11	Ad on the elevated corridor	Sq.mtr	26858

Source: Author's Estimations

Station wise Advertisement Space and Component wise Advertisement space is specified in Annexure 3. It can be seen that different stations differ only in terms of hoarding space.

Rates and occupancy levels for above space are based on prevailing market prices at nearest Delhi metro station and obtained through discussion with advertisement agencies holding rights to Delhi Metro spaces. The rates are escalated at 5% pa. An average 85% of the total advertisement space would be occupied throughout the projection period.

A second source of revenue is the licensing of stalls, phone booths and ATMs. Following is the aggregate commercial space for all RRTS stations based on estimated demand due to expected foot falls and station design.

Table 4-19: Aggregate commercial space at station premises

Types of Licenses	Total for all stations (Area in Sq. mtrs.)
Tea And Refreshment Stalls	2336
ATMs	920
Book Stalls	514.8
Juice Stalls	810
Milk And Milk Products Stall	570
Chemists	514.8
Phone Booth	270
Retail Kiosks	920
Parking *(No of lots)*	19

Source: Author's Estimations

It is estimated that appox. 90% of the total space would remain occupied during the projection period. The licenses would be given for one year to five years at prevailing rentals escalated at 5% pa over 30 years. Following is the proposed unit size and estimated rent for 2011 in Delhi for stall licenses.

Table 4-20: Unit size and estimated rental for stall licenses

Particulars	Size of the stalls (sq.mtr)	Rental Rs. / sq.mtr /month at Delhi (2011 prices)
Tea and Refreshment Stalls	40	750
ATMs	20	650
Book Stalls	40	750
Juice stalls	30	675
Milk and Milk products Stalls	30	675
Chemist Stalls	40	750
Phone Booths	10	600
Kiosks	20	625
Parking space (lump sum) Rs. Lakh (annual)		10

Source: Author's Estimations

Revenue from stall licensing within the station premises

Following is the summary of revenue from Advertisement and Licenses.

Table 4-21: Revenue from Advertisement and Licenses

	Particular	2017	2021	2031	2041	2046	Total	Share
A	**Advertisement Revenue**	*Rs. Crore*						
1	Hoarding at platform	3.68	13.65	24.44	36.15	41.91	**750.82**	23%
2	Hoardings at Entry Area	0.35	1.29	2.32	3.43	3.98	**71.22**	2%

	Particular	2017	2021	2031	2041	2046	Total	Share
3	Glow Cubes	0.24	0.88	1.58	2.33	2.71	**48.46**	2%
4	Kiosks	0.01	0.05	0.08	0.12	0.14	**2.52**	0%
5	LED Displays	0.00	0.01	0.01	0.01	0.02	**0.28**	0%
6	Advertisements on Trains	0.78	4.83	12.22	22.10	27.71	**404.44**	13%
7	Advertisement on tickets	6.09	9.81	24.80	44.85	56.23	**829.98**	26%
8	Hoardings at Parking lots	0.64	2.38	4.26	6.30	7.30	**130.85**	4%
9	Advertisement on lifts	0.36	1.33	2.39	3.53	4.10	**73.38**	2%
10	Advertisements on escalators	0.13	0.49	0.88	1.30	1.50	**26.92**	1%
11	Ad on the pillars of elevated corridor	4.25	15.80	28.28	41.84	48.50	**868.82**	27%
	Total	**16.52**	**50.52**	**101.25**	**161.98**	**194.09**	**3207.71**	**100%**
B	**License Income**							
1	Tea And Refreshment Stalls	1.15	2.71	4.86	7.19	8.33	**149.90**	25%
2	ATMs	0.36	1.07	1.91	2.83	3.28	**58.94**	10%
3	Book Stalls	0.15	0.47	0.83	1.23	1.43	**25.58**	4%
4	Juice Stalls	0.40	0.94	1.68	2.49	2.89	**51.97**	8%
5	Milk And Milk Products Stalls	0.28	0.66	1.19	1.75	2.03	**36.57**	6%
6	Chemists	0.20	0.60	1.07	1.58	1.84	**32.98**	5%
7	Phone Booths	0.13	0.31	0.56	0.83	0.96	**17.41**	3%
8	Retail Kiosks	0.36	0.95	1.70	2.52	2.92	**52.47**	9%
9	Parking Lots	2.53	3.32	5.94	8.79	10.19	**185.96**	30%
	Total	**5.57**	**11.03**	**19.74**	**29.21**	**33.87**	**611.79**	100%

Source: Author's Estimates

The estimated revenue for RRTS from various sources is summarized below;

Table 4-22: Summary of estimated revenue

Particular (Rs. in Crore)	2017	2021	2031	2041	2046
Fare Box	995	1583	4090	9237	12801
Advertisement	17	51	101	162	194
License Fees	6	11	20	29	34
Carbon Credit	99	133	185	0	0
Net Revenue From TOD	794	2792	5412	0	0
Total	**1911**	**4570**	**9807**	**9428**	**13029**

Source: Author's Estimations

It can be seen that overall fare box collection contributes around 61% of the total revenue while TOD/property income is considered after deducting construction and administration cost for property development. It is around 36% of the total revenue. However the pattern of revenue stream in entire operation period is shown below:

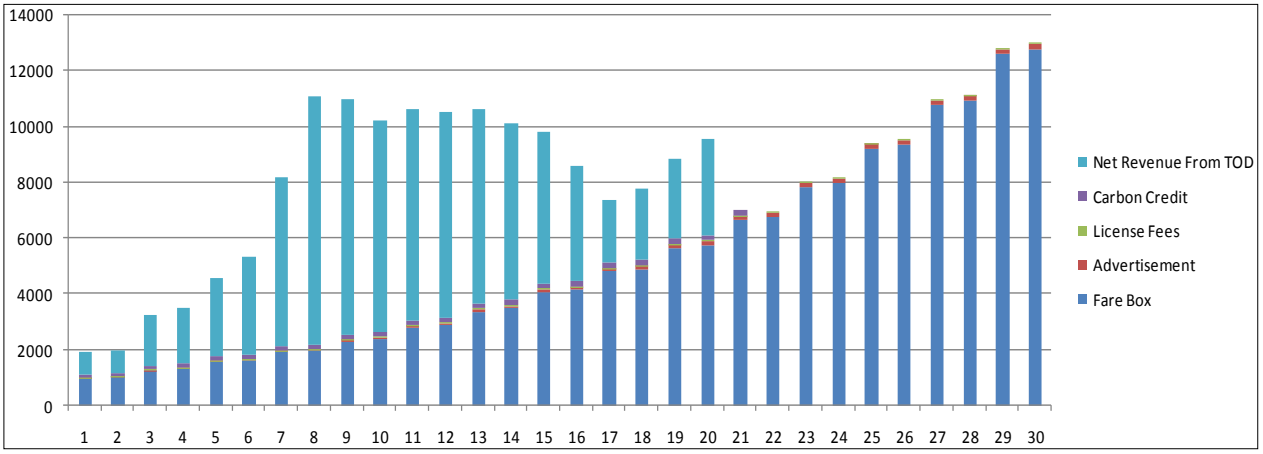


Figure 4-2: Pattern of revenue for RRTS

Revenue from property development is estimated to be the major source during middle years. Revenue from advertisement and licenses are envisaged to be trivial. The revenue from carbon credit is discussed in economic analysis in detail.

Other Assumptions

The assumptions related to taxation, depreciation and amortization prescribed as per Company's Act 1956 and Income Tax Act, 1961 are as follows;

Table 4-23: Depreciation and Tax related Assumptions

Depreciable components	Dep. Rates As per Income Tax Act	Dep. Rates As per Companies Act
E & M Works	60%	7.07%
Traction and Power		
Signaling and Telecom		
Rolling Stock (BG)		
Utilities		
Special noise & vibration reduction treatment equipments		
Alignment and Formation	10%	1.63%
Important Bridges		
Station Buildings		
Depot		

Depreciable components	Dep. Rates As per Income Tax Act	Dep. Rates As per Companies Act
Permanent Way		
CISF Barracks		
Amortization		
General Charges (Years)	5	
Income Tax Input		
Number of years for which 80IA benefit is available	10	
80 IA block of years	20	
Exemption Allowed u/s 80IA	100%	
MAT tax rate	19.35%	
Corporate Tax Rate	33.99%	
Cut off rate of Payable tax of the Book profit to introduce MAT	18.00%	

The corporate tax calculated in the financial model comprises of effects of Minimum Alternative Tax (MAT) as well as benefit available under IT Act. As per Income tax Act, u/s 80 IA, 100% income tax payable is exempted to infrastructure projects for a continuous period of 10 years during a block of 20 years. However during the exemption period, MAT is payable.

Based on the above estimations and inputs, a detailed financial model has been created to assess operational sustainability of RRTS and financial returns from the project in totality without considering the implementation model and agency. Operational Viability is discussed next.

4.6. Operational Viability of RRTS project

Operational Viability for the RRTS is described as follows:

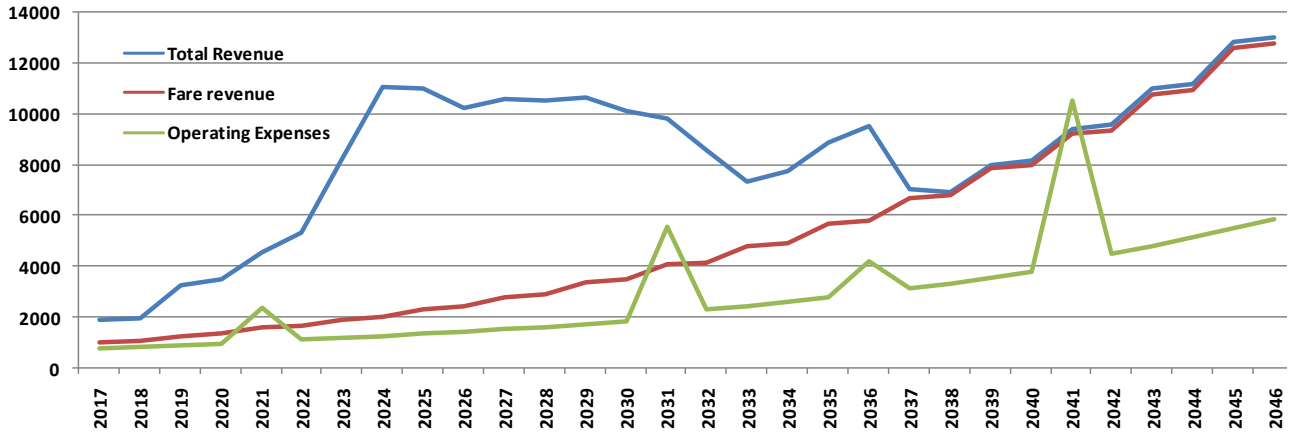


Figure 4-3: Operational viability of the project

It can be seen that the fare income is able to cover the operating expenses and the project is operationally viable even based on fare income alone. However fare revenues are not sufficient to allow recovery of investments in the project and debt service. For this purpose, property development is required.

Overall, the operating surplus is estimated to remain around more than 64% over the projection period. It is mainly due to Fare box revenues being supported handsomely by property development income. The fare revenue grows at 9% over 30 years (a combined effect of increase in fares and increase in traffic). Property revenues grow at 8% pa for 20 years. In comparison, there is a 7% pa growth on an average in O&M expenses over 30 years. The operating ratio decreases during periodic replacement of assets though.

4.7. Financial returns

The financial returns are calculated in terms of Internal Rate of Return (IRR) to assess the viability of the project. These returns are calculated without considering the financing options and implementation model which is done subsequently[4]. The projection of cash flow for the project is as follows:

[4] It is possible to calculate the IRR of an project cashflow without considering the financing options since interest costs are usually excluded from free cash flow in order to provide an opportunity to compare the returns with the cost of capital later.

Table 4-24: Projected cash flow for the Base Case

Particular	2012	2013	2014	2015	2016	2017	2021	2031	2041	2046
Rs. Crore										
Outflows										
Project Investments	2838	6016	9565	10139	3583					
O&M Costs						794	2376	5573	10558	5911
Taxes						0	0	1306	0	2392
Total Outflows (A)	**2838**	**6016**	**9565**	**10139**	**3583**	**794**	**2376**	**6879**	**10558**	**8303**
Inflows										
Revenue						1911	4570	9807	9428	13029
Total Inflows (B)	0	0	0	0	0	1911	4570	9807	9428	13029
Net Cashflow (B-A)	**(-) 2838**	**(-) 6016**	**(-) 9565**	**(-) 10139**	**(-) 3583**	**1117**	**2195**	**2928**	**(-) 1130**	**4726**
Project IRR	**10.55%**									

Source: Author's analysis

It is to be noted that if the project is developed by the Government SPV the Weighted Average Cost of Capital (WACC) would be around 5% due to access to soft loans from the multilaterals at low interest rates to the Government agencies. In this case the project is financially viable. However WACC in case of private sector could be as high as 12%-15% in which case the project becomes unviable. The above return can reduce nominally with inclusion of Interest During Construction (IDC) in the project cost.

Paucity of budgetary allocation and limited multilateral finance pose a big challenge to the government in terms of garnering the required resources for execution of such large scale project. However poor returns from mass transit projects keep the private away from participation. Under this situation project structuring becomes the crucial issue for successful implementation of the project. Various options for financing and project development have therefore been explored and are discussed further to arrive at suitable project financing and implementation structure.

4.8. Financing and Implementation models

Various Implementation models are analyzed for implementation of RRTS. The models are segregated in to three parts based on their respective nature as follows

1. Public Sector Models
2. Public Private Partnership (PPP) Models
3. Mix of public and private sector models (Revenue Share Model).

Involvement of public sector in project implementation would require equity contribution from Central and State Governments. Thus, various methods for interse allocation of equity among the State and Central Governments are explored before discussing the models themselves. The equity for this project would be shared only among the state Governments of Delhi, Haryana and Rajasthan and not Uttar Pradesh since the latter is not among the beneficiary for this project line.

It is estimated that MOUD, Ministry of Railways and NCPRB together would bring 50% of the total equity. Interse allocation between these Govt Departments would be decided by the Govt. of India. The State Governments of Delhi, Haryana and Rajasthan would bring rest 50% of the total equity.

Interse allocation of the equity among the above State Governments can be derived based on following alternative methods:

1. Allocation based on Length
2. Allocation based on Investment

Following table shows proposed equity participation of each state government based on length/investment of RRTS project

Table 4-25: Equity participation based on length

Particular	Length of the corridor (Km)	% of Total Investment as proportion of equity for 50% contribution
Govt. of Delhi	32	8.89%
Govt. of Haryana	78	21.7%
Govt. of Rajasthan	70	19.4%
	180	**50%**

Source: Author's analysis

The average cost of underground length of the project is estimated at Rs 306cr/km and that for the elevated portion at Rs.93 Cr. / km. Proportion of equity of each state government based on investment is thus as follows;

Table 4-26: Equity participation based on Investment

Particular	Adopted for proportion of equity for 50% contribution
Govt. of Delhi	19.5%
Govt. of Haryana	17.5%
Govt. of Rajasthan	13.0%
Total	**50%**

Source: Author's analysis

Between both the methods the equity allocation as per investment appears to be more balanced. For further analysis thus the allocation of equity as per investment based method is used, though it does not affect the project returns.

The alternative financing and implementation models are discussed further.

Public Sector Model

The urban rail rapid transit projects are recent developments in India. Kolkata Metro is the oldest urban rail project, which is run by Indian Railways. The Delhi Metro is the most successful example in the recent past. It is owned and operated by Delhi Metro Rail Corporation (DMRC), a SPV floated by GNCTD and GOI. Notably both the above projects are implemented and operated by Central and State Government agencies. The proposed Chennai and Bangalore Metro projects would be implemented based on DMRC model. Following is the funding pattern of Metro projects which are implemented and run by Public sector SPVs.

Table 4-27: Metro rail projects in India run by Public Sector agencies

Project	Length (Km)	Status	Total Project Cost *Rs. Crore*	Govt. Equity	Multilateral Debt	Other Sources
Kolkata Metro (N-S Corridor)	16.5	Operational	NA			
Kolkata Metro (Extension of N-S corridor)	8.7	Operational	NA	100%	Nil	Nil

Project	Length (Km)	Status	Total Project Cost *Rs. Crore*	Govt. Equity	Multilateral Debt	Other Sources
Kolkata Metro (E-W corridor)	13.74	Under Implementation	4676	55%	45% (JICA-ODA)	Nil
Delhi Metro (Phase 1)	65.1	Operational	NA	30%	60% (JICA-ODA)	10% Sub debt by GOI
Delhi Metro (Phase 2)	82.11	Operational		44% (Equity capital, Internal Accruals, Property Development)	46% (JICA-ODA)	10% Sub debt by GOI
Chennai Metro	45	Under Implementation	14600	30% (15% GOI and GOTN each	59% (JICA-ODA)	11% Sub debt by GOI and GOTN
Bangalore Metro	41.7	Under Implementation	8156	30% (15% GOI and GOKN each	45% (JICA-ODA)	25% Sub debt by GOI and GOKN

Source: DMRC DPR, other published sources
NA: Not Available

Public Sector Model under this report would imply implementation by SPVs owned by Central and State Governments. The SPV would develop, operate and maintain the RRTS project. It would also construct and sale the commercial residential properties at RRTS stations as discussed in TOD. The base project cost of Rs. 24600 crore would be escalated upto Rs. 32664 crore including the IDC.

Funding under this model is normally availed at concessional rates from the multilateral agencies. Maximum funding by Multilaterals (Mainly JICA) in other urban rail projects by Govt. entities has been observed at 60%. Considering the situation for this project, a situation can arise where debt is not available beyond 50% of project cost so as taken upto 45%. Equity contribution would remain 30%. Balance of the fund could be mobilized through 1) Creation of Mass Rapid Transit Fund (MRTF) and 2) Issue of tax free bonds 3) Cess on Stamp duty in TOD area 4) Interest free

subordinate debt from State and Central Governments towards tax on project goods and cost of land. Following are the means of finance under this model.

Table 4-28: Means of finance for public sector model

Sr. No.	Means of Finance	Contribution	Rs. Crore
1	**Equity Contribution**	**30%**	**9799**
	Contribution of from GOI (MOUD, MOR and NCPRB)	*50%*	*4900*
	GNCT –Delhi	*19.5%*	*1911*
	Govt. of Haryana	*17.5%*	*1715*
	Govt. of Rajasthan	*13.0%*	*1274*
2	**Contribution from MRTF**	**5%**	**1633**
3	**Contribution from Cess on Stamp duty in TOD area**	**2%**	**728**
4	**Tax free bonds**	**5%**	**1633**
	Interest rate	8%	
	Bullet Repayment period (years)	5	
5	**Senior Debt**	**45%**	**14678**
	Term loan from Multi Laterals		
	Interest Rate pa	1.90%	
	Repayment Tenure (years)	30	
	Grace Period (years)	5	
	Effective Period (Years)	35	
6	**Subordinate Debt (Interest Free Loan) from Central Govt. for tax on project goods**	**8%**	**2611**
	Repayment Tenure (without grace period) (years)	10	
7	**Subordinate Debt (Interest Free Loan) from Central Govt. for cost of land acquired for the project**	**5%**	**1581**
	Repayment Tenure (without grace period) (years)	10	
	Total		**32664**

Source: Author's analysis

The interse allocation of the remaining 50% equity among the States is taken as discussed in the previous section.

Debt is proposed to be availed from multilaterals like JICA at a concessional rate of interest of 1.9%. The Interest Rate for multilateral is assumed to be a little higher than the standard 1.5% pa to account for Guarantee commissions and other costs charged by Central/State Governments. The proposed RRTS seems capable of

sustaining this level of debt. The minimum DSCR works out to be 3.50. The average DSCR is 8.75. The hedging costs for the debt may work out to be in the range of 3-4% for yen dominated debt and are assumed to be borne by the Government.

The modalities of the proposed Mass Rapid Transit Fund, cess on stamp duty in TOD area and Tax free bonds are discussed further.

Mass Rapid Transit Fund (MRTF)

The proposed fund would be a revolving fund, dedicated to development and sustenance of Urban Mass Transit Systems in NCR and concerned States. The corpus of the fund can be collected from the following sources.

Table 4-29: Likely Sources for proposed MRTF

Sr. No.	Resources	Remarks
1	Cess on VAT	Applicable to entire state as the proposed RRTS would benefit entire state economy. As per estimations approx annual VAT collection of Delhi State was Rs. 11000 crore in 2009-10. While Rajasthan and Haryana have collected around Rs. 10000 crore and Rs. 9000 crore for the same period. The collection is estimated to grow at average 7% over next 30 years. By levying 0.5% cess on VAT, average Rs. 700 crore pa can be accumulated from the proposed fund.
2	Cess on Property Tax	Applicable to ULBs on RRTS corridor. Given the size and diversity, it is difficult to estimate the property tax. Implementation would be difficult due to opposition from fund starved small ULBs.
3	Cess on Building Use Permission	Applicable to the towns from which proposed project would pass. Difficulty of level for implementation would be same as Cess on property tax.
4	Sale of extra FSI	This is already captured in the development property under TOD and hence not considered here.
5	Cess on fuel /vehicle registration	Difficult to implement as the project area passes through jurisdictions of several states/cities. Not everyone in the affected states would be equally benefited from the project, and imposition in part of the state would be difficult to implement. It may be mentioned that GoKn has notified a law that allows collection of Rs 2 per litre on fuel purchased within Bangalore City.

Source: Author's estimations

Around 5% of the total project cost is proposed to be contributed from the above fund. The fund can be utilized for sustainability of the project operations.

Cess from Transactions

As discussed earlier, resource generation could be possible from other sources through application of statutory levies or cess. This cess could be levied upon those who are benefiting indirectly from the project. One such category of stakeholders is owners of property situated in the proximity to stations. These owners would benefit in terms of rise in prices of their property due to the project facility emerging in proximity. A financing mechanism for capturing part of this value arising to property owners could be structured as follows:

- Area approximating 1 sq km in radius around each station could be earmarked as the Delineated Area (DA). Property owners whose properties are situated in the DA would need to pay a cess on every transaction in addition to stamp duty and other statutory levies. Cess could be applied on transactions of both Built Up Area (BUA) and open area /plots situated in the DA. For this purpose cess of Rs 750/ sq mt for open area/plots and Rs 500/- per sq mt for BUA has been taken. Calculations are made only for BUA as transactions in land are difficult to estimate.
- A higher Floor Area Ratio (FAR) could be permitted in the Delineated Areas around stations situated away from urbanised areas based on concurrence of State Governments. Higher FAR of upto 3 could be permitted for this purpose. (Higher FAR may not be possible in stations situated in high density areas in and nearer New Delhi, except for specific TOD complexes constructed on the station box).

  Based on the above, estimates of income through the proposed TOD Cess on Transactions are calculated using the following inputs and assumptions:

Table 4-30: Estimation for delineated area for cess on transactions

No. of Stations	19
Radius (km)	1
Delineated Area near each station (sq km)	3.14
Delineated Area near each station (sq m)	3140000
Total del. area for all stations (sq. km)	60
Total del. area for all stations (hac.)	5966
Land Area already developed	30%
Land Area yet to be developed outside of urbanised areas	30%
Land Area already developed	1790
Land Area yet to be developed (hac)	1790
Remove 50% for green area/roads/common area (hac)	895
Net area for built up (hac)	895
Average FSI that will be consumed in DA outside urbanised areas	3
Total BUA (hac) - (A)	2685
Existing Developed land area (hac)	1790
Remove 65% for green areas, roads, common areas (hac)	1163
Net developed Land Area (hac)	626
Average FSI consumed	1.5
Total BUA (hac) - (F)	940

Source: Author's estimations

Following is the proposed rate for cess on transactions

Table 4-31: Proposed rate for Cess on Transactions

Rate for Cess on Transaction	(Rs/Sq mt)
Land Transaction	750
Property Transaction	500

Source: Author's estimations

Another key input to the calculations is the velocity of transactions (expressed as percent of total BUA in the Delineated Zone) whose ownership changes hands. The velocity is highest around the time the project is completed and then slows down to stabilise at a level of around 5% as shown below.

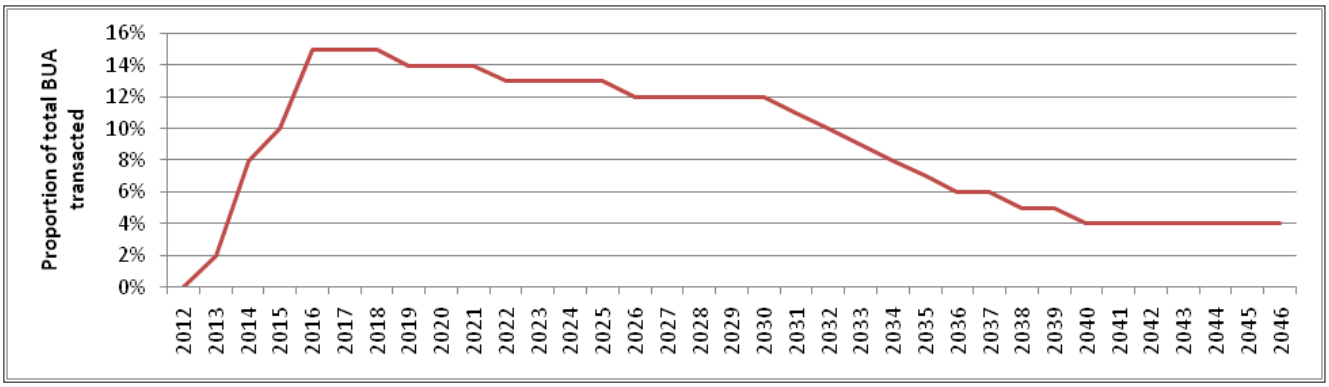


Figure 4-4: Velocity of transaction

Source: Author's estimations

It may be kept in mind that income will start during the construction years itself as soon as the transaction cess is levied. Using the above assumptions, the following income is estimated from TOD Cess.

Table 4-32: Calculation of Cess on transaction

Year	Cess Calculation for Area yet to be developed				Cess Calculation for Developed Area			
	Velocity of Transaction	Total BUA (hac)	BUA under transaction	Cess (Rs Crore)	Total BUA (hac)	BUA under transaction	Cess (Rs Crore)	Total Cess
	A	B	C = (A x B)	C x Rate	F	G = A x F	G x Rate	
2012	0%	2685	0	0	940	0	0	**0**
2013	2%	2685	54	27	940	19	9	**36**
2014	8%	2685	215	107	940	75	38	**145**
2015	10%	2685	268	134	940	94	47	**181**
2016	15%	2685	403	201	940	141	70	**272**
2017	15%	2685	403	201	940	141	70	**272**
2018	15%	2685	403	201	940	141	70	**272**
2019	14%	2685	376	188	940	132	66	**254**
2020	14%	2685	376	188	940	132	66	**254**
2021	14%	2685	376	188	940	132	66	**254**
2022	13%	2685	349	175	940	122	61	**236**
2023	13%	2685	349	175	940	122	61	**236**
2024	13%	2685	349	175	940	122	61	**236**
2025	13%	2685	349	175	940	122	61	**236**
2026	12%	2685	322	161	940	113	56	**217**
2027	12%	2685	322	161	940	113	56	**217**
2028	12%	2685	322	161	940	113	56	**217**

Year	Cess Calculation for Area yet to be developed				Cess Calculation for Developed Area			
	Velocity of Transaction	Total BUA (hac)	BUA under transaction	Cess (Rs Crore)	Total BUA (hac)	BUA under transaction	Cess (Rs Crore)	Total Cess
2029	12%	2685	322	161	940	113	56	**217**
2030	12%	2685	322	161	940	113	56	**217**
2031	11%	2685	295	148	940	103	52	**199**
2032	10%	2685	268	134	940	94	47	**181**
2033	9%	2685	242	121	940	85	42	**163**
2034	8%	2685	215	107	940	75	38	**145**
2035	7%	2685	188	94	940	66	33	**127**
2036	6%	2685	161	81	940	56	28	**109**
2037	6%	2685	161	81	940	56	28	**109**
2038	5%	2685	134	67	940	47	23	**91**
2039	5%	2685	134	67	940	47	23	**91**
2040	4%	2685	107	54	940	38	19	**72**
2041	4%	2685	107	54	940	38	19	**72**
2042	4%	2685	107	54	940	38	19	**72**
2043	4%	2685	107	54	940	38	19	**72**
2044	4%	2685	107	54	940	38	19	**72**
2045	4%	2685	107	54	940	38	19	**72**
2046	4%	2685	107	54	940	38	19	**72**

Source: Author's estimations

As can be seen, the total income from cess during construction years (2012-16) is Rs. 634 crore which can be used in the equity of the project. Further income during operations period (2017-2046) can flow to the project entity. **This income is considered to be accruing only to the Government project entity and not to any private sector partner and hence it has been considered only in the case of Public Sector Model and the Mixed Public and Private Sector Model and not in the case of PPP based implementation models.**

It must be mentioned that the above mechanism has the following limitations:

- Mechanisms will have to be worked out for cess collection and then transfer of this to the project entity. It is likely that collecting agency is revenue or local authority who are used to traditional manner of working. Hence integrating with them could be a challenge.

- Properties falling in the Delineated Area would have to be clearly identified and this information will have to be communicated to the Revenue or local authorities who would be collecting the cess. This could be cumbersome as this will require physical surveys to identify exact parcels which fall in the DA and outside.

In areas where property prices are low, the cess amount could represent up-to 3% of the property value. Paying this over and above the stamp duty and other levies could represent a very high cost for the property owners and therefore could dampen the property prices. However this is mitigated by the observation that property prices have tended to rise manifold in areas where such high quality public transit is introduced and this may well compensate the owners.

Tax free Bonds

In 2010, the GoI introduced a new section 80CCF in the Income Tax Act, 1961 to provide for tax deductions for subscribers to long-term infrastructure bonds and pursuant to that the Central Board of Direct Taxes passed Notification No. 48/2010/F.No.149/84/2010-SO(TPL) dated July 9, 2010. These long term infrastructure bonds offer an additional window of tax deduction of investments up to Rs. 20,000. This deduction is over and above the 1 lakh deduction available u/s 80C, 80CCC and 80CCD read with section 80CCE of the Income Tax Act. Infrastructure bonds help in intermediating the retail investor's savings into infrastructure sector directly. Such issuance provides a window to infrastructure projects for accessing cheaper funding as the interest rate (coupon) on these bonds could be fixed at a rate which is somewhat lower than the market rate for bonds of equal maturity.

In the RRTS project, the proposed public sector SPV can issue Bonds with above Tax Benefits to part finance the project cost. It would at current market rates for debt have to offer around 8% pa as the return to bond holders. It is envisaged that around 6% of the total project cost can be raised in this manner. Maturity period of bond could be 5 years and interest rate could be around 8%. The bonds would be repaid at one go (bullet) in the 5^{th} year as the financial model shows that the project would have sufficient cash for repayment by that time.

Finally the subordinate debts are actually deferred payments to the Central and State Governments. Such debts are payable in first 10 years of operations.

Financial Returns

The Project IRR under this model is calculated to be 11.22%. As against this the WACC is 4.85% due to access to low cost funds. This means the project is financially viable under this model. The minimum DSCR of 3.50 and average DSCR of 8.75 also represents the adequate debt service capacity of the project.

Implementation models on Public Private Partnership basis are discussed further.

Public Private Partnership Models

As the experience of private participation in Infrastructure sectors like roads, ports, power generation etc. has been evolved and matured, it is replicated in urban infrastructure and transportation. As a result many upcoming metro projects are being implemented on PPP basis. Delhi Metro Airport Express link, Hyderabad Metro and Mumbai Metro are the fresh examples. However, structures of these PPP projects are different as showcased below:

Table 4-33: Metro rail projects in India implemented in PPP format

Projects	Concessionaire	Project cost *Rs. Crore*	VGF	Revenue Share (pa)	Means of Finance *Equity*	*Debt*
Delhi Metro Airport Express Link *(Revenue Share Model)*	JV of Reliance Infrastructure Limited of India and Construcciones y Auxiliar De Ferrocarriles (CAF) of Spain	Total Project Cost = Rs. 5700 crore. Cost for the concessionaire: Rs. 2800 Crore[5]	Nil	Approx Rs. 51 Crore pa and 1% to 5% share in gross revenue[6]	30%	70%[7] 17.25 years Term loan by consortium of 8 banks lead by Axis bank

[5] *DMRC Website*
[6] *World Bank PPI update note 39. September 2010*
[7] *World Bank PPI update note 39. September 2010*

Projects	Concessionaire	Project cost *Rs. Crore*	VGF	Revenue Share (pa)	Means of Finance *Equity*	*Debt*
Hyderabad[8] Metro *(VGF Model)*	L&T Metro Rail (Hyderabad) Ltd.	16378	1458 (9% Total Project Cost)	Nil	21% (Rs. 3440 Crore)	70% (Rs. 11480 Crore)
Mumbai Metro - VAG Corridor *(VGF Model)*	Mumbai Metro One Pvt. Ltd. – Joint Venture of Reliance Energy Ltd and Veolia Transport of France	2356	650 (28% of the Total Project Cost)	Nil	22% (Rs.513 Crore)	50% (Rs. 1194 Crore)

Source: DMRC published information, World Bank data base, and Press release by concessionaires

As can be seen from the above, mainly two types of PPP models are implemented in rail based rapid transit systems in India. One is the Revenue Share model and the other is the VGF Model. In case of the Airport Express Line, concessionaire of this Delhi Airport Metro link project is responsible for all investments except civil works. The civil works have been carried out by DMRC. Thus the concessionaire is able to share revenue as the project investment is low.

In other cases VGF is required to make the project viable. The VGF share has ranged from 9% to 28%. The share of non fare revenue is expected to be fairly significant by the Concessionaire in case of the Hyderabad Metro.

Both Mumbai and Hyderabad projects are remarkable in the sense that they have been able to obtain debt on commercial terms for public transport projects which were hitherto considered non viable, even with some VGF. However, the debt servicing in the Hyderabad Metro is crucially dependent on the non fare income from property, and thus exposes the financiers to the risks of the property development business. Property development is notorious for its unpredictability and fluctuations, and the Reserve Bank of India has often limited Banks from taking exposure to this sector beyond a point through regulatory interventions. Thus, under the circumstances, the experience of Hyderabad Metro remains to be seen.

[8] *Press release by L&T Metro Rail (Hyderabad) Limited on April 05,2011*

The financing for RRTS poses even greater challenges than the above project due to the size of the project cost. Further the quantum of property development involved is large, giving rise to huge uncertainties and risk. Thus newer models for implementation are required. Newer models may assist to reduce some risks through better allocation, though it cannot eliminate or even significantly reduce the risks.

Private Sector Models imply PPP models where full or partial projects are implemented by the private sector and the capital and operation expenditure is recovered either through rights to revenue streams or through annuity payments by the Government.

Possibilities of Private Sector Participation in the project are thus explored and the following PPP models are evaluated.

Table 4-34: Proposed PPP Models for the Project

Sr. No.	Format	Structure
1	VGF Model	Entire project cost to be borne by the private player. Land is acquired by the Government at its own cost (as proposed in Base Case), but rights are granted for Property Development/TOD to the concessionaire on this land. The concessionaire would ask for VGF in this case which would be the bidding variable. The overall share of VGF in the project cost would be capped at 40% as per Government policy in this regard which stipulates 20% funding by Govt. of India and 20% more from State Government / Sponsoring agency.
2	Annuity Model	An SPV would be formed for the project implementation by the Government. The private player would however bear the entire project cost. The revenue would be collected by the SPV. The concessionaire would ask for fixed annuity amount to be paid in equal annual installments over the entire concession period. The annuity amount would be the bidding variable.
3	Grant During Operation	The private player would bear 100% of project cost and collect the revenue as well. The Government would provide an equal amount of revenue shortfall grant every year for the entire concession period to maintain favorable returns of the concessionaire. The grant quoted per year would be the bidding variable.

Sr. No.	Format	Structure
4	Property Development by Private Sector	This model is a variation of the public sector model. Under this model, all activities other than property development continue to be undertaken by the Public Sector SPV. Since the real estate development would not be an area of expertise for the SPV (in base case scenario), the property development business can be concessioned to a private player. The private player would in return for these rights, pay upfront premium in installments during the initial years of operations. Total upfront premium (over a period) could be the bidding variable.

Source: Author's Analysis

The magnitude of the project cost and construction of huge amount of property are key challenges to private sector under various PPP formats. The private developer has to develop BUA of 56.73 Lakh Sq.mtr. The development of real estate is separate nature of business with it's own risk factors. The absence of expertise could jeopardize the revenue stream from the property development and further the financial viability of the project.

Multilateral assistance is not available for PPP projects. Thus the cost of debt would rise to 14%[9] (SBI PLR). Thus the project cost, owing to significant amount of Interest during Construction, would increase upto Rs. 36400 crore. It increases the risk of financial closure.

Each of the above option for PPP was analyzed and assessed. The outcome is presented below in tabular form.

Table 4-35: Assessment of PPP modes of Project Implementation Formats

Sr. No.	Formats	Assessment
1	VGF	• The Concessionaire would bear almost the entire project cost. However the land required for the project cost broadly at Rs. 2012 crore would be acquired by the Government and handed over to PPP partner for project and for TOD.

[9] *SBI PLR rate as on 13/08/2011 was 14.25%*

Sr. No.	Formats	Assessment
		• The Weighted Average Cost of Capital (WACC)[10] is 14%. • VGF level at 40% of Project Cost • PIRR is 15% and EIRR is 19%. Minimum DSCR is 0.87 Thus the project is barely viable under this model, given a difference of only 1% between cost of capital and PIRR. However it gives lower return than the cost of equity (20%). Also the project would not be able to service the debt. The returns would not attract the private sector. Also the private sector needs to be convinced of the high revenue potential from property development. However, the cap on VGF is 40% and hence the project fits within this policy.
2	Annuity	• The Concessionaire would bear 100% of the project cost • The annuity amount payable to the concessionaire by the Govt. would out to be around Rs.11000 crore pa to maintain Concessionaire PIRR of 18% while average annual revenue of the SPV is Rs. 8400 crore. • Annuity format in this case creates a profound long term liability on the Cash flow of the Government. • The Public sector SPV would end up paying Rs. 330000 crore as annuity amount over a period of 30 years against aggregate revenue of Rs. 25000 crore earned during the same period. Thus the SPV would require to pay an additional amount of Rs. 78000 crore over a period of 30 years. Therefore annuity would appear as an expensive option. Also the traffic risk is not passed on to the private sector.
3	Grant During Operation	• Entire project cost would be borne by the concessionaire. He would retain the project and property development revenue

[10] *WACC = (Sr.Debt (58%) * Cost of Debt (14%) + Subdebt (12%)*Cost of Debt (0%) +Equity (30%) * Cost of Equity (20%)*

Cost of equity is considered based on dividend paid by Listed companies over last few years.

Sr. No.	Formats	Assessment
		• The concessionaire would further ask for equal grant to be paid every year over the concession period of 30 years. The grant during operations works out to be Rs. 5300 crore annually to sustain the viability of the project for the concessionaire. This aggregates to 1.6 lakh crore over the concession period. Thus this works out to be an expensive option.
4	Property Development by Private Sector	• The concessionaire(s) would construct, market, lease and maintain the property. He would also retain the income from property. • The construction and lease rates as well as phasing are estimated to be the same as in the Base Case. • The concessionaire(s) would pay premium to the Public Sector SPV. 30% of the premium amount would be paid during the construction period (In 2016) while remaining part would be paid in seven equal installments during operation period. • The concessionaire(s) can pay Rs. 26000 crore as premium amount from property development over a period of 8 years between 2016-2023. In present value terms, this means that almost the entire project cost can be recovered through premium. • The key uncertainly and difficulty in this model is finding one or more private developers who are willing to purchase the rights to property development by payment of upfront premium. The actual premium that may be available might be lower since the private sector assumes the higher risk of delay in main project and also assumes the risk for off take of property. Also it may be difficult to identify all the land for property development for the Government in the beginning. Overall, it may not yield expected values as the property developers may see it as a huge unbundled risk.

Source: Author's Analysis

Mix of public and private sector model (Revenue Share Model):

We have earlier conceptualized and discussed pure public sector model for financing and implementation. We have also seen several options for PPP models. Finally a combination of public sector model and PPP model can be conceptualized through what could be termed as the Revenue Share Model. This model is somewhat akin to the implementation model for the Airport Express line of the Delhi Metro.

According to this model, the public sector SPV engages in land acquisition, civil construction, alignment and formation, R&R and some related items. This is financed through equity from Governments, MRT Fund, infrastructure Bonds, and multilateral (JICA) funding. The income from Cess on Transactions is also retained by the SPV.

A private sector Technology and Operations Company (Tech Ops) is retained by the SPV through competitive bidding. The Tech Ops Company is responsible for financing and construction of critical P-Way, all electrical, mechanical works, traction, power and rolling stock. The Tech Ops also operates and maintains the system besides collecting revenue such as fare, advertisement, license fee and TOD. Some part of the revenue is shared by the operator with the SPV which becomes the bidding criteria for selection of the operator company. The figure shown below illustrates this arrangement.

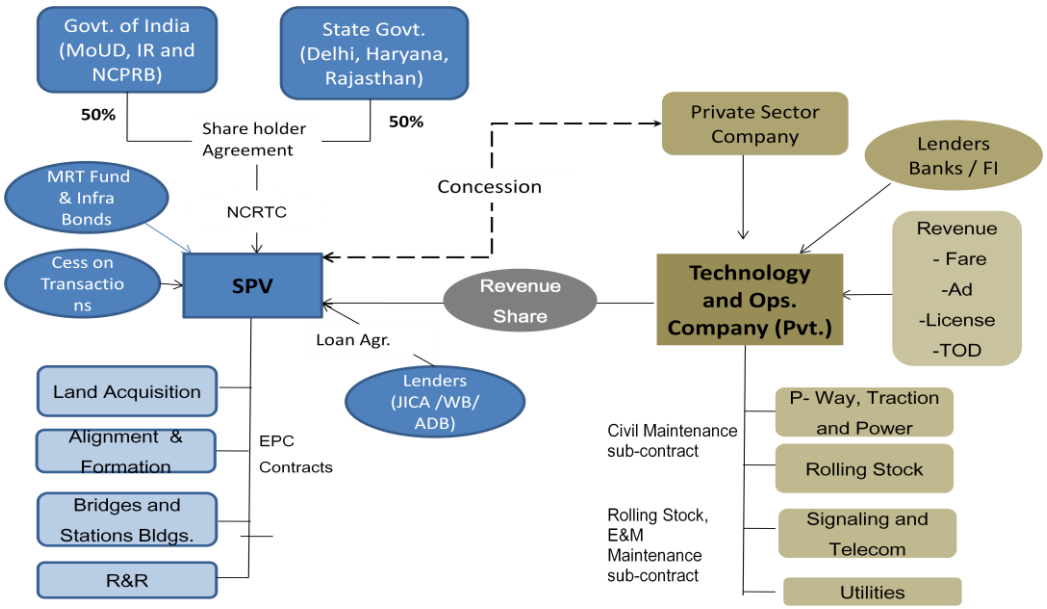


Figure 4-5: Structure of Revenue Share Model

Source: Author's Analysis

Accordingly the total project cost burden to the SPV and Tech Ops works out as follows:

Table 4-36: Project Cost for each Participant in the Revenue Share Model

Item	SPV	Tech Ops	Total
Govt Land	1317	0	1317
Pvt. Land	159	0	159
Alignment and Formation	10730	0	10730
Important Bridges	30	0	30
Station Buildings	1989	0	1989
E & M Works	0	659	659
Depot	0	200	200
Permanent Way	0	1245	1245
Traction and Power	0	846	846
Signalling and Telecom	0	1946	1946
Rolling Stock (BG)	0	3590	3590
Utilities	0	227	227
R&R	200	0	200
CISF Barracks	40	0	40
Special noise & vibration reduction treatment	0	50	50
General Charges including Design Charges	390	263	653
Contingencies	446	271	716
Total	15299	9297	**24596**
Share	62%	38%	100%

Source: Author's Analysis

The above arrangement gives the public sector the advantage of keeping the multilateral funding limited and keeping its cost of funding low. The TechOps will however be able to finance its share of the capital cost from equity and debt available on commercial terms. The overall funding pattern for the escalated project cost under this model would look like the following:

Table 4-37: Means of Finance for the Project under Revenue Share Model

Means of Finance	Contribution (%)	Project Cost (Rs. Crore)
SPV (Public Sector)		
Contribution of from GOI (MOUD, MOR and NCPRB)	15%	2989
GNCT -Delhi	6%	1166

Means of Finance	Contribution (%)	Project Cost (Rs. Crore)
Govt. of Haryana	5%	1046
Govt. of Rajasthan	4%	777
Cess on Property Transaction	4%	728
MRTF	5%	996
Bonds	5%	996
Soft loan	41%	8088
Sub Debt from Central and State Government for Tax	8%	1559
Sub Debt from State Government for Land	8%	1581
Total of above	**100%**	**19927**
Tech Ops Company (Private Sector)		
Equity Contribution	50%	6107
Senior Debt	41%	5055
Central and State Government for Tax	9%	1052
Total of above	**100%**	**12214**
Aggregate Total		**32141**

Source: Author's Analysis

Calculations show that the SPV is able to service its debt through receipts from Cess on Transactions and the Revenue Share it receives from TechOps. The Tech Ops is benefited through revenue from all sources including property development / TOD and hence is able to make a reasonable Equity IRR of 21% even after sharing a competitive 10% of the revenue.

4.9. Conclusion

On an escalated project cost of Rs. 32141 crore, the financial analysis for Alwar RRTS shows that the project is able to return an IRR of around 10%. This IRR is generic without considering financing options though such options are introduced subsequently in the chapter and discussed in detail.

The sources of revenue for the project are fares, advertisement and license incomes, and income from the proposed property development along stations (Transit Oriented Development). While the fares revenues are able to cover just the operational cost, higher project returns are possible due to income from property development. Income from property development is notoriously fickle and hence in order to keep the property development income conservative, a development

period of 20 years for the TOD has been taken. This is in line with the fact that the project line runs into areas where industrial and urban development is only emerging and thus the demand for property will correspondingly have long gestation period.

Financing and implementation models are analyzed in this chapter next. Public Transit systems and particularly rail based systems are characterized by capital intensiveness and long gestation periods. This makes recovery of investment at a viable rate difficult, although the benefits to the economy and society are immense. Such systems generate externalities, which are not captured in the cash flow. (An attempt to capture both the costs and the benefits to the economy in the section on economic analysis next).

However subsidizing the capital and often even the operating costs is common for such systems around the World. Even Hong kong metro (MTR) which is considered to be a successful model for leverging through property development (37% income is from non fare sources) saw around 80% investment from the Government for the first three lines and around 66% for the next two lines.

However, the resource constraints with the exchequer and competing demand from other projects require that alternative funding models and mechanisms be examined. There is further a need to explore how the role of the private sector can be structured into the implementation so that private sector investment capacity, risk appetite and technology capability can be synergised with public sector to achieve project goals.

Keeping both the above in mind, innovative funding mechanism in terms of cess on property transactions has been discussed. The possible revenue through this mechanism has also been calculated and incorporated in some of the financing options discussed here. Further, several alternative financing models have been discussed here such as (i) public sector model (ii) PPP model and (iii) mix of public sector and private sector model.

The Public Sector Funding model primarily looks at the project as being implemented by the Public Sector SPV promoted by the Government of India and the State Governments. This model has the advantage of being able to attract cheap multilateral debt besides keeping public interest paramount. This model fixes the project cost at Rs.32664 crore after including both escalation and interest during Construction. The project IRR thus drops marginally to 10%. The chief disadvantage of this model is the difficulty associated with a Government SPV in playing the role of property developer. Property is one of key revenue streams and thus any delay or inefficiency in property development for TOD would result in lowering of returns. Thus this option has the prime disadvantage of exposing a public sector organisation to the (property market's) demand risk and which perhaps a public sector SPV may not be in the best position to negotiate. The analysis then looks at a few PPP models.

The final model discussed is the Revenue Share model. (Please see the section just before the conclusion). According to this model, the public sector SPV engages in land acquisition, civil construction, alignment and formation and some related items. A private sector operator is retained by the SPV which then is responsible for financing and construction of P-Way, all electrical, mechanical works, traction, power and rolling stock. The operator also operates and maintains the system besides collecting revenue. Some part of the revenue is shared by the operator with the SPV. This final model allows a balanced role for both the public and private sectors whereby the risk and returns seem to be allocated more judiciously in terms of their ability to bear. The model seems to have the following benefits:

i. It loads all technology related functions onto the private sector which is often more competent in this regard and hence could use its technological expertise in building and operating a modern system.
ii. It loads the revenue risk onto the private sector, in particular the demand risk from property development while allowing the SPV to share some of the revenue.
iii. It retains certain risks with the public sector such as Land Acquisition and R&R which are tasks best performed by the public sector.

iv. It allows the public sector to borrow cheap funds from a multilateral and hence this benefit is not lost for the project.

The limitation of the model seems to be its crucial dependence on the Cess on Transactions to get implemented since the SPV needs this source of funds in order to be able to repay the multilateral debt. On the upside, the cess on Transactions also raises the possibility of windfall profits to the SPV if the velocity of transactions rises higher than estimated.

The PPP models either appear unattractive for the private sector (VGF model) or are too expensive for the Government (Grant during Ops and Annuity models) or load a huge risk on the private sector making it unattractive for them and thus ability to get revenue from them uncertain (Property Development by Private Sector) Overall, the Revenue Share model and the Public Sector model both seem relatively better suited for implementation compared to others, though the Revenue Share model relies critically on the success of the Cess on Transactions and of the property development revenue to private operator company. The public sector model on the other hand loads all these risks are assumed on the public sector, perhaps as the only agency which could bear them given the magnitude.

The following table summarises the role of different parties and attractiveness in each financing and implementation model.

Table 4-38: Summary of implementation models through PPP

Model	Construction	O&M	Property Development	Attractiveness
Base Case	SPV	SPV	SPV	Higher
VGF	Pvt. Sector	Pvt. Sector	Pvt. Sector	Limited
Annuity	Pvt. Sector	Pvt. Sector	Pvt. Sector	Limited
Grant During Operations	Pvt. Sector	Pvt. Sector	Pvt. Sector	Limited
Only Property Dev.. By Pvt. Sec.	SPV	SPV	Pvt. Sector	Limited
Revenue Share	SPV and Pvt. Sector	Pvt. Sector	Pvt. Sector	Higher

Source: Author's Analysis

5. Economic Analysis

5.1. Executive Summary of Economic Analysis

The Economic analysis of RRTS project has been undertaken with an objective to evaluate the contribution of proposed RRTS project to social objectives and to the economy.

In order to assess economic viability, economic benefits and costs associated with the project have been identified to the extent possible. The "With project" scenario is compared with the option of "Without project scenario" to determine the economic benefits. The benefits consist of quantifiable and non quantifiable benefits. These are presented in table 5-1. The quantifiable benefits have been captured in this analysis.

Table 5-1: Summary of Quantifiable and Non Quantifiable Benefits.

Benefits	Quantifiable Benefits	Non Quantifiable Benefits
Fuel Savings	√	
Savings in capex of Vehicle	√	
Savings in Road Infrastructure Capex	√	
Savings in Road Infrastructure maintenance cost	√	
Savings due to pollution reduction	√	
Passenger Time Savings	√	
Savings in VoC	√	
Savings due to accidents reductions	√	
Econ. Impetus to micro region		√
Overall increased mobility		√
Better urban planning		√
Benefits to City Image		√
Better access to workplace due to TOD		√
Better Comfort Level to Passengers Traveling on RRTS		√
Indirect benefits of Reduce Pollution to Population leaving around project corridor		√

Source: Author Analysis

The total economic cost is subtracted from the total benefits to estimate the net benefit of the project. Discounted Cash Flow (DCF) technique has been used to determine the economic viability of the project. Detailed methodology and approach are described in subsequent section of Approach and Methodology section. The outcome of economic analysis is presented in table 5-2.

Table 5-2: Summary of Outcome of Economic Analysis

Particular	Outcome
Economic Internal Rate of Return	21.8%
Economic net present value (ENPV) @ 12% discount rate (Rs crore)	14667
Benefits to Cost ratio	1.76

Source: Author Analysis.

Further, the effects of increase/decrease of critical factors such as economic cost and benefits on economic viability of the project have been estimated through sensitivity tests. The result of the sensitivity tests for the project is presented in the table 5-3.

Table 5-3: Summary of Outcome of Sensitivity Analysis

Sensitivity parameters	EIRR	ENPV (Rs crore)	Benefits to Cost ratio
Increase in Economic Cost of the Project by 10%.	19.9%	12748	1.6
Decrease in benefits by 10%.	19.7%	11281	1.59
Combined scenario of increase in Economic Cost of the Project by 10% and decrease in Economic benefits by 10%.	17.9%	9363	1.44

Source: Author Analysis.

Based on the analysis following conclusions can be drawn.

- Project provides 21.8% of E-IRR which is higher than the social opportunity cost of capital i.e 12% normally used in the Asian context by ADB and World Bank. Thus on these counts, the returns are higher than the opportunity cost.
- Further the project provides 1.76 of benefits to cost ratio indicating 76% higher benefits would be accrued to the economy than the economic cost of the project.

- Project provides E-IRR of 17.9% under the most pessimistic scenario of increase in economic Cost of the Project by 10% *combined with* a decrease in economic benefits by 10% which is also determined to be higher than social cost of capital.
- Project also provides many quantifiable benefits which may further improve economic rate of returns.
- Thus project is determined to be economically viable.

The detailed discussion pertaining to economic costs and benefits are presented in the subsequent sections of the report. The discussion starts with the methodology for economic analysis followed by discussion on economic costs associated with the project and identification and quantification of benefits. Detailed output is presented in Annexure 5.

Final section discusses the economic viability of the project under the different sensitivity tests.

5.2. Approach and Methodology for Economic Analysis

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

The project benefits have been computed through comparison of costs arising out of "with project" and "without project" scenario. For instance, in without project scenario, the economic costs incurred by the economy in carrying the diverted traffic to proposed RRTS project by the alternative mode of transport viz., road, rail has been computed. Therefore, the economic benefits would arise due to savings in cost that would accrue to the economy by moving the project traffic over the

alternate mode of transport. In addition, other social benefits that would be accrue to the economy due to savings of direct/indirect costs namely, fuel savings, environmental pollution, accident reduction, maintenance cost, passenger time savings etc . These have been computed using the "with project" and "without project" scenario. These savings in social costs have also been considered to the extent that they are quantifiable. These social benefits have been computed based on economic prices instead of market prices. Shadow prices have been used to arrive at the economic costs/benefits. To arrive at the shadow prices, appropriate conversion factors (for converting market prices to economic cost) have been applied.

The pictorial representation of methodology of Economic analysis is specified in Figure 5-1 below.

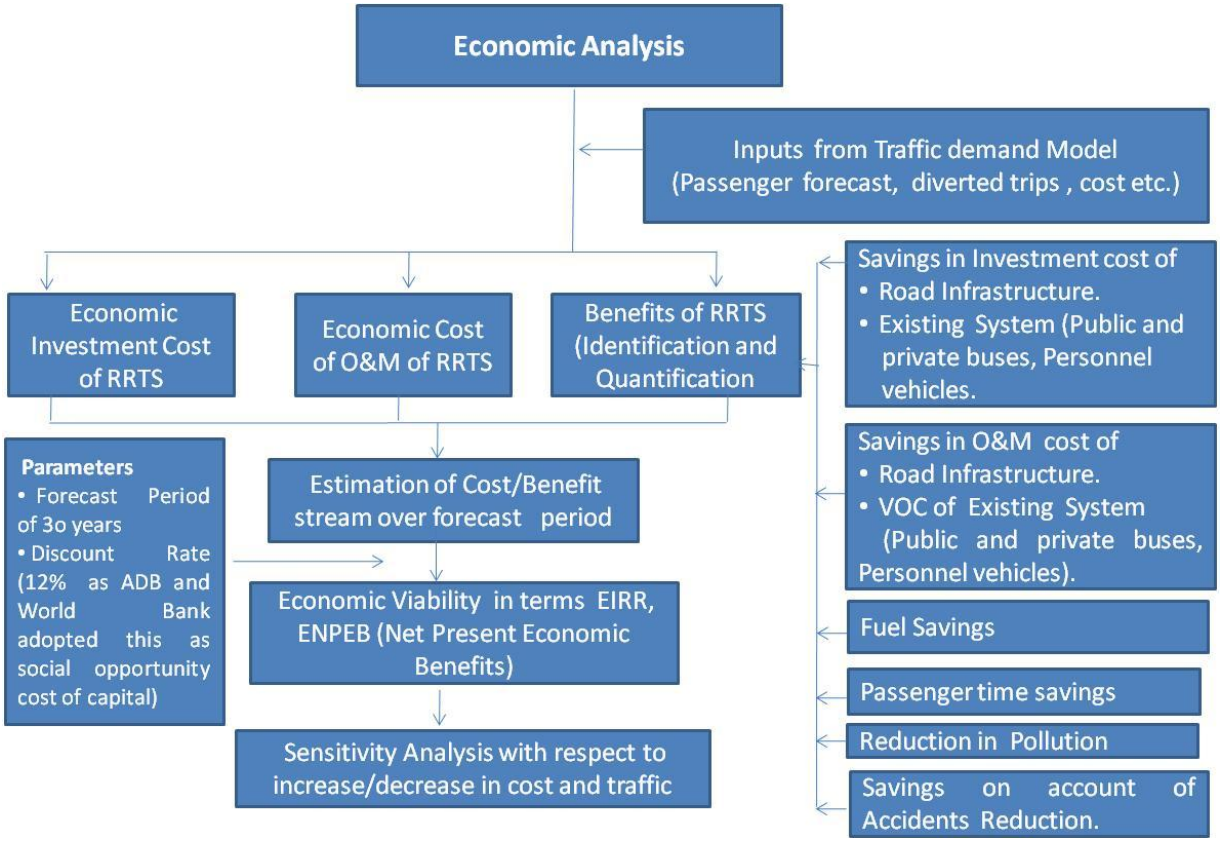


Figure 5-1: Methodology for Economic Analysis

Source: Author Analysis.

The annual stream of economic costs and benefits have been computed for analysis period of 30 years. Economic viability has been undertaken using the Discounted

Cash Flow (DCF) technique to obtain the economic internal rate of return (EIRR %) and economic net present value (ENPV) for the proposed project. This is followed by a 'sensitivity analysis' by increasing or decreasing the critical factors affecting the cost and benefit streams of the proposed project, in order to ascertain their effect on the economic feasibility indicators i.e. ENPV, EIRR.

5.3. Estimation of Economic Project Cost of RRTS

The Economic project cost (i.e. capital cost) of the RRTS is calculated from the financial project cost on the following basis.

- Tax components are excluded from the financial project cost as it represents transfer payments.
- Interest during Construction (IDC) has been excluded from the financial cost.
- On capital cost sides subsidies and market distortion including foreign exchange distortions are very difficult to evaluate. Therefore, the practice is to apply an overall conversion factor (CF) to cost figures to eliminate all possible distortions including foreign exchange distortions if applicable. ADB projects in the past have used in India a conversion factor (CF) equal to 0.90. Hence to eliminate all possible distortion owing to subsidies, wages of laborers and foreign exchange distortion, conversion factor equal to 0.9 have been used to arrive at Economic project cost.

The Economic project cost for the RRTS project is specified in table 5-4.

Table 5-4: Economic Cost of Project

Particular	Amount (Rs crore)
Land Cost (A)	1475
Total Hard Cost excluding Land Cost (B)	21751
General Charges including Design Charges @ 3% of B : (C)	653
Physical Contingencies @ 3% of (A+B+C) : (D)	716
Total Financial cost (A + B + C +D) (Excluding IDC and Taxes): (E)	**24596**
Economic Capital cost @ 0.9 of (E) above	**22136**

Source: Author Analysis

**Design charges include land layout design charges*

The construction period for the project is proposed as five years. The proposed phasing of construction is explained in the table 5-5.

Table 5-5: Phasing of Economic cost of Project

Year	Phasing	Economic Cost of Project (Rs crore)
2012	10%	2214
2013	20%	4427
2014	30%	6641
2015	30%	6641
2016	10%	2214
Total	**100%**	**22136**

Source: Author Analysis

As specified in above Table that total economic cost of the project is arrived at Rs 22136 crore at completion. Total net present value of Economic cost of project has been arrived at Rs 15709 crore using the discount rate of 12%.

5.4. Estimation of Economic cost of Operation and Maintenance

Operation and maintenance costs under "with the project" situation are derived from financial O&M estimates. As per the prevailing practice, only real prices has been considered in computation of economic O&M estimates. The conversion factor equal to 0.9 is applied to arrive at economic O&M estimates. This is owing to adjust the market prices for transfer payment like taxes, subsidies etc. for operation, repair& maintenance, material requirement and staff salary. The O&M Cost also includes replacement cost. Detailed discussion on financial O&M cost is specified in financial analysis chapter. Economic cost of Operation and Maintenance of RRTS project is summarized in table 5-6.

Table 5-6: Economic Cost of Operation & Maintenance

Particular	2017	2018	2019	2020	2021	2031	2036	2041
O&M Cost (in rs. Crore)	632	632	632	632	1330	1701	1895	1793

Source: Author Analysis

Total net present value of Economic cost of O&M has been arrived at Rs 3477 crore using the discount rate of 12%.

5.5. Economic Benefits of RRTS

As discussed, in the Approach and Methodology section, proposed project will accrue tangible and non tangible benefits due to reduction in traffic to existing system. It also contributes to diversion of passenger traffic from alternate mode i.e. Road and Rail to RRTS system. As a result there will be reduction in number of vehicles carrying passengers with introduction of RRTS and hence it also reduces congestion. This will also lead to savings in capex of transport system, i.e roads, rails, vehicles etc. In addition, other social benefits that would be accrue to the economy due to savings of direct/indirect costs namely, environmental pollution, accident reduction, maintenance cost, passenger time savings, vehicle operating cost etc. Following table 5-7 elaborates the quantifiable/non quantifiable benefit stream that would be accruing to economy with introduction of RRTS.

Table 5-7: Economic and Social Benefits arising from RRTS

Sr. No	Benefit	Direct Benefit due to RRTS	In direct benefits due to decongestion on other modes/routes owing to RRTS
1	Lower Capex in Vehicle i.e Bus, Car, Auto , Two wheelers ,Rail etc.	RRTS would significantly contribute in diversion of Traffic from existing mode of transport. This will lead to savings in followings. • Capex of vehicles carrying the diverted trips. • Capex of alternate mode of transport i.e Road that would be required to cater to increased traffic, in case RRTS is not introduced.	
2	Lower capex of Existing mode of Transport i.e Road etc.		
3	Reduced Road Stress	Reduced need for road maintenance due to reduced traffic on account of diverted trips on RRTS.	
4	Lower Vehicle Operating Cost	Due to absence vehicles of diverted pax	Due to smoother operations of existing vehicles.

Sr. No	Benefit	Direct Benefit due to RRTS	In direct benefits due to decongestion on other modes/routes owing to RRTS
5	Fuel Saving	Fuel saved on vehicles of diverted pax.	Fuel saved by plying vehicles due to smoother operations on decongested roads.
6	Reduction in accidents	Lower accidents due to absence of vehicles of diverted pax	Lower accidents from plying vehicles due to decongested roads / other modes
7	Reduction in Pollution	Absence of carbon emissions from vehicles of diverted pax.	Lower emissions on decongested roads.
8	Passenger time saving	• Higher speed of RRTS as compared to present transport system . • Reduction of waiting time for people diverted to RRTS from existing Bus and Rail owing to higher frequency and speed.	Due to faster speeds possible from lower congestions levels, though this may also encourage car owners who would otherwise use public transport to use cars.
9	Better access to workplace due to TOD	Shorter trip distances for workers employed on TOD stations, employment etc.	
10	Econ. Impetus to micro region	Better and faster accessibility due to RRTS may enhance labour pool and skill availability with multiplier benefits	Improved accessibility due to decongested roads/other modes may enhance labour pool and skill availability with multiplier benefits.
11	Overall increased mobility	Better quality of life to citizens, particularly to daily commuters, women, students, elderly and disabled.	Benefits resulting from reduced congestion captured, other benefits may not be captured.
12	Better urban planning	Would make possible integrating land use with transport, enabling better town planning and contributing to efficiency due to better allocative efficiency of capital.	

Sr. No	Benefit	Direct Benefit due to RRTS	In direct benefits due to decongestion on other modes/routes owing to RRTS
13	Benefits to City Image	Would improve city image attracting higher investments and businesses, could decrease outmigration and increase immigration.	
14	Better Comfort Level to Passengers Traveling on RRTS	Improved quality of services, ease, reduction in crowding owing to higher frequency and speed. These factors enhance Comfort Level to Passengers.	
15	Indirect benefits of Reduce Pollution to Population leaving around project corridor	Diversion of Traffic will also contribute to reduced congestion and pollution thereof.	

Source: Author Analysis

- Impact can be quantified using proxies and estimates when necessary
- Impact difficult to quantified due to absence of universally accepted methods

Estimates of quantifiable benefits are explained in subsequent sections. While non quantifiable benefits have not been drawn in to analysis.

Transport Demand on RRTS

Existing Transport system on project corridor consist of Buses, Railway, shared auto rickshaw, cars and two wheelers. Traffic chapter provides details of the traffic demand estimates. The traffic demand estimates is in table 5-8.

Table 5-8: Traffic Demand on RRTS

Particular	2017	2021	2031	2041	2046
Total Peak hour Diverted Trips (Lakh)	0.74	0.91	1.26	1.51	1.68
Total Trips on RRTS (Lakh/ day)	7.37	9.12	12.55	15.11	16.27
Average Trip Length (km)	27.1	25.96	27.69	28.78	29.3

Source: Traffic Estimates and OD Analysis

Occupancy factors of different category of vehicles have been arrived based on actual traffic survey. These occupancy figures have been used to arrive at the numbers of diverted vehicles.

Table 5-9: Occupancy factors of different category of vehicles

Type of Vehicle	Occupation Factor/ Capacity Utilization
Two Wheelers	1.5
Car	2.25
Auto	5
Public Transport (BUS)	41.34
Rail	720[11]
Rolling stock (Engine+ wagon) per train	11

Source: Traffic Survey

Above occupancy factors and number of trips of each category of vehicle have been applied to total daily diverted trips to arrive at the daily diverted vehicles.

Table 5-10: Daily Diverted Vehicles *Figures in number*

Particular	2017	2021	2031	2041	2046
Two Wheelers	37982	52072	87384	98724	101941
Car	29653	43970	72528	77500	77828
Auto	2391	3350	3670	6658	8712
Public Transport (BUS)	1138	1186	1331	1587	1684
Rail	5	5	6	7	7
Total	**71169**	**100583**	**164918**	**184476**	**190172**

Source: Author Analysis

Based on Origin Destination analysis, average trip distance has been found out which has been specified in table 5-9. Annual vehicle run has been derived based on product of annual numbers of vehicle plying on the RRTS corridor, number of trips and average trip length.

Savings in Capital Cost of Vehicles

As specified above, with introduction of RRTS, there would be a reduction of vehicles such as Two wheelers, Cars, Auto, Buses, Rail etc on proposed corridor. As indicated in Table above, there would be a daily reduction of 71169 vehicles alone in 2017.

[11] Majority of long route trains are plying on this route and each train has 10 wagons with carrying capacity of 72 persons per wagon.

This reduction of vehicles corresponds to savings of capital expenditure. Further there would be a reduction of replacement cost of vehicles as each vehicle category has limited operational life. The operational life of Two wheelers, Car, Auto, Bus, Rail (Rolling stocks) have been considered 5 years, 12 years, 7 years, 10 years and 20 years respectively. This is based on prevailing industry practice.

In spite of efficient public transport system, there is a desire for owning a car and two wheelers among the people for weekends and for travelling outside the city. Thus it is assumed that only half of the diverted passengers (people diverted to RRTS and who would use the RRTS for commuting to work) would not be purchasing car and two wheelers.

Following estimates have been undertaken to arrive at savings in capex of different category of vehicles.

Table 5-11: Economic Price of Different Type of Vehicles

Particular	Financial Price of Vehicle at 2011 prices (Rs.)	Economic Price of Vehicle @ 0.9 of financial price at 2011 prices (Rs.)
Two Wheelers	50000	45000
Car	400000	360000
Auto	180000	162000
Public Transport (BUS)	2400000	2160000
Rail (Rolling stocks)	50000000	45000000

Source: Various sources and respective website of vehicle manufactures, Author Analysis.

Above mentioned economic prices of different vehicles have been used to arrive at savings in capex of vehicles which would have been diverted in "With RRTS Project" scenario. The savings with respect to diverted vehicles would be Rs 1169 crore in 2017 for the project. Year wise savings in capex of vehicles are specified in Annexure 5.

Total savings in economic cost of the vehicle during the 30 years operational years of RRTS would be Rs 6949 crore.

Savings in Road Infrastructure Cost and Land Acquisition Cost

The RRTS system would bring savings in investment in Road infrastructure. This is owing to shifting of passengers to RRTS system and reduction in vehicle in existing

road infrastructure thereof. Owing to unavailability of information pertaining to existing capacity of road, it is assumed that diverted traffic would be accommodated in separate road corridor along the RRTS project corridor.

Indian Road Congress's norms for the PCU factors for various vehicle types have been used to arrive at peak hour PCUs of diverted traffic.

Peak hour Road capacity norms for level of service C, stipulated by Indian Road Congress (IRC) have been used to arrive at road infrastructure requirements. Based on this, it is worked out that total of three eight lane road, one six lane road and one four lane road would be required during operational years to accommodate the diverted traffic in "Without RRTS Project" scenario. While considering the prevailing road development plans and existing roads, it is worked out that two six lane roads and two four lane roads would be required during operational period of to accommodate the diverted traffic in "Without RRTS Project" scenario .Thus RRTS project would contribute in savings in road infrastructure investment in two six lane roads and two four lane roads.

Following road infrastructure cost norms have been used to arrive at Road infrastructure investment requirement.

Table 5-12: Norms used for Economic cost of Road Infrastructure

Capacity of Road	Financial Cost per KM (Rs crore) in 2011	Economic Cost per KM (Rs crore) in 2011 @0.9 of financial cost
4- lane	10.85	9.8
6-lane	14.7	13.22

Source: Planning Commission constituted B K Chaturvedi committee report for road infrastructure cost estimates[12].

Total savings in economic cost of the Road infrastructure during the 30 years of operational period would be Rs 2242 crore in present value terms. The discount rate of 12% is used to arrive at present value.

[12] B K Chaturvedi committee estimated road infrastructure cost of 4- lane and 6- lane road as Rs 9.6 crore per km and Rs 13 crore per km in 2009-10 respectively. While WPI of 6.31% is applied to derive the cost at 2011 prices.

Considering the prevailing norms, six lane highway and four lane highway requires 60 mt ROW and 45 mt ROW respectively. This translates into land area requirement of 1080 hac of land (180 km X 60 mt ROW) for six lane road and 810 hac of land (180 km X 45 mt ROW) for four lane road. Thus total land area requirement for construction of two six lane roads and two four lane roads is estimated at 3782 hac. It is considered that these roads would be constructed away from the proposed RRTS stations. Thus one third of the average prevailing circle late at proposed RRTS station is considered to arrive at savings in land acquisition. Total savings in economic cost of the land acquisition cost would be Rs 11353 crore in present value terms.

Savings in Road Infrastructure Maintenance Cost

As specified above, RRTS project would contribute in savings in road infrastructure investment in three eight lane roads and one four lane road. This will also lead to savings in road maintenance cost of these corridors which would have been occurred in "Without Project" scenario.

Prevailing industry norms for routine maintenance and periodic maintenance of Road infrastructure have been adopted in order to arrive at economic maintenance cost of Road infrastructure[13].

Total savings in economic Road infrastructure maintenance cost during the 30 years of operational period would be Rs 438 crore in present value terms.

Savings in Fuel Consumption

As a result of diversion of vehicular traffic to RRTS System, there would be a considerable savings in fuel consumptions. There would be an inter- fuel substitution of Petrol, Diesel and CNG to electricity. Fuel saved due to traffic diversion to RRTS is estimated using the following formula.

Savings in Fuel Consumption = (Annual Run of each Diverted Vehicle (i.e Vehicle Km)/ Fuel consumption Norms of different category of Vehicle i.e mileage) X Respective Fuel Prices.

[13] Annual Routine maintenance is adopted 1.5% of economic cost of road project. Periodic maintenance at 5% of economic project cost at regular interval of 5 years.

Using the above formula it is estimated that total cumulative savings in Petrol, Diesel and CNG are 30999 lakh lit., 13692 lakh lit., and 11399 lakh kg respectively during the thirty years of operational period. Fuel consumption norms used in analysis are stipulated below.

Table 5-13: Fuel Consumption Norms

Mode	Fuel Consumption Norms (Mileage)
Two wheelers (km/lit) (Petrol)	35
Car (km/lit) (Petrol)	13
Car (km/lit) (Diesel)	16.9
CNG Bus (km/KG)	2.94
Diesel (Km /Lit) for Bus	2.94
Auto Petrol (Km/Lit)	20
Auto CNG (Km/kG)	31.2
Consumption of Diesel per train km (Lit. per train km)	3.50

Source: Various sources, DTC, Industry estimates

It is also assumed that fuel of Auto and Bus shall be substituted by CNG form 2023 onwards. Prevailing fuel prices in Delhi as on 16th January, 2012 has been used to compute the savings in fuel consumptions.

Table 5-14: Fuel Prices

Type of Fuel	Price of Fuel
Petrol (Rs/lit)	68.26
Diesel (Rs/Lit)	46.2
CNG (Rs/KG)[14]	33.75

Source: IOCL, BPCL and Various sources. Note: Prices as on 16th January, 2012

Based on above, corresponding cumulative fuel savings would be Rs 3748 crore in net present value terms during the 30 years of operational period. Detailed year wise savings in fuel is presented in Annexure 5.

Savings due to Accident Reduction

The reduction in traffic volumes on road owing to modal transfer to RRTS System is expected to reduce the accidents on project corridor. Further reduction in accidents will also lead to savings from damaged to vehicle and savings towards medical and

[14] *Source: Average price In NCR Region as on 18 august, 2011.*

insurance expense to personal involved in the accidents. This also leads to reduction of productivity to the economy by the personal involved in the accident. Further it is to be noted that highest safety standards have been considered for RRTS project so as to minimal chance of accidents in RRTS system.

Owing to unavailability of past records of the accidents for vehicles plying in project corridor, The relationship exist between the number of vehicle playing and number of persons killed and injured in road accidents as specified in Road User Cost Study (CRRI, 1982) which is later updated by Dr. L.R. Kadiyali in association with Loss Prevention Association of India, have been considered[15] to measure the accident cost to the economy. This relationship is specified below.

1. **No of person Killed in Road Accidents:** Y1 = 49.43 *X + 750.42, Where: X= No of Vehicles affected in Lakh, Y1= number of persons killed in road accidents in a particular year, R square= 0.89.

2. **No of person injured in Road Accidents:** Y2 = 257.04 * X + 3181.41, Where: X= No of Vehicles affected in Lakh, Y2= number of persons injured in road accidents in a particular year, R square= 0.90.

3. **Damage of Vehicles :** Y = 143.63 * X + 3345, Where : X= No of Vehicles on the road , Y= damage to the vehicle in a particular year, R square= 0.90

Further to above past road accidents records stipulated by MORTH[16] have been assessed which displayed declining trends in road accidents and persons killed. The outcome of accidents estimated using the formula above is much higher than the accidents trends displayed by MORTH records. **Thus a very conservative approach has been undertaken by using the MORTH level of accidents estimates for future accidents in the "Without RRTS Project" scenario.**

Further to above, the Road User Cost Study also estimated cost of accidents which included components like gross loss of future output due to death/major injury, medical treatment expenses, legal expenses, and administrative expenses on police, insurance companies and the intangible psychosomatic cost of pain. The value of accidents and damaged to vehicle is presented in Table 5-15.

[15] *Source: Planning Commission constituted study "Social Cost Benefit Analysis of Delhi Metro" by Institute of Economic Growth by RITES*
[16] Ministry of Road Transport & Highway

Table 5-15: Economic Cost of Accident

Particular	Economic Cost (at 2011-12 Prices)
Cost of fatal accident (person killed) (Rs at 2011-12 prices)	437342
Cost of fatal accident (person Injured) (Rs at 2011-12 prices)	64256
Cost of damage to Two wheelers	2286
Cost of damage to Car	9763
Cost of damage to Bus	32818
Cost of damage to Auto	3900

Source: Planning Commission constituted study "Social Cost Benefit Analysis of Delhi Metro" by Institute of Economic Growth by RITES

Based on above, the reduction in accidents for different types of vehicles is estimated. The estimates of cost of damage to cars, buses and two-wheelers in road accidents, as reported in the above table are used to estimate the total savings in compensation paid due to damage caused vehicles. Thus total savings of Rs 2952 crore is estimated due to accident reduction in present value terms during the thirty years of operational period. Year wise details are presented in Annexure 5.

Savings due to Pollution Reduction

Factors such as fewer vehicles due to diversion to efficient RRTS System and decongesting existing road and rail network, would lead to reduction in green house gas emission in the region.

Unlike the existing transport system, which runs on a combination of petrol, diesel and CNG, the proposed RRTS Project will be operated entirely through electric system, thereby further enhancing the GHG emission reduction potential of the project.

Considering the above potential, United Nations Framework Convention for Climate Change (UNFCCC) approved methodology i.e "ACMOO16" for rail based MRTS have been used to estimate the possible carbon emission reduction. This methodology has been stipulated by UNFCCC under the possible financing through Clean Development Mechanism (CDM).

Based on above Methodology, Carbon finance i.e Monetization of emission reduction is calculated as follows.

Carbon Finance = Emission Reduction from RRTS Project **X** Price of per tone of CO2.

Emission Reduction from Project: Baseline Emission (In without project, BAU) **-** Project Emission (Direct Project Emission + Indirect Project Emission).

The price of per tone of CO2 is considered as Rs 800, which was carbon trading price in spot market in European Energy Exchange as on 12th August, 2011.

In order to estimate baseline emission, emission per kilometer run of each vehicle category has been estimated. Default vehicle technology improvement factor of 0.99 as stipulated under the UNFCCC methodology has been used to arrive at year wise emission factor of each vehicle category. Following emission parameters along with vehicle technology parameters has been used to estimate emission factor for each vehicle category.

Table 5-16 : Emission Parameters

Particular	Value	Unit
Net calorific value gasoline/Petrol	43.9	MJ/kg
Net calorific value diesel	42.7	MJ/kg
Net calorific value CNG	35.6	MJ/m3
Specific weight gasoline	0.759	kg/l
Specific weight diesel	0.83	kg/l
Specific weight CNG	0.717	kg/m3
CO2 emission factor gasoline	67.5	gCO2/MJ
CO2 emission factor diesel	72.6	gCO2/MJ
CO2 emission factor CNG	54.3	gCO2/MJ
CH4 emission factor of CNG buses	162	gCO2/km
CH4 emission factor of CNG light vehicles	9.9	gCO2/km

Source: BPCL and IPCC

Based on above inputs, emission parameters for each vehicle category and baseline emission in without project scenario has been estimated.

In order to estimates the saving in carbon emission, project emission (Emission due to RRTS Project) is estimated using the UNFCCC methodology. The methodology stipulated following formula for estimating the direct project emission.

$PE_y = EC_{pj,j,y} \times EF_{el,j,y} \times (1 + TDL_{j,y})$

Where,

$EC_{pj,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr).

$EF_{el,j,y}$ = Emission factor for electricity generation for source j in year y (tCO_2/ MWh).

$TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y

Following inputs have been plugged into above formula to estimate direct project emission.

Table 5-17: Emission Parameters for electricity grid

Particular	Value	Unit
Emission factor of Indian grid ($EF_{el,j,y}$)*	0.81	tCO_2/MWh
Average technical transmission and distribution losses for providing electricity ($TDL_{j,y}$)**	3.91%	Percent

*Source: *Emission factor of National Grid by Central Electricity Authority, ** Power Grid Corporation of India, 2010.*

Based on above, reduction in total emission is estimated at 64 million tones CO_2 during the operational period of 30 years.

Thus, pollution emission savings has been arrived at Rs 667 crore in net present value terms during the 30 years of operational period. Detailed year wise savings due to pollution reduction is presented in Annexure 5.

Passenger Time Savings

The RRTS system would be faster than alternate transport mode i.e road transport modes, existing rail etc. This will also lead to considerable saving in time of passenger travelling on RRTS System. The savings of travel time of passenger travelling by RRTS instead of alternate mode of transport is calculated as follows:

Passenger Time Savings = (Time spent by diverted Passenger on RRTS - Time spent by diverted passenger on alternate transport mode) X Value of Passenger

Average speed of two wheeler, car, shared auto, Bus and Existing railway is estimates at 25 km/hr, 40 km/hr, 15 km/hr, 35 km/hr and 50 km/hr respectively in the without project scenario. Speed of proposed RRTS is estimated at 90 km/hr, thus bringing enormous time saving benefits. Any benefits due to increase in speeds due to decongestion taking place on the roads in the "With Project Scenario" has not been considered in the analysis as we expect only a marginal rise in speeds and hence only very limited time savings.

The estimates for economic value of passenger time are stipulated below.

Table 5-18: Economic Value of Passenger Time[17]

Per	Amount (Rs per hour of Passenger) at 2011 prices
Value of Time of Passenger	94

Source: Author Estimates

With the implementation of the RRTS project, the total passenger time savings are estimated at Rs.9579 crore during the operational years in present value terms. Detailed year wise passenger time savings due to RRTS Project is presented in Annexure 5.

Savings in Waiting Time

Further it is also estimated that RRTS would bring benefits in terms of reduction of waiting of approximately 10 minutes for people diverted from existing Bus and Rail. Though the benefit accruing is meager and valued at Rs 6.6 crore during the operation period.

[17] *Daily average Income of passengers travelling on different vehicle category have been divided by daily working hours to arrive at value of passenger time.*

Savings in Vehicle Operating Cost

The reduction in vehicle operating cost (VoC) of diverted vehicle is obtained as product of annual run of diverted vehicle and VoC/ vehicle km.

Table 5-19: Vehicle Operating Cost Other than Fuel Cost

Vehicle Category	Voc/Km Other than Fuel Cost in 2011 (Rs)
Two wheelers	0.5
Car	1.25
Auto	1
Bus	15

Source: Industry norms and Author estimates

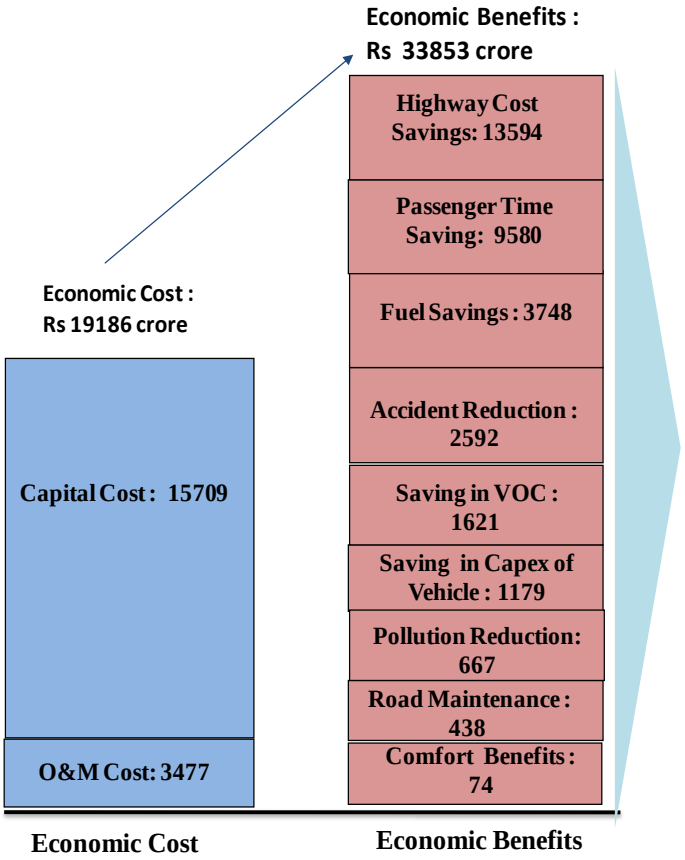
With the implementation of the RRTS project, the total savings in Vehicle Operating cost of diverted trips are estimated at Rs. 1621 crore during the operational years in present value terms. Year wise details are presented in Annexure 5.

5.6. Outcome on Economic Viability

The detailed discussion on outcome and sensitivity tests is specified below.

As discussed in section above, the cost and benefits streams for the thirty years period in economic prices have been estimated and presented in Annexure 5[18]. Further, the Discounted Cash Flow (DCF) technique has been used to obtain the economic internal rate of return (EIRR) and economic net present value (ENPV) for the RRTS Project. The result of the economic analysis is presented in table 5.20. The benefits are listed in the order of their magnitude, with the largest benefits accruing out of Highway Cost (about more than one third).

[18] It is to be noted that the residual value of the RRTS project in last year has not been taken into account as benefit.



Parameters	Outcome
Economic Internal Rate of Return	21.8%
Economic net present value (ENPV) @ 12% discount rate (Rs crore)	14667
Benefits to Cost ratio	1.76

Figure 5-2: Outcome of Economic Analysis (Amount in Present Value Terms)

Source: Author Analysis, Amount (Rs crore) in present value terms. (Graph not to scale)

As discussed above, in realistic/base traffic demand scenario, economic viability analysis is 21.8% EIRR which is higher than social cost of capital i.e 12%.

Above economic appraisal is based on estimates of project cost and benefits which indicates that economic viability of the project to a large extent depends on realization of these estimated benefits. Circumstances and situations which negate, or limit these economic benefits may reduce the economic viability. Similarly, situations of uncaptured benefits, or those that accelerate or enhance the value of captured benefits may further improve the economic rate of return.

To understand the impact of increase/decrease of critical factors such as economic cost, traffic and benefits on economic viability of the project to a certain extent, sensitivities tests with respect to followings have been carried out.

a) Increase in Economic Cost of the Project by 10%.
b) Decrease in benefits by 10%.

c) Combined scenario of increase in Economic Cost of the Project by 10% and decrease in Economic benefits by 10%.

The result is presented in Table 5-20 below.

The outcome of the economic viability under above mentioned sensitivity tests are presented in Table below.

Table 5-20: Economic Viability of Project under Different Sensitivity tests

Particular	Economic Internal Rate of Return @ 12% discount rate	Economic net present value (ENPV) @ 12% discount rate (Rs crore)	Benefits to Cost ratio
Increase in Economic Cost of the Project by 10%.	19.9%	12748	1.6
Decrease in benefits by 10%.	19.7%	11281	1.59
Combined scenario of increase in Economic Cost of the Project by 10% and decrease in Economic benefits by 10%.	17.9%	9363	1.44

Source: Author Analysis

It is seen from the above Table that under the different sensitivity tests, EIRR is more than 15% which is higher than the social cost of capital i.e 12%.

5.7. Conclusion

Following conclusion can be drawn from the economic analysis of the project.

- Project provides 21.8% of E-IRR which is higher than the social opportunity cost of capital i.e 12% normally used in the Asian context by ADB and World Bank. Thus on these counts, the returns are higher than the opportunity cost.
- Further it also provides 1.76 of benefits to cost ratio indicating 76% higher benefits would be accrued to the economy than the economic cost of the project if project is undertaken.
- Project provides E-IRR of 17.9% under the most pessimistic scenario of increase in economic Cost of the Project by 10% *combined with* a decrease in economic benefits by 10% which is also determined to be higher than social cost of capital.
- Project also provides many quantifiable benefits which may further improve economic rate of returns.
- Thus project is determined to be economically viable.

6. Assistance Required

6.1. Decision on the changes in alignment suggested by Haryana Government

The decisions regarding the change in alignment in Haryana area as suggested by Haryana Govt. officers and the related works involved are to be taken on priority. Our letters to NCRPB dated 22/12/11 and 26/12/11, copies at Annexure 2 may please be seen in this regard and go ahead given for the work to be carried out on the additional 35 kms (approximately) of new alignment in Haryana State.

6.2. Stakeholders Workshop

Field work of the Topographic survey and the Geotechnical investigations of the approved alignment have been completed. The alignment is being marked on the Revenue maps. The land for the line and land parcels for stations, parking and Transit Oriented Development (TOD) are being identified. On a preliminary assessment, the major issues for the consideration of stakeholders are availability of land and ROW for the RRTS, its Depots, Sub-stations, land parcels for TOD, identification of underground Utilities which would need to be diverted, and R & R issues. In our assessment the Stakeholders would include three State Governments, MORTH (NHAI), AAI, DLF, HSIDC, RIICO, Ministry of Railways, DMRC, DDA, MCD, NDMC, DTC, Electricity Authorities in the three States, and Land & Development Authority. NCRPB may please finalise the list of stakeholders for planning the workshop.

Thereafter, stakeholder workshop will be planned.

Annexure 1 : Minutes of CRC Meeting held on 14.10.2011

3/11/11
MD may like to Peruse.
03/11/11

राष्ट्रीय राजधानी क्षेत्र योजना बोर्ड
NATIONAL CAPITAL REGION PLANNING BOARD
प्रथम तल, कोर–IV बी/1st Floor, Core - IV B
भारत पर्यावास केन्द्र/India Habitat Centre
लोधी रोड़, नई दिल्ली–110 003 / Lodhi Road, New Delhi-110 003
शहरी विकास मंत्रालय/Ministry of Urban Development
दूरभाष/Phone : 24642284, 24642287, फैक्स/Fax : 24642163

No.K-14011/59/2009-NCRPB (Vol.XI) Dated: 01.11.11

Subject: Minutes of the meeting of Consultancy Review Committee (CRC)/Sub-committee to Task Force for the "Feasibility Study on Regional Rapid Transit System (RRTS) Corridors followed by Preparation of Detailed Project Report" for NCR held on 14.10.11

Meeting of Consultancy Review Committee (CRC) /Sub-committee to Task Force for the above mentioned study was held under the Chairmanship of Smt. Naini Jayaseelan, Member Secretary, NCR Planning Board on 14.10.11 at 03:00 P.M. Minutes of the same are enclosed for your kind perusal and necessary action.

Yours faithfully,

(R.C. Shukla)
Joint Director (T)

Encl.: As above

To,

1. Shri S.K. Lohia, OSD (UT) & EO JS, G. Floor, 'C' Wing, MoUD, Nirman Bhawan, New Delhi
2. Shri S.K. Singh, Joint Secretary (UT), Ministry of Urban Development, Nirman Bhawan, New Delhi
3. Shri P.K. Deb, Additional Chief Secretary, Urban Development, Local Self & Housing Department Govt. of Rajasthan, Room No.8223 New (221 Old), II Floor, S.S.O. Building, Secretariat, Jaipur- 302005
4. Shri S.S. Dhillon, Financial Commissioner & Principal Secretary, Town & Country Planning Deptt., Govt. of Haryana, Haryana Civil Secretariat, Sector 17, Chandigarh.
5. Shri R. Chandramohan, Pr. Secretary-cum-Commissioner (Tr.), GNCT-Delhi, 5/9, Under Hill Road, Delhi
6. Shri Ravindra Singh, Principal Secretary, Housing Department, Govt. of Uttar Pradesh, Bapu Bhawan, Vidhan Sabha Marg, Lucknow, Uttar Pradesh
7. Shri Bhuvnesh Kumar, Commissioner, Meerut Division, Govt. of UP, Civil Lines, Meerut, U P
8. Shri Rajiv Chaudhary, Executive Director (Works Planning), Railway Board, Ministry of Railways, Room no. 142-A, Rail Bhawan, New Delhi
9. Shri C.S. Verma, Additional Commissioner, NCR, Town & Country Planning Deptt., Navyug Market, Commercial Building, II Floor, Ghaziabad, U.P
10. Managing Director, Delhi Metro Rail Corporation Limited, Fire Brigade Lane, Barakhamba Road, New Delhi-110001
11. Shri Majid Ali, Principal Secretary, Transport; Transport Deptt., U.P. Secretariat, Lucknow, U.P.
12. Mrs. Keshni Anand Arora, Principal Secretary (Transport), Govt. of Haryana, Room No. 41, 7th Floor, Haryana Civil Secretariat, Sector 1, Chandigarh. Ph: 0172-2740278, Fax: 2700803
13. Shri Deepak Upreti, Pr. Secretary (Tr.), Govt. of Rajasthan, Parivahan Bhavan, Sahahkar Marg, Jaipur.
14. Shri S.K. Gupta, Chief Engineer (Planning), Delhi Metro Rail Corporation Limited, 7th Floor, Metro Bhawan, Fire Brigade Lane, Barakhamba Road, New Delhi-110001
15. Shri G.P. Garg, Advisor, Urban Mass Transit Company Ltd., 5th Floor, 'A' Wing, IFCI Tower, Nehru Place, New Delhi-110019

Copy to:
PS to Member Secretary, NCR Planning Board

Minutes of the Meeting of Consultancy Review Committee (CRC)/ Sub-Committee to Task Force for the "Feasibility Study on Regional Rapid Transit System (RRTS) Corridors followed by Preparation of Detailed Project Report" for National Capital Region held on 14.10.11 at 03:00 P.M.

Meeting of the Consultancy Review Committee (CRC)/ Sub-Committee to Task Force for the "Feasibility Study on Regional Rapid Transit System (RRTS) Corridors followed by Preparation of Detailed Project Report" for NCR was held under the Chairmanship of Smt. Naini Jayaseelan, Member Secretary, NCR Planning Board on 14.10.11 at 03:00 P.M. in the Conference Room of NIUA, II Floor, Core IV-B, India Habitat Centre, Lodhi Road, New Delhi. List of the participants is at **Appendix-I**.

2. Chairman welcomed the members of CRC & Consultants and requested them to make a detailed presentation on the Feasibility Report on Delhi-Gurgaon-Rewari-Alwar Corridor submitted by them on 27.09.11. Chairman also requested the representatives of State Governments to flag the issues related to their area, if any; during the meeting.

3. During the presentation, Shri S.S. Dhillon, Financial Commissioner & Principal Secretary (FC & PS), Town & Country Planning Deptt., Govt. of Haryana, suggested one more station between Rajiv Chowk and Manesar to be located near village Kherki-Daula where the NPR & SPR meet at NH-8. He also suggested that the land acquisition rates considered by Consultant are much less than prevalent rates in Haryana. Chairman suggested that land acquisition rates need to be increased as per the present scenario. Consultant was requested to interact with the State Governments for that.

4. Shri S.S. Dhillon also informed that the proposed alignment is in conflict to existing Master Plan in 3 towns viz. Dharuhera, Rewari and Bawal. In response to this, Consultant informed that the alignment considered by Govt. of Haryana is old; in the new/ approved alignment, there appears no conflict. Consultant was requested to incorporate suggestions of Govt. of Haryana and modified the alignment, if found conflicting with Master Plan.

5. Shri Dhillon also suggested that the FSI in TOD area should not be beyond 2.5, as Consultant has proposed 4. In response to this, Shri S.K. Lohia, OSD (UT), Ministry of Urban Development informed that the FAR in the TOD area are generally high to increase the financial viability of the Project as well as reduce the walking distance to access the public transport system along TOD. It also promotes linear development along public transport corridor. FSI in Bangluru and Mumbai TOD areas have been proposed as high as 4. In addition, Shri Subhash Chandra Sharma, DTP (NCR), Govt. of Rajasthan informed that unlimited FAR has been permitted along Jaipur Metro route, subject to provision of adequate parking. Shri Rajeev Malhotra, Chief Regional Planner, NCR Planning Board informed that high FAR is not proposed all along the corridor. It will be in TOD area only.

6. Shri S.K. Gupta, Chief Engineer Planning, DMRC made some suggestions. Most of the suggestions have been discussed earlier and decision was already taken in the earlier meetings. He opined that coach width should be 3.2 m wide, as no coach design for such speed for broad gauge is available. It will also increase size of tunnel structure, which lead to addition in construction and maintenance cost. The axle load should be limited to 17 tonnes. Beyond city limits, it was suggested that the corridor should be at-grade as evacuation problem at elevated tracks during accidents would be serious issue. It should have integration and common ticketing with DMRC. Delhi-Alwar corridor should go upto Rewari in 1st phase. Because, if the distance is more than 80 kms, toilet facilities in trains have to be provided.

9. Shri R.K. Karna, Director, NCR Planning Board informed that first the Debt:Equity ratio for the project should be decided, then equity distribution should be decided. It may be taken 30:70. The project should go as 'Pass-Through System' to avoid Government guarantee fee as 1.2%. Shri Lohia suggested that, Consultant can take DMRC funding system for RRTS also. He also pointed out that EIRR & FIRR needs revision.

10. Chairman suggested that we should avoid financing issues at this stage and concentrate more on technical issues

11. After discussions and deliberations following decisions were taken:

    i) Consultant should check the alignment at Dharuheda, Rewari and Bawal and modify, if found conflicting with Master Plan.

    ii) Land Cost taken for financial analysis need to be revised based on prevailing rates.

    iii) The amount due as Central Taxes would be treated as interest free subordinate debt to be shared between the Central and the State Government. The State Taxes shall be waived off/reimbursed by the States.

    iv) Contribution of project cost should not be taken as 12.5%. It is equity contribution just to form the company. It should be decided on the basis of length of RRTS corridor in the State and benefits thereon.

    v) Committee approved the Feasibility Report and directed to release the payment. The Committee directed to submit the addendum on Feasibility Report after incorporating the above suggestions.

Meeting ended with vote of thanks to the Chair.

Annexure 2 : UMTC Letters

Urban Mass Transit
Company Limited

No.UMTC/GPG/RRTS/NCRPB/144 Dated: 22.12.2011

To,

The Member Secretary
NCR Planning Board
Core IV-B, 1st Floor
India Habitat Centre, Lodhi Road
New Delhi – 110003

Sub: Consultancy Services for carrying out the feasibility study for Delhi-Gurgaon-Rewari-Alwar Regional Rapid Transit System (RRTS) corridor followed by preparation of Detailed Project Report (Contract No.3 of 2009-2010 dated 23.03.2010) – **Change of Alignment in Haryana.**

Ref:- Our letter No. UMTC/GPG/RRTS/NCRPB/127 Dated 15.11.2011

Madam,

During our presentation on "Feasibility Report" of Delhi - Alwar RRTS project to the Consultancy Review Committee (CRC) on 14.10.2011, Sh. S.S. Dhillon, Principal Secretary and Financial Commissioner, Town and Country Planning, Govt. of Haryana had raised the following points concerning the alignment.

1 One more station between Rajiv Chowk and Manesar be located near Village Kherki-Daula.
2 The proposed alignment is not in tune with the Master Plan in three towns viz Dharuhera, Rewari and Bawal, and will need modifications

The CRC had directed that the consultant should incorporate suggestions of Govt. of Haryana.

In accordance with the direction of CRC, we had detailed discussions with Senior Town Planner, Gurgaon and District Town Planner (DTP), Rewari on 09.11.2011, followed by the discussion with DTP, Rewari on 18.11.11 and finally in a meeting chaired by Sh. S.S. Dhillon at Chandigarh on 22.11.2011. After the discussion, we have marked the modifications in the alignment, required by Haryana Govt. in Dhruhera-Rewari-Bawal areas, on a Key Plan, and from rough measurement on a Google Map, the length of modification in the alignment works out to about 35 km, though the total length of the corridor will remain 180 km as before.

It is noteworthy that Delhi - Alwar RRTS alignment was finalised after field inspection and discussions with Haryana Govt. officers, and the same was presented in the Corridor Alignment Report submitted to NCRPB on 30.12.2010, which was approved by the CRC on 17.3.2011 and later on also by the Task Force on 29.06.2011.

Contd...2

Rec'd. 22/12/11

Registered Office : 5th Floor, 'A' Wing, IFCI Tower, 61 Nehru Place, New Delhi-110 019 t (91) 11 41606074/75/76/78 f (91) 11 26410763 | www.umtc.co.in

-2-

It is for your appreciation that the modification in the alignment now suggested by Haryana Govt. officers, involves fresh field visits, Topographic Survey and Geotechnical Investigation of about 35 km length and also an exercise on the traffic projections for the additional stations, which would require above 3 months time by the consultants to complete this job, and the consultant will have to incur additional expenditure on the manpower and the field investigations. The extra cost involved is being estimated and will be submitted shortly for your approval and go ahead.

A key plan showing the change in the alignment at Dharuhera and in Rewari-Bawal region, marked in red, is attached. Kindly advise us how we will be compensated for the extra work that will have to be done for the changed alignment in Haryana area and who will pay us for the same.

Assuring you our best services at all times.

Yours faithfully

(G. P. Garg)
Sr. Advisor

Encl: As Above

Urban Mass Transit
Company Limited

No.UMTC/GPG/RRTS/NCRPB/146 Dated : 26.12.2011

To,

The Member Secretary,
NCR Planning Board,
Core IV B, First Floor,
India Habitat Centre,
New Delhi – 110 003.

Sub: Consultancy Services for carrying out the feasibility study for Delhi-Gurgaon-Rewari-Alwar Regional Rapid Transit System (RRTS) corridor followed by preparation of Detailed Project Report – **Estimated Cost for additional work due to change of alignment in Haryana.**

Ref:- Contract No.3 of 2009-2010 dated 23.03.2010.

Madam,

This is in continuation of our letter No.UMTC/GPG/RRTS/NCRPB/144 dated 22.12.2011 on the above subject. The additional work required to be carried out due to modifications suggested by Haryana Govt. in the alignment will be as under:

1. Meetings with DTP, Rewari and field officials of HSIIDC as desired by Haryana Govt. in the minutes circulated by CCP (NCR), Panchkula, for finalising the amended alignment;
2. Reconnaissance of the area (about 35km in length) after setting the preliminary alignment on Google map;
3. Topographical Survey for 50 metres on either side of the additional length, and of wider land strips for locating Rewari station, the main maintenance depot near Rewari, as well as Kherki-Daula and Bawal stations;
4. Geo-technical investigations along the modified alignment and the depot area;
5. Designing the modified length of alignment and its plotting on the Topo Survey Sheets;
6. EIA and R&R issues in the modified alignment;
7. Exploring feasibility of TOD near the new sites of Kherki-Daula, Rewari and Bawal stations;

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8. Revisiting travel demand forecasts by running traffic model due to change of stations;
9. Preparation of fresh Operation Plan/time tabling based on the revised traffic forecast and station distances;
10. Estimation of Project cost, Financial analysis and Economic analysis, after incorporating the changes;
11. Preparation of addendum to the Feasibility Report due to these large scale changes.

These activities will require about 3 months time over and above the present timelines. The cost of carrying out additional field investigations and that of the manpower required for above listed activities has been estimated to be Rs. 1.35 crores (Rs, One Crore and Thirty Five lakhs).

It is very kindly requested to please sanction additional Rs. 1.35 crores over and above the contract value, and convey your approval for taking up the above work at the earliest, so that we may remobilise our resources without any loss of time.

Assuring you our best services at all times.

Yours faithfully,

(G.P. Garg),
Senior Advisor

Annexure 3 : Advertisement space on each station

Sr. No.	Station Name	HOARDINGS PLATFORM AREA			HOARDINGS AT ENTRY POINTS			GLOW CUBES	KIOSKS	LED Displays (52 inches)	ADVERTISEMENT IN PARKING LOTS		ADVERTISEMENT ON LIFTS			
		Nos Left Hand Side	Nos. Right Hand Side	Area of hoarding (Per unit In sq. mt.)	Nos. of Hoardings (Left Hand Side)	Nos. of Hoardings (Right Hand Side)	Area of hoarding (Per unit In sq. mt.)	Nos.	Nos	Nos.	No. Hoardings	Size of unit (Sq.mtr)	Dimensions of one side of Lift (sq mt)	No. of Lifts	Dimensions of 5 sides of lift (sq mts)	Ad space out of total space (50% of total space)
1	Kashmere Gate	10	10	10.08	4	4	4.5	160	2	4	2	10.8	3.06	2	15.3	15.3
2	New Delhi	10	10	10.08	4	4	4.5	160	2	4	2	10.8	3.06	2	15.3	15.3
3	Nizamuddin	10	10	10.08	4	4	4.5	160	2	4	2	10.8	3.06	2	15.3	15.3
4	INA	10	10	10.08	4	4	4.5	160	2	4	2	10.8	3.06	2	15.3	15.3
5	Dhaula Kuan	10	10	10.08	4	4	4.5	160	2	4	2	10.8	3.06	2	15.3	15.3
6	Mahipalpur	10	10	10.08	4	4	4.5	160	2	4	2	10.8	3.06	2	15.3	15.3
7	Cyber city	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
8	IFFCO Chowk	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
9	Rajiv Chowk	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
10	Manesar	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
11	Panchgaon	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
12	Daruhera	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
13	BTK	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
14	MBIR	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
15	Rewari	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
16	Bawal	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
17	SNB	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
18	Khaital	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3
19	Alwar	10	10	4.5	4	4	4.5	128	2	4	2	10.8	3.06	2	15.3	15.3

Annexure 4 : Projected Profit and Loss Account

Particular	2017 Rs. Crore	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2046
Fare Box	995	1049	1255	1324	1583	1635	1914	1976	2314	2389	2798	2889	3383	3492	4090	4166	4813	4903	5665	12801
Advertisement	17	26	37	44	51	55	59	64	69	75	80	85	90	95	101	108	114	121	127	194
License Fees	6	7	8	10	11	12	13	14	14	15	16	17	18	19	20	21	22	23	24	34
Carbon Credit	99	109	119	129	133	145	152	147	154	161	168	176	183	191	185	193	194	194	195	0
Net Revenue From TOD	794	779	1853	2005	2792	3521	6072	8895	8462	7594	7554	7358	6967	6336	5412	4131	2237	2529	2857	0
Total	**1911**	**1970**	**3272**	**3513**	**4570**	**5368**	**8210**	**11097**	**11014**	**10235**	**10616**	**10524**	**10641**	**10134**	**9807**	**8618**	**7380**	**7770**	**8869**	**13029**
Staff Salaries	220	240	262	285	311	339	370	403	439	479	522	569	620	676	737	803	875	954	1040	2683
Operations (Traction Expenses)	360	378	397	417	480	504	530	556	584	613	644	676	710	745	953	1000	1050	1103	1158	2074
Energy Expenses	162	172	182	193	205	217	230	244	258	274	290	308	326	346	366	388	412	436	462	878
Repair & Maintenance exp	51	54	57	61	64	68	72	77	81	86	91	97	103	109	115	122	130	137	146	276
Admin Expenses	0	0	0	0	1315	0	0	0	0	0	0	0	0	0	3402	0	0	0	0	0
Replacement in Equipment (10% of Project Cost)	220	240	262	285	311	339	370	403	439	479	522	569	620	676	737	803	875	954	1040	2683
Total	**794**	**844**	**898**	**956**	**2376**	**1128**	**1201**	**1279**	**1362**	**1452**	**1547**	**1649**	**1758**	**1875**	**5573**	**2314**	**2467**	**2630**	**2806**	**5911**
Operating Surplus (EBIDTA)	**1117**	**1126**	**2373**	**2557**	**2195**	**4239**	**7009**	**9817**	**9651**	**8783**	**9069**	**8875**	**8883**	**8259**	**4234**	**6304**	**4913**	**5139**	**6063**	**7118**
Operating surplus/Total Rev.	**58%**	**57%**	**73%**	**73%**	**48%**	**79%**	**85%**	**88%**	**88%**	**86%**	**85%**	**84%**	**83%**	**81%**	**43%**	**73%**	**67%**	**66%**	**68%**	**55%**
Depreciation (As per Cos Act)	900	900	900	900	900	900	900	900	900	900	900	900	900	900	368	279	279	279	279	279
Amortization	131	131	131	131	131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PBT	**87**	**95**	**1343**	**1526**	**1165**	**3339**	**6109**	**8918**	**8752**	**7883**	**8170**	**7975**	**7983**	**7359**	**3866**	**6026**	**4635**	**4861**	**5784**	**6839**
TAX	0	0	0	0	0	0	0	0	0	0	0	0	2855	2660	1306	2023	1562	1650	1974	2392
PAT	**87**	**95**	**1343**	**1526**	**1165**	**3339**	**6109**	**8918**	**8752**	**7883**	**8170**	**7975**	**5128**	**4700**	**2560**	**4003**	**3072**	**3211**	**3811**	**4447**

Note: The above projections are for the generic model without taking into account the method of financing and implementation option. Thus interest cost in not considered.

Annexure 5 : Economic Cost and Benefit Streams for the Project

Amount in Rs Crore

Year	Economic Cost			Benefits											Net Benefits
	Capital Cost	O&M Cost	Total Cost	Fuel Savings	Savings in Capex of Vehicle	Savings due to accidents reductions	Savings in Highway Cost	Savings in Road Infrastructure maintenance cost	Savings due to pollution reduction	Passenger Time Savings	Savings in VoC	Savings due to Waiting time reduction	Comfort Benefits	Total Benefits	
2012	2214		2214	0	0	0	0	0	0	0	0	0	0		-2214
2013	4427		4427	0	0	0	0	0	0	0	0	0	0		-4427
2014	6641		6641	0	0	0	0	0	0	0	0	0	0		-6641
2015	6641		6641	0	0	0	0	0	0	0	0	0	0		-6641
2016	2214		2214	0	0	0	0	0	0	0	0	0	0		-2214
2017	0	632	632	562	1169	408	14409	36	99	1501	259	0.2	10	18453	17821
2018	0	632	632	600	73	443	0	36	109	1579	270	0.2	11	3121	2489
2019	0	632	632	641	78	481	0	36	119	1661	282	0.2	12	3310	2678
2020	0	632	632	684	83	522	0	36	129	1747	295	0.2	13	3509	2877
2021	0	1330	1330	729	89	566	14409	71	133	1837	308	0.2	14	18157	16827
2022	0	669	669	767	142	594	0	190	145	1905	321	0.2	14	4079	3410
2023	0	669	669	744	66	622	0	71	152	1975	335	0.2	15	3981	3312
2024	0	669	669	784	107	652	0	71	147	2049	349	0.2	16	4175	3506
2025	0	669	669	826	74	684	0	190	154	2124	363	0.2	17	4433	3764
2026	0	669	669	870	77	717	0	71	161	2203	378	0.2	18	4495	3827
2027	0	669	669	916	409	751	0	190	168	2285	394	0.2	19	5132	4463
2028	0	669	669	964	91	786	0	71	176	2370	411	0.2	20	4889	4220
2029	0	669	669	1015	624	823	0	71	183	2457	428	0.2	21	5623	4954
2030	0	669	669	1068	150	862	10779	217	191	2549	445	0.2	22	16283	15615
2031	0	1701	1701	1124	197	902	0	98	185	2643	464	0.2	23	5635	3934
2032	0	746	746	1142	201	915	0	217	193	2721	473	0.2	24	5885	5139

Year	Economic Cost			Benefits											Net Benefits
	Capital Cost	O&M Cost	Total Cost	Fuel Savings	Savings in Capex of Vehicle	Savings due to accidents reductions	Savings in Highway Cost	Savings in Road Infrastructure maintenance cost	Savings due to pollution reduction	Passenger Time Savings	Savings in VoC	Savings due to Waiting time reduction	Comfort Benefits	Total Benefits	
2033	0	746	746	1161	129	928	0	98	194	2802	482	0.2	24	5817	5071
2034	0	746	746	1179	100	941	0	186	194	2886	491	0.2	24	6002	5256
2035	0	746	746	1198	103	954	0	217	195	2973	501	0.2	25	6165	5419
2036	0	1895	1895	1217	348	967	0	98	196	3063	510	0.2	25	6424	4530
2037	0	746	746	1236	450	981	0	217	196	3156	520	0.2	26	6781	6035
2038	0	746	746	1255	149	994	0	98	197	3253	530	0.2	26	6502	5755
2039	0	746	746	1274	119	1008	0	186	197	3353	540	0.2	27	6704	5957
2040	0	746	746	1293	122	1021	10779	243	198	3457	550	0.2	27	17692	16945
2041	0	1793	1793	1312	661	1035	0	124	188	3566	560	0.3	28	7473	5680
2042	0	801	801	1327	259	1045	0	243	188	3665	568	0.3	28	7323	6522
2043	0	801	801	1341	185	1055	0	124	187	3767	576	0.3	28	7265	6463
2044	0	801	801	1355	140	1065	0	212	187	3873	585	0.3	29	7446	6644
2045	0	801	801	1369	185	1075	0	331	186	3983	593	0.3	29	7751	6950
2046	0	801	801	1383	369	1085	0	243	185	4096	602	0.3	30	7993	7191

Annexure 6 : Km wise fares

Slab based flat fare						Distance based fare											
KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)
1	15	**11**	20	**21**	30	**31**	34	**41**	42	**51**	56	**61**	67	**71**	78	**81**	89
2	15	**12**	20	**22**	30	**32**	34	**42**	43	**52**	57	**62**	68	**72**	79	**82**	90
3	15	**13**	20	**23**	30	**33**	34	**43**	44	**53**	58	**63**	69	**73**	80	**83**	91
4	15	**14**	20	**24**	30	**34**	34	**44**	45	**54**	59	**64**	70	**74**	81	**84**	92
5	15	**15**	20	**25**	30	**35**	34	**45**	46	**55**	61	**65**	72	**75**	83	**85**	94
6	15	**16**	20	**26**	32	**36**	37	**46**	47	**56**	62	**66**	73	**76**	84	**86**	95
7	15	**17**	20	**27**	32	**37**	38	**47**	48	**57**	63	**67**	74	**77**	85	**87**	96
8	15	**18**	20	**28**	32	**38**	39	**48**	49	**58**	64	**68**	75	**78**	86	**88**	97
9	15	**19**	20	**29**	32	**39**	40	**49**	50	**59**	65	**69**	76	**79**	87	**89**	98
10	15	**20**	20	**30**	32	**40**	41	**50**	52	**60**	66	**70**	77	**80**	88	**90**	99

Distance based fare																	
KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)	KM	Fare (Rs.)
91	100	**101**	111	**111**	122	**121**	133	**131**	144	**141**	155	**151**	166	**161**	177	**171**	188
92	101	**102**	112	**112**	123	**122**	134	**132**	145	**142**	156	**152**	167	**162**	178	**172**	189
93	102	**103**	113	**113**	124	**123**	135	**133**	146	**143**	157	**153**	168	**163**	179	**173**	190
94	103	**104**	114	**114**	125	**124**	136	**134**	147	**144**	158	**154**	169	**164**	180	**174**	191
95	105	**105**	116	**115**	127	**125**	138	**135**	149	**145**	160	**155**	171	**165**	182	**175**	193
96	106	**106**	117	**116**	128	**126**	139	**136**	150	**146**	161	**156**	172	**166**	183	**176**	194
97	107	**107**	118	**117**	129	**127**	140	**137**	151	**147**	162	**157**	173	**167**	184	**177**	195
98	108	**108**	119	**118**	130	**128**	141	**138**	152	**148**	163	**158**	174	**168**	185	**178**	196
99	109	**109**	120	**119**	131	**129**	142	**139**	153	**149**	164	159	175	**169**	186	**179**	197
100	110	**110**	121	**120**	132	**130**	143	**140**	154	**150**	165	**160**	176	**170**	187	**180**	198