2012

Life Cycle Cost Analysis of Five Urban Transport Systems

BUS METRO RAIL MONORAIL LIGHT RAIL TRANSIT BUS RAPID TRANSIT

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EXECUTIVE SUMMARY

It is crucial that India implement efficient and reliable Urban Passenger Transport Systems to ensure the sustenance of a high growth rate and alleviation of poverty. According to a study, by 2030, India will have more than 68 cities having a population of above a million people and 590 million Indians will be staying in cities and towns, twice the American population today. Further, cities' contribution to the GDP growth will be nearly 3/4th and more than 70% of new employment will be generated there. McKinsey's assesses that India need to construct 2.5 billion square meters of roads and 7,400 Km of Metro and Subways in the twenty year time-frame ending 2030. The urban transport scenario in India is unsatisfactory - there is severe quantity and quality deficit. The country is unmistakingly on the path of rapid increase of motorisation, which has accelerated in the past two decades.

The choice of the Urban Transport System is the key decision point for cities, states and the central government. It is most relevant because different classes of cities and different corridors in the same city require different public transport solutions. The country has so far failed to develop objective criteria for the selection of public transport modes. The Working Group for Urban Transport for the 12th Five Year Plan has suggested a shift from the current DPR based approach selection criteria to PHPDT, City/Town Population and Average Motorised Trip Length based.

Nonetheless, it will be appropriate if PHPDT, population and trip length criteria can also be clubbed with the "Cost Based Comparative Approach" to arrive at the proposed appropriate mix of public transport systems.

This study focussed at introducing a scientific cost based approach of arriving at "The Full Life Cycle Cost of different systems"- thereby making "Life Cycle Costs of the Systems" integral to informed decision taking. From this perspective the study marks a paradigm shift and IUT believes that the final outcome of the report shall be first tool available for informed decision making in the country by the policy planners and the union/state/city governments to make the choice of a particular urban transport mode or a combination of that.

Equally importantly, the study has focused on seeing the impact of external environment changes like changing inflation index, variation in interest rates and fluctuation of interest rates etc. that often influence and impact the systems stability and cost over its operational life. The purpose of this exercise has been to ensure that commercial decision-making is informed more particularly from the point of view of appropriate price discovery and consequent transparent subsidy regime definition, if such a situation emerges.

In this report, IUT has evaluated five urban transport systems namely Metro Rail, Mono Rail, Light Rail (both at grade and elevated), Bus Rapid Transit System and Ordinary bus Services.

It is important to note that a system like metro rail has a civil structure (approximate 50% of CAPEX) whose life span runs in many decades (more than 50 years), whereas a system like normal urban bus service has a life span of just 10 years. Various components of different systems show substantial variability in terms of their life and such variability has been carefully accounted for. As a part of analysis due care has also been taken to emphasise how different systems with varying life and varying capacity limitation behave for life cycle cost analysis.

At the beginning of this research, a hypothetical case was assumed based on which the initial LCC of the urban transport systems has been calculated. A hypothetical case of 20 km corridor having a PHPDT of 15,000 is considered for which the LCC has been calculated for 30 year duration for each chosen system. Towards the end of the study, the results have been applied to real life scenarios.

Metro Rail System

Metro Rail is the most prevalent urban transport system in the world after urban bus and has gained further momentum in the recent years particularly due to upswing in the global crude prices. At present more than 175 cities in the world have operational metro rail, while 50 more are in the process of constructing it – 25 of them in China and 9 of them in India itself. The system has a flexible PHPDT carrying capacity and it varies from 20,000 to up to 90,000 depending upon the type of systems used (which impacts the minimum headway), rolling stock and train set configurations (depend upon the design of civil structures like station length).

System	Coach Configuration	Train Set Capacity	Maximum PHPDT at 2.5 minute headway	Maximum PHPDT at 1.5 minute headway
Metro Rail	4	1,100	26,400	44,000
	6	1,650	39,600	66,000
	8	2,200	52,800	88,000

For the purpose of this study, to understand the Capital Expenditure (CAPEX) requirements of this system, the actual construction costs as well as the DPR costs of Delhi Metro Rail Corporation (DMRC) Ph II, DMRC Ph III, Hyderabad Metro Rail Limited (HMRL), and Kochi Metro have been analysed. Post analysis of detailed aspect wise construction and implementation cost, CAPEX assumptions taken for this system (at 2012 prices) for the hypothetical 20 km corridor. The O&M cost data of this system has been assumed from the time series O&M data of DMRC which is currently the only operational large scale metro rail system in India.

Mono Rail System

Monorail is a sleek, elevated transit system which can be built to efficiently serve areas where metro rail cannot penetrate. As it requires a very narrow right of way, and navigate such areas which Metro Rail cannot, it can comfortably be built in an area dominated by high-rises and sharp turns.

Mumbai monorail which is under construction has an assumed PHPDT in first and last year of Project life between 7000-8500 PHPDT whereas the latest DPR of Kozhikode puts the first and last year peak PHPDT as 7000-11500 approximately. A three car mono rail system has been planned both for Mumbai and Kozhikode. A three car system depending upon specification can carry between 400-500 passengers. A monorail can carry a maximum PHPDT of about 28,000 if the highest possible system configuration is taken into account.

System	Coach Configuration	Train Set Capacity	Maximum PHPDT at 2.5 minute headway
Mono Rail	3	384	9,216
	6	768	18,432
	9	1,152	27,648

To understand the CAPEX requirements for this system, the available costs of Kozhikode Monorail, the proposed three corridors of Delhi Monorail and under construction Mumbai Monorail system have been used. The cost data of Kozhikode Monorail which is latest has been used as the basis of making assumptions in this study.

As no monorail system is presently operating in the country, the O&M costs data has been approximated by IUT using available number from project reports, emerging international trends and O&M cost benchmarks. Also the O&M cost data of first year of Kozhikode (2015-16) has been used to derive the O&M cost for the first year in this study for the hypothetical case.

Light Rail System

Light Rail or LRT is a preferred mode where ample right of way is available. Built at-grade or elevated (in portions of narrow right of way). Since LRT is generally built at-grade, they take away the pavement size thereby leaving less space for other modes of commute and may also have interfering space with bus and personalised vehicles. Unless segregated, they tend to ply at slower speeds as their speeds are restricted by other traffic flows, especially at junctions. In the Indian context, with the unplanned spread of the cities, providing the right of way at-grade may not be easy.

The Light Rail System is a preferred mode of transport in areas with a maximum PHPDT of around 23,000 for elevated structure. At grade LRT because of the inherent limitations of a mixed used traffic has a lesser systems capacity.

System	Coach Configuration	Train Set Capacity	Maximum PHPDT at 2.5 minute headway
Light Rail	2	484	11,616
	4	968	23,232

Elevated LRTS is known for being more efficient and has higher carrying capacity than monorail. Modern Light Rail has in recent decades made a comeback in Europe, Australia, and Americas and in recent years even in Asia.

Only 2007-08 price level CAPEX data is available for Delhi LRT and the same has been escalated to arrive at the cost of the hypothetical 20 km LRTS at 2012-13 levels. The O&M data of no Light Rail System is available as on date in the Indian context and thus for the sake of simplification per km O&M Cost of Elevated Light Rail has been assumed at the same level as that of Elevated Monorail

Bus Rapid Transit System

The Bus Rapid Transit System or BRTS is generally a closed mass rapid transit system with dedicated lanes for bus operations. Since its conception as a viable option in Latin America, many cities have adopted it with varied results. BRT is an advanced bus system serving travel corridors with an operational advantage such as exclusive lanes and traffic preference on signals. BRT is faster and more reliable service than ordinary bus services. BRT systems possess a unique advantage of implementation as they ply on segregated Right of Ways (ROW).

BRTS has arrived late in India - even later than arrival of Delhi Metro Phase I. Two cities - Delhi & Ahmedabad have commissioned a few kilometres of BRTS. While the BRTS of Delhi has performed sub-optimally since inception, Ahmedabad's experience has been somewhat better. Today, a dozen cities are planning or implementing BRTS. But the efficacy of the system in cities where ROW segregation at grade has difficulties is yet to be established.

Exceptions apart, the system can passenger flow of 4,000 to 10,000 PHPDT is what can be achieved with BRTS, more so in Indian consideration, and has much lower costs than the other transit systems like metro rail, monorail and light rail. But headway of 0.6 minute has been observed at different intersections of Delhi BRTS which has also been assumed for this study.

System	Coach Configuration	Train Set Capacity	Maximum PHPDT at 1 minute headway	Maximum PHPDT at 0.6 minute headway
BRTS	1	80	4,800	8,000
	2	160	9,600	16,000

CAPEX estimates for BRTS have been derived using data from detailed project reports of Ahmedabad Phase I, Phase II and of Rajkot. Though O&M Cost Data for varied timeline is available, it has been considered prudent to base the assumptions made out of the most recent comparable data available for DTC, BEST, BMTC, MTC(Chennai) & Thane taken from the Journal of Indian Transport (CIRT, Pune) – Latest Edition (April – June 2012). Also since it for ordinary bus systems, an additional O&M cost for the OCC, Security etc. has been incorporated to arrive at the BRTS O&M cost data to be used for this study. To bring the latest O&M cost to present price level a 9% increase was assumed for the manpower and 5% for the other costs.

Ordinary Bus Services

Ordinary Bus Service is a building block of any public transport system across the globe. The requirement of capital expenditure to kick start/maintain this system is one of the lowest among the other modes of urban transport and the bus operator does not have to contribute to the capital costs of creation of infrastructure. Till very recently, ordinary bus was the only mode of public transport in Indian cities. Except Mumbai (before arrival and expansion of Delhi Metro), all principal cities heavily depended on this mode. In many Indian cities, buses do carry up to fifty per cent of all the people commuting by mechanised transport. In Mumbai, whose lifeline is the suburban rail network, the ridership of buses is equally impressive at 5-6 million per day. On the contrary, in Delhi, DTC and Delhi Metro routes are not rationalised DTC is carrying daily commuter trips of 4.5 million.

An ordinary bus service can manage a passenger flow of 3,000 to 5,000 PHPDT. In medium and large sized cities, even today, ordinary buses remain and shall be the predominant mode of urban transport except in higher density corridors, where metro rail systems get created with time.

The CAPEX information for this mode is primarily picked from the Recommendations of Working Group on Urban Transport for 12th Five Year Plan. Similar to BRTS system, the O&M cost data of ordinary bus services have also been assumed from the latest available cost data of bus systems of different metropolitan cities in the CIRT journal.

Assumptions

It has been observed that in general headway of 2.5 minutes to 3 minutes is best suited for rail based system. Thus headway of 2.5 minutes has been considered for all rail based systems. In addition headway of 1 minute has been assumed for ordinary bus services whereas the same has been assumed at 0.6 minutes for BRTS. Based on the headway and capacity of coaches assumed at peak carrying capacity of 6 persons per square meter the total rolling stock requirements have been derived. For the sake of comparison, cost of per unit rolling stock has been assumed at Rs. 10 Crore for all the 3 systems. A station distance of 1 km for Metro Rail, station/shelter distance of 750 m for Monorail, Light Rail and BRTS system and shelter distance of 500 m for ordinary bus services has been assumed. The CAPEX requirements for five systems are presented in the table below:

Item (in Rs Crore)	Unit	Unit Cost - Metro Rail	Total Cost – Metro Rail	Unit Cost - Mono Rail	Total Cost – Mono Rail	Unit Cost – Light Rail	Total Cost – Light Rail
Land		**@10%**	**321.36**	**@10%**	**378.24**	**@10%**	**281.11**
Alignment and Formation							
Elevated viaduct section	R. Km.	**32.00**	640.00	**22.50**	450.00	**21.00**	420.00
OCC Building	LS	**50.00**	50.00	**40.00**	40.00	**40.00**	40.00
Station Buildings							
Elevated stations	Each	**16.00**	320.00	**9.00**	243.00	**10.00**	270.00
E&M Works							
Elevated station (E&M, Lifts, etc.)	Each	**7.00**	140.00	**2.50**	67.50	**2.50**	67.50
Depot	LS	**50.00**	50.00	**120.00**	120.00	**70.00**	70.00
Permanent Way	R. Km.	**7.00**	140.00		-	5.00	100.00
Traction & power							
Elevated	R. Km.	**8.00**	160.00	**5.50**	110.00	**5.50**	110.00
Lift	Each	**0.30**	24.00	**0.30**	16.20	**0.30**	16.20
Escalator	Each	**1.00**	80.00	**1.00**	54.00	**1.00**	54.00
Signalling and Telecom							
Signalling	R. Km.	**13.00**	260.00	**9.00**	180.00	**8.00**	160.00
Telecom	Each Stn.	**3.00**	60.00	**2.00**	54.00	**2.00**	54.00
Automatic fare collection	Each	**3.40**	68.00	**2.50**	67.50	**2.50**	67.50
R & R	R. Km.	**3.20**	64.00	**2.00**	40.00	**2.00**	40.00
Misc. Civil Utilities	R. Km.	**3.80**	76.00	**2.00**	40.00	**2.00**	40.00
Electrical Utilities	R. Km.	**2.90**	58.00	**2.50**	50.00	**2.50**	50.00
Telecom Utilities	R. Km.	**0.50**	10.00	**0.50**	10.00	**0.50**	10.00
Rolling Stock	Each	**10.00**	920.00	**10.00**	2,130.00	**10.00**	1,160.00
General Charges (except land)		**@3%**	93.60	**@3%**	110.17	**@3%**	81.88
Contingencies		**@3%**	**106.05**	**@3%**	**124.82**	**@3%**	**92.77**
Total			3,641.01		4,285.42		3,184.95
Every Route Km			182.05		214.27		159.25

CAPEX of BRTS and ordinary bus is presented below:

Item (in Rs Crore)	Unit	BRTS	Total BRTS	BUS	Total BUS
Land Cost		**@5%**	**56.76**	**@5%**	**16.34**
Roadway Development	R. Km.	**8.55**	171.00		-
Bus Stops	Each	**0.40**	10.80	**0.30**	12.00
Foot over Bridges	Each	**0.25**	6.75		-
Operational Infrastructure (Terminals & Depots)					
Depots	Each	**10.00**	70.00	**10.00**	80.00
Workshops and Terminals	Each	**20.00**	20.00	**25.00**	50.00
Operation Control Center (OCC)	LS	**10.00**	10.00		-
Bridges and Flyovers	R. Km.	**31.80**	636.00		-
ITS application and External Tracking	LS	**29.50**	29.50	**10.00**	10.00
Bus Cost	Each	**0.40**	148.00	**0.40**	165.20
General Charges (except land)		**@3%**	33.06	**@3%**	9.52
Contingencies		**@3%**	35.76	**@3%**	10.29
Total Cost			**1,227.62**		**353.34**
Every Route Km			61.38		17.67

The Working Group Report suggests the requirement of a depot for every 50 buses, with the cost per depot at Rs. 8 Crore. It also estimates one workshop for every 250 buses at Rs. 20 crore, as well as a terminal for every two million population for another Rs. 20 crore, The depots, workshops and terminal costs suggested in the WG report are inclusive of land acquisition and machinery costs.

CAPEX requirements of At Grade Light Rail are as below:

Item (in Rs Crore)	Unit	Light Rail (AG)	Total Light Rail (AG)
Land Cost		**@10%**	**189.52**
Fixed Infrastructure - Civil	R. Km.	**13.00**	260.00
Fixed Infrastructure - Electrical	R. Km.	**9.00**	180.00
Depots	LS	**80.00**	80.00
Operation Control Center (OCC)	LS	**40.00**	40.00
Rolling Stock	Each	**10.00**	1,240.00
Signaling	R. Km.	**2.00**	40.00
General Charges (except land)		**@3%**	55.20
Contingencies		**@3%**	62.54
Total Cost			**2,147.26**
Every Route Km			107.36

The assumptions which were taken in this study for deriving the operations and maintenance cost of the urban transport systems are divided mainly among three critical parameters:

- **Energy Costs**
- **Staff Costs**
- **Repair and Maintenance Costs**
- **Replacements**

After accounting for the 20% regeneration potential of present day modern rolling stock the average per car km traction energy consumption for metro rail, mono rail and light rail systems have been assumed as 2.38 KWh, 1.57 KWh and 1.96 KWh respectively. Similarly for auxiliary energy consumption a consumption of 250 KWh and 2200 KWh has been assumed for each station and depot respectively. For this study, IUT has adopted the initial electricity supply rate of Rs. 4 per KW (2012 prices). The same has been escalated at a rate of 5% per annum.

For bus based transport system efficiency of 3.5 km every litters/kg of fuel has been assumed. Since in general most of the bus based transport system in India is running on diesel thus IUT has considered diesel as fuel at Rs. 45 per litre, with an annual price increase at 5%. The model also incorporates CNG as an alternative fuel choice to ensure that the future scenarios are amiably depicted. The CNG price chosen for this study is Rs. 40 per kg with an escalation of 5%.

The staff requirement per km derived for the various systems has been provided in the table below:

System	Staff Requirement (Per km)
Metro Rail	31.70
Monorail	25.20
Light Rail	19.85
BRTS	92.50
Ordinary Buses	103.25

For every bus a staff requirement of 5 has been assumed which has been segmented upon Traffic, Workshop & Maintenance, and Administration & Account. Similarly for rail based systems a detailed break up has been made for the staff required to carry out the operations as well as for the maintenance works.

Another important consideration in relation to Human Resources is the remuneration, for this purpose, a system average has been chosen based on the 6th Pay Commission. The remuneration has been kept at an average of Rs. 9 lakhs per annum with a yearly increment of 9%. The Assumed Unit Cost of Repair & Maintenance (2012 prices) is below:

Aspects	Metro Rail	Mono Rail	Light Rail	Unit
Building	**29.48**	**22.11**	**22.11**	Rs Lakh per Station
Plant & Machinery	**12.57**	**9.43**	**9.43**	Rs Lakh per Car
Other R&M	**2.3%**	**2.3%**	**2.3%**	Of Building, Plant & Machinery Costs
Other O&M Costs	**11%**	**11%**	**11%**	of Energy, Staff and R&M costs

For bus based systems, the repair and maintenance cost is assumed as:

Component	Cost	Unit
Building/roads	**2.10**	Rs Lakh per bus stop
Tyres & Tubes	**1.13**	Rs per effective Km
Spare Parts	**1.12**	Rs per effective Km
Other R&M costs	**2%**	of building spare and Tyres

Conclusions

The LCC derived for the various modes in the hypothetical case are as follows:

Systems	Number of Seats**	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	25,300	7,792.49	**30.80**
Monorail	27,264	7,676.58	**28.16**
LRTS (Elevated)	28,072	6,539.18	**23.29**
LRTS (At Grade)	30,008	4,578.65	**15.26**
BRTS	29,600	6,574.69	**22.21**
Buses	33,040	5,727.82	**17.34**

Headway for Rail Based Systems has been assumed at 2.5 minutes, whereas for BRTS it has been assumed at 0.6 minutes and for Ordinary Buses at 1 minute.

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

**Number of Seats has been ascertained by multiplying the capacity of each vehicle set with the total sets required for the functioning of the system as ascertained in *Annexure I – Rolling Stock Requirement Assessment*.

It is evident from the above table that LRTS (At Grade) has the least per seat life cycle cost of Rs 15.26 lakh. The LCC of both bus (Rs 17.34 lakhs) and BRT (Rs 22.21 lakhs) is higher than that of LRTS (At Grade). The LCC of Metro rail is high because it is a high capacity mode, much beyond the assumption of 15000 PHPDT made for the hypothetical case. Therefore for a proper comparison, the LCC of various modes has been calculated at different PHPDT levels i.e. demand or usage levels. The result is summarized in the table below. At this hypothetical stage it has been assumed that the capacity of the modes is not a limitation. This aspect of modal capacity and feasibility has been examined later in this section.

PHPDT	Metro Rail	Monorail	LRTS (Elevated)	LRTS (At-Grade)	BRTS	Buses
3000	80.80	69.45	73.10	39.42	41.27	**17.75**
5000	56.94	49.24	49.32	27.59	31.81	**17.78**
7000	45.03	39.32	38.34	22.83	27.81	**17.51**
10000	36.12	32.77	28.92	18.26	24.59	**17.36**
12000	31.88	29.47	25.74	**16.63**	23.40	17.29
15000	27.98	26.93	21.86	**14.91**	22.17	17.30
20000	23.14	24.05	18.85	**13.31**	21.01	17.22
25000	19.97	22.33	16.76	**12.30**	20.21	17.24
30000	18.39	21.14	15.37	**11.64**	19.75	17.19
35000	16.89	20.34	14.33	**11.20**	19.37	17.19
40000	16.05	19.74	13.60	**10.88**	19.14	17.16
45000	15.39	19.29	13.04	**10.62**	18.92	17.18
50000	14.67	18.91	12.59	**10.39**	18.77	17.19

As evident from the above table, LRTS (At grade) remains the cheapest mode at various levels of demand. In all cases LCC reduces substantially as the PHPDT i.e. demand increases except in the case of the buses. Furthermore, in terms of life cycle cost, elevated LRTS also becomes cheaper than BRTS above 15,000 PHPDT.

The table further illustrates that elevated LRTS is cheaper than Metro rail at all PHPDT levels i.e. demand levels. Between Metro rail and Monorail, the table shows that monorail is cheaper than Metro rail up to 15000 PHPDT. However Metro rail is cheaper than Monorail above 15000 PHPDT. A comparison between Metro rail and Monorail is irrelevant because monorail is a medium capacity mode and also as Monorail is recommended for special locations where the road right of way is limited and elevated Metro rail or elevated LRTS will be unsuitable for environmental reasons.

Impact of Capacity Limitations

In actual practice, all modes have an upper limit to capacity; for example bus with a capacity of 80 persons operating at 1 minute headway can carry a maximum of 4,800 PHPDT and not 15,000 PHPDT as assumed in the hypothetical case. Similarly, Metro rail is a very high capacity mode compared to Monorail, LRTS and BRTS. The limiting capacity of each mode depends on factors such as the number of coaches in a train and the frequency of service. The maximum capacity of a mode as per the coach configuration of the train is presented in the table below. The LCC corresponding to each configuration is depicted in the last column of the table.

System	No. of Coaches in the Train	Train Set Capacity	Maximum PHPDT	LCC per seat (in INR Lakh) *
Metro Rail	4	1100	26,400	21.30
	6	1650	39,600	17.03
	8	2200	52,800	15.07
Mono Rail	3	384	9,216	36.38
	6	768	18,432	25.80
	9	1,152	27,648	22.28
Light Rail elevated	2	484	11,616	33.01
	4	968	23,232	19.10
Light Rail At-grade	2	484	11,616	19.90
	4	968	23,232	13.23
BRTS	1	80	8,000	26.65
	2	160	16,000	24.99
Ordinary Buses	1	80	4,800	17.99

Headway for Rail Based Systems has been assumed at 2.5 minutes, whereas for BRTS it has been assumed at 0.6 minutes and for Ordinary Buses at 1 minute.

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

It may be noted that with the increasing mode capacity and hence PHPDT, LCC for Monorail and LRT fall substantially in comparison to Metro rail, BRTS and Bus Services.

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1 INTRODUCTION

The World Bank, in its "Strategy Note on Urban Transport in India", holds firmly to the notion that it is crucial that India implement efficient and reliable Urban Passenger Transport Systems to ensure the sustenance of a high growth rate and alleviation of poverty. It further emphasises that such impact of urban transport on poverty reduction happens both through its indirect effects as a stimulator of poverty reducing growth and through its direct effects on the quality of life of the people. The McKinsey Report "India's urban awakening: Building inclusive cities, sustaining economic growth"[1] estimates by 2030 India will have more than 68 cities having a population of above a million people and 590 million Indians will be staying in cities and towns, twice the American population today. Further, cities' contribution to the GDP growth will be nearly 3/4th and more than 70% of new employment will be generated there. McKinsey's assessment of urban transport infrastructure requirement is humongous – just to take two critical parameters, the report assesses the need for constructing 2.5 billion square meters of roads and 7,400 Km of Metro and Subways in the twenty year time-frame ending 2030.

The urban transport scenario in India is unsatisfactory - there is severe quantity and quality deficit. The country is unmistakingly on the path of rapid increase of motorisation, which has accelerated in the past two decades. A study by Ministry of Urban Development (MOUD), Government of India, presents the following dismal scenario of the share of public transport in different classes of cities:[2]

Table 1-1: Traffic and Transportation Policies and Strategies in Urban Areas (May 2008)

City Category	City Population Range (in Lac)	WSA/MOUD 2007 (%)	RITES Study 1994 (%)
1	< 5.0	0.0 – 15.6	14.9 – 22.7
2	5.0 – 10.0	0.0 – 22.5	22.7 – 29.1
3	10.0 – 20.0	0.0 – 50.8	28.1 – 5.6
4	20.0 – 40.0	0.2 – 22.2	35.6 – 45.8
5	40.0 – 80.0	11.2 – 32.1	45.8 – 59.7
6	> 80.0	35.2 – 54.0	59.7 – 78.7

The current country status is one of huge public transport infrastructure deficit and equally troublesome lack of last mile connectivity and safe infrastructure for non-motorised transport. Obviously, the country is in need of fast movement away from motorization to rapid provisioning of public transport.

The choice of the Urban Transport System is the key decision point for cities, states and the central government. It is most relevant because different classes of cities and different

[1] "India's Urban Awakening: Building inclusive cities, sustaining economic growth", McKinsey Global Institute (April 2010)
[2] Page 24 "Recommendations of Working Group on Urban Transport for 12th Five Year Plan"

corridors in the same city require different public transport solutions. The country has so far failed to develop objective criteria for the selection of public transport modes. The Working Group for Urban Transport for the 12th Five Year Plan has suggested a selection criteria based on the PHPDT, City/Town Population and Average Motorised Trip Length. The Working Group suggested criteria are as follows:

Table 1-2: Selection Criteria of Mass Rapid Transit Mode

Mode choices	PHPDT (2021)	Population (2011 Census; in millions)	Average Motorised Trip Length (Km)
Metro Rail	>= 15,000 for at least 5 km continuous length	>= 2	> 7 – 8
LRT (Primarily at grade)	=< 10,000	> 1	> 7 – 8
Monorail	=< 10,000	> 2	About 5 – 6
Bus Rapid Transit System	>= 4,000 and up to 20,000	> 1	> 5
Organised City Bus Service		> 1 lac (Hilly towns – 50,000)	> 2 – 3

The above, for the first time provides a tool for decision taking. Nonetheless, it will be appropriate that the above criteria is superimposed with the "Cost Based Comparative Approach" to arrive at the proposed appropriate mix of public transport systems, to decide one system in preference of the others and to arrive at transparently determined pricing mechanism for different urban transport systems. The current approach which decision takers follow for metro rail, monorail and BRTS is a DPR based approach. A project is approved based on upfront investment costs (EPC costs) associated with such systems. For buses it is more "top down" largesse under JNNURM, while LRT as a system has not yet been introduced in the modern avatar.

This study focussed at introducing a scientific cost based approach of arriving at "The Full Life Cycle Cost of different systems"- thereby making "Life Cycle Costs of the Systems" integral to informed decision taking. **From this perspective the study marks a paradigm shift and IUT believes that the final outcome of this report shall be the first tool available for informed decision making in the country by the policy planners and the union/state/city governments to make the choice of a particular urban transport mode or a combination of that.**

In addition to EPC costs, PHPDT and route length linked Operations and Maintenance costs, interest and other associated costs and replacement cost during the project life period have been considered integral to such an analysis. The emphasis has been to ensure that these costs are embedded in the process of calculating the "composite Life Cycle Cost" and "Unit Life Cycle Cost" duly taking into account all internalities and externalities, to arrive at a better understanding of how the sustenance of such a system impact the economies of scale with the purpose of assisting the correct decision making at the time of investment. Equally importantly, the study has focused on seeing the impact of external environment changes like changing inflation index, variation in interest rates and fluctuation of interest rates etc. that often influence and impact the systems stability and cost over its operational life. The purpose of this exercise has been to ensure that commercial decision-making is informed more particularly from the point of view of appropriate price discovery and consequent transparent subsidy regime definition, if such a situation emerges.

The prime emphasis of the analysis of the "Life Cycle Cost of Public Transport Systems" has been its role in choosing a specific public transport mode suitable for a particular city or for a particular corridor of a city. Apart from being a key decision point in investment decisions, Life Cycle Cost Analysis as finally arrived at shall be critical input to the government and service providers in transparent pricing of the services/transparent provisioning of subsidy on the pricing regime.

Based on comparison of the LCC across the modes i.e. the lowest overall cost while achieving the required level of service in a hypothetical controlled context, IUT has evaluate, the following principal modes of public transport:

1

Metro Rail System

2

Mono Rail System

3

Light Rail System

4

Bus Rapid Transit System

5

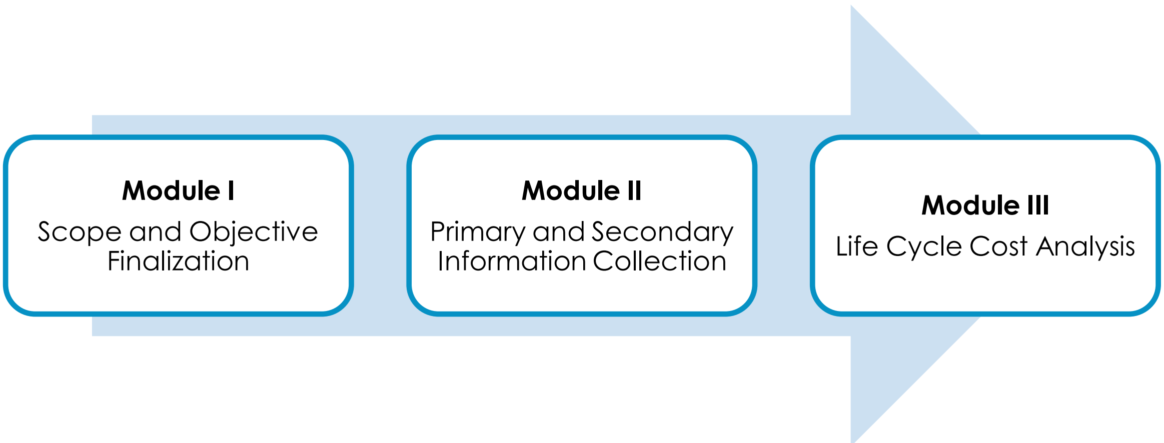
Ordinary Bus Service

2 APPROACH AND METHODOLOGY

"Life-cycle costing" (LCC) is an economic evaluation tool used to compare available alternatives. Our approach for this study was developed carefully to meet the key objectives of the engagement in an organized, efficient and timely manner. Thus the approach followed built on success factors identified by IUT and the working team for the study from their previous experience of similar assignments. It is a combination of approach and skill that helps in delivering the assignment requirements.

A key factor for this assignment was to collect information related to Capital Expenditure and Operating & Maintenance costs from various primary and secondary sources. In our approach, a multi-disciplinary team was brought together significant national and international relevant experience in urban transport, O&M cost optimization of transport modes, financing transport projects, PPP, capacity building etc. Also the team included two uninitiated young members to bring out of box thinking.

A modular approach has been the key differentiator of our approach to this assignment; which has ensured in keeping a check the overall quality of the final output. The study has been carried out principally following a modular approach. The key modules are:



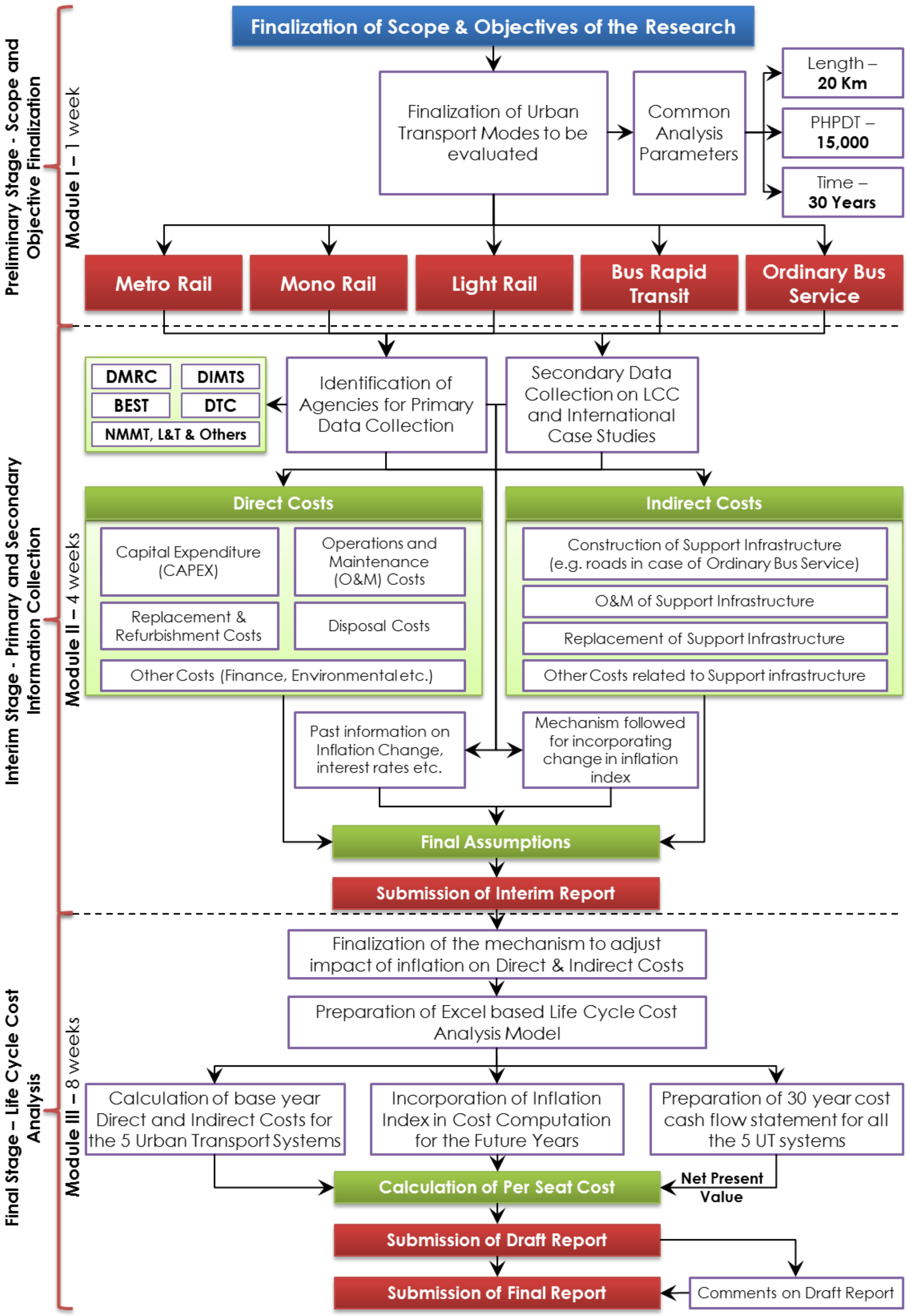
2.1 Module I - Scope and Objective Finalization

For the purpose of this study, five key urban public transport modes were selected which are – Metro Rail, Monorail, Modern Light Rail, Bus Rapid Transit and Ordinary Bus Service. The chosen systems represent "the big picture" of public transport in urban space. Since each of the selected urban transport modes has a different cost (both initial capital cost and recurring operating and maintenance cost), life, carrying capacities etc.; their life cycle cost comparison presented special difficulties. Because of which, within the common analysis parameters, the per unit life cycle cost too was attempted.

At the beginning of this research, a hypothetical case was assumed based on which the initial LCC of the urban transport systems has been calculated. A hypothetical case of 20

km corridor having a PHPDT of 15,000 is considered for which the LCC has been calculated for 30 year duration for each system. Towards the end of the study, the results have been applied to real life scenarios. The detailed methodology followed for the study is represented below:

Figure 1: Approach & Methodology Flowchart



It is important to note that a system like metro rail has a civil structure (approximate 50% of CAPEX) who life span runs in many decades (more than 50 years), whereas a system like normal urban bus service has a life span of just 10 years. Various components of different systems show substantial variability in terms of their life and such variability has been carefully accounted for. As a part of analysis due care has also been taken to emphasise how different systems with varying life and varying capacity limitation behave for life cycle cost analysis.

2.2 Module II - Primary and Secondary Information Collection

The landscape of urban transport in India presents a special difficulty with regard to robust data collection.

The oldest and most prevalent system of urban transport in the country is ordinary bus service and the nation, till very recently did not have an "Urban Bus Specification". The legacy services of BEST, DTC and other major cities used to run on buses made on truck chassis manufactured by Tata Motors and Ashok Leyland. These services had low capacity, low life spans and very high O&M costs. The man-power to bus ratio in these institutions too are abnormally high at 10 persons per bus.

The bus landscape has changed somewhat with the introduction of low-floor buses, AC buses and higher life span Volvo buses. At one end of cost efficiency are Bangalore City Bus Service and the first cluster bus services run by DIMTS in Delhi, and at the other end are old legacy urban bus transport services. As a part of the study, all these aspects needed harmonisation and normalization from cost perspective and the same has been carefully attempted.

On the contrary, in the case of Metro rail, the highest of the urban transport hierarchies has construction costs data and stabilised O&M cost data only available from one city and one organisation (DMRC). Of the other operational systems – Kolkata cost data is not comparable and Bengaluru's 6.7 kilometre long operational stretches is just one year old. Nonetheless, in case of metro rail estimated capital costs and estimated O&M cost data is available from the completed DPRs of a dozen cities. IUT during this module started with DMRC data, analysed other proposed system's data and has carefully arrived at its own normative numbers.

India has no operational monorail system. As yet there is no clarity available as to what is going to be the completed unit cost of construction of the Mumbai Monorail project. However, updated (December 2011) prefeasibility cost data for monorail in Delhi (Shastri Park to Trilokpuri) and DPR cost data (May 2012) for proposed monorail in Kozhikode are also available, both estimated CAPEX and OPEX. IUT has used the available data to arrive at its normative data post analysis of such cost data, duly comparing it with internationally benchmark-able data. In the case of monorail, both CAPEX and OPEX have variability based upon the systems and technology platforms selected and IUT has tried to harmonising the same.

Modern light rail is so far an alien system for the country. The only domestic cost data available is a dated DPR (2007-08 price level) for approximately 45 km of light rail in Delhi. Apart from updating CAPEX and OPEX data in this DPR, IUT has also attempted at learning and gain insight from recent developments in the arena from Europe, Canada, Australia and other countries. An effort has been made to arrive at normative cost, duly taking into account the technological changes and growing technological platforms for LRT systems.

Likewise, BRTS as a system is new to India and except Delhi and Ahmedabad there are no operational systems. Nonetheless various DPR figures are available for CAPEX of fixed infrastructure. IUT has taken into account these numbers and the assumptions available in the latest reports of working group on urban transport for the 12th Five Year Plan. For BRTS allowances have been made for O&M data of depots, workshops and control centre.

During the stage of the preparation of the Intermediate Report, primary data was collected through various domestic agencies such as Delhi Metro Rail Corporation (DMRC), Delhi Integrated Multimodal Transit System (DIMTS), Brihan Electricity and State Transport (BEST), Delhi Transport Corporation (DTC), Bangalore Metropolitan Transport Organisation (BMTC), Larsen and Toubro (L&T) etc. The relevant data from feasibility reports, detailed project reports and completed costs wherever available too has been considered. The primary data was captured for all the cost aspects associated with the particular system operator and classified as direct and indirect costs. In addition, information was also collected for the trend in macroeconomic indicators such as interest rates and inflation index. During this stage, information was also collected with regards to the incorporation of inflation index by the urban transport operators in their actual costs for the next stage of analysis.

The culmination of this module was presented as the interim report, which inter-alia, among other aspects, also provided detailed cost assumption for each mode for derivation of the Life Cycle Cost Analysis (LCCA).

2.3 Module III - Life Cycle Cost Analysis

The first task of this module has been to finalize the mechanism for adjusting the impact of inflation index on the direct & indirect costs of the selected systems. Since the O&M cost of any urban transport system largely varies due to inflation, rise in ridership and ageing of system, a regression was done to generate an equation defining the relationship of inflation, ridership, and ageing of systems to the O&M costs. For all the selected systems, it was assumed that the full capacity will be reached within five years of their commencement of operation, thus assigning the variation in costs with the change in inflation. A scientific analysis of inflation has been done for all the five major areas – manpower costs, energy costs (Oil, CNG or electricity as the case may be), normal repairs and maintenance costs, major overhauling costs and replacement costs over their 30 year operation cycle. The special problem in this inflation analysis is that all five vary in a non-linear manner.

As a final outcome of this study, an excel model of life cycle costs for all the selected five urban transport systems has been developed. Post this; the present value of this cost was derived. An analysis has been performed to calculate the per seat life cycle cost for all the five systems.

While making the 30 year life cycle cost calculations, two scenarios have been considered. The first scenario considers only the direct costs, whereas the second scenario considers both the direct and a suitable allocation of indirect costs.

At the end of this stage, sensitivity analysis for the selected fixed parameters has been included.

3 METRO RAIL SYSTEM

3.1 About the system

Metro Rail is the highest in the hierarchy of public transport systems. It normally runs at fully grade-separated right-of-ways. Metro rail is a high-capacity system with a train consisting of four to ten cars. Metro rail systems require an exclusive, completely grade-separated alignment, thru subways or elevated structures. The carrying capacity of Metro rail can be up to 70,000- 80,000 per hour per direction traffic (PHPDT) depending upon the capacity of rolling stock used, the train configuration and the installed systems (signalling and telecom to provide minimum possible headway).

Table 3-1: Metro Rail Capacity

Metro Rail	Carrying Capacity (passenger/hour) PHPDT
Metro Rail	Up to 70,000-80,000

Metro rail as a system is costly to build, operate and maintain. Nonetheless, for corridors with a Per Hour per Direction Traffic (PHPDT) of over 20,000, it is the only system of urban transport which works.

Metro Rail is the most prevalent urban transport system in the world after urban bus and has gained further momentum in the recent years particularly due to upswing in the global crude prices. At present more than 175 cities in the world have operational metro rail, while 50 more are in the process of constructing it – 25 of them in China and 9 of them in India itself.

Depending upon grade (elevated or underground), the quality and size of the stations, type of rolling stock (including automation features), signalling and other systems, ATS, ATP and ATO, both the CAPEX and the OPEX of metro rail show great variance.

3.2 CAPEX Information

The Indian tryst with capital cost estimation of Metro Rail started with Phase I of Delhi Metro. Capital cost estimates of Bangalore, Hyderabad and Chennai DPRs were based on awarded tender costs of DMRC Phase I. Recent capital costs like Pune, Ludhiana, updated Kochi, Lucknow, Jaipur, Navi Mumbai and Delhi Metro Phase III, have at its base the completion cost data of DMRC Phase II.

Though land costs in different cities are different, for a logical comparison, IUT has harmonised the land cost through averaging out and a specific percentage has been taken as the land cost. Though it has been possible to collect all the DPR's capital cost data, a representative sample of unit rates is provided below. Some of the estimates for obvious reasons are lump sum estimates (e.g. bridges, depot and OCCs) and have been subsequently averaged at the time of making the assumptions:

Table 3-2: Capital Cost Pricing Comparison

Item	Unit	DMRC Ph II at Jan 2010 levels (INR In Crore)	DMRC Ph III at Jan 2010 levels (INR in Crore)	HMRL Ph III at 2005 price level (INR in Crore)	Kochi Metro at May 2005 price level (INR in Crore)
Alignment and Formation					
Underground section by Cut & Cover excluding Station length	R. Km.	91.94	96.34		
Tunnelling by TBM	R. Km.	144.48	137.44		
Ramp (Underground)	R. Km.		42.54		
Elevated viaduct section	R. Km.	28.90	28.45	17.00	15.00
Special Spans	R. Km.		39.90	17.00	
Ramp (Elevated)	R. Km.		17.46	17.00	
At-Grade	R. Km.				6.15
Important bridges	**LS**	**76.28**	**65.00**		
OCC Building	**LS**			**50.00**	
Station Buildings					
Underground Station	Each	157.61	107.63		
Elevated stations					10.00
Type (A) way side	Each	13.13	13.61	10.00	
Type (B) Way side with signalling	Each	14.45	14.97		
Type (C), Terminal station	Each	15.76	16.32		
E&M Works					
Underground station (E&M, Lifts, Escalators, DG sets, UPS, TVS, ECS etc.)	Each		49.08		
Elevated station (E&M, Lifts, Escalators, DG sets etc.)	Each		6.22		
Depot	**LS**	**38.00**	**40.00**	**50.00**	**100.00**
Permanent Way					
Ballast less/Ballasted track for elevated , underground and at grade alignment	R. Km.	6.50	6.17	4.95/1.44	2.95/2.97
Traction & power					
Under Ground Section	R .Km.	13.79	12.13		
Elevated & at grade section	R. Km.	6.57	8.15	5.00	10.00
Lift (for elevated stations)	Each	0.26	0.28	0.20	
Escalator (for elevated stations)	Each	1.05	0.68	0.80	0.80
Signalling and Telecom.					
Signalling	R. Km.	15.10	7.72	11.50	3.50
Telecom	Each Stn.		2.65		1.50
Automatic fare collection					
Underground stations	Each	4.27	2.82		
Elevated stations	Each	3.28	2.82	2.50	1.25
R & R incl. Hutments and road restoration etc.	**R. Km.**		**2.94**	**1.15**	**0.99**
Misc. Utilities, other civil works such as median, road signage etc.	**R. Km.**	**3.94**	**3.00**	**2.50**	**3.00**
Electrical Utilities	**R. Km.**		**2.64**		
Telecom Utilities	**R. Km.**		**0.42**		
Rolling Stock (SG)	**Each**	**5.58**	**8.00**	**4.90**	**4.00**
General Charges incl. Design charge on all items except land		**@ 3%**	**@ 3%**	**@ 5%**	**@ 5%**
Contingencies		**@ 3 %**	**@ 3 %**	**@ 3 %**	**@ 3 %**

As completion costs of Ph-II of Delhi Metro and the estimated costs of Ph-III is the latest and most of the DPRs too have been prepared by DMRC, an average two has been used for making the capital cost assumptions at 2012 price. For bringing the cost to current level, a 5% annual escalation has been assumed.

3.3 Operation & Maintenance Cost Information

The oldest operating metro rail system in the country is Kolkata, whose O&M cost is totally outside the comparative framework because of dated systems and very high per kilometre manpower deployed as compared to the modern systems. Bangalore has so far started operations of 6.7 km of network, which has just completed first year of operations (operations started in October 2011), and both its fixed infrastructure and systems are currently in defects liability period and do not reflect the representative cost structure.

As such only stabilised O&M cost is of Delhi Metro and many years data is available from this system. IUT has attempted harmonising of the O&M cost of DMRC for every year with the total passenger carried and the total length of the operating network during the year.

It can be seen from the table that staff cost and energy costs followed by repair and maintenance costs are the three key determinants of the O&M cost. But for subsidised energy (at no profit no loss), the energy costs have potential to become the highest contributor to O&M Cost.

Also, as the system becomes older, man power cost shall increase (because of more number of services to accommodate growing commuter numbers) and the repairs and maintenance cost too will increase because of aging and extensive utilisation effect. During the thirty year time span, there will also be need for replacement and refurbishing of systems including rolling stock. Rolling stock can be expected to have a life of 25 years (can be extended further with refurbishing) and S&T, Traction and other systems have a lesser time span of around 15-20 years.

A calculation of per km O&M cost for various years of Delhi Metro is given below.

Table 3-3: DMRC O&M Cost (2004-10)

Particulars (In Rs. Crore)	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**
Energy Cost	9.58	28.56	48.06	51.48	70.72	80.31
Repair & Maintenance						
Building	2.52	6.47	13.00	15.09	18.83	20.64
Plant & Machinery	6.69	7.01	11.34	24.44	45.34	38.26
Other R&M Cost	0.37	0.60	1.15	1.28	1.24	0.84
Total Repair & Maintenance	**9.59**	**14.08**	**25.49**	**40.81**	**65.43**	**59.74**
Staff Costs	**17.49**	**26.34**	**37.24**	**48.63**	**66.89**	**93.42**
Other Costs	**7.45**	**11.65**	**15.18**	**17.34**	**20.46**	**22.67**
Land License Fee	-	-	-	-	1.80	1.20
Printing & Stationery	-	-	-	-	1.86	1.92
Vehicle Hire	-	-	-	-	2.59	5.58
Telephone	-	-	-	-	0.94	1.28
Insurance	-	-	-	-	0.61	0.65
Security – CISF	-	-	-	-	3.56	2.58
Misc. Admn. Expenses	-	-	-	-	9.09	9.46

Particulars (In Rs. Crore)	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Total Other Costs	**7.45**	**11.65**	**15.18**	**17.34**	**20.46**	**22.67**
Total Cost	**44.11**	**80.63**	**125.97**	**158.26**	**223.5**	**256.14**
Route Km	26	56	65.1	65.1	65.1	70.36
Average O&M Cost Rs. Crore per Km/annum	1.70	1.44	1.94	2.43	3.43	3.64
Percentage Variation		-15%	34%	26%	41%	6%

As evident form the above table, Staff cost is the most significant O&M cost in the list which was overtaken by energy cost in between but has remained the highest in 2009-10. Energy cost in the initial years of operations where less and has significantly increased over the period of five years. Per km O&M cost of DMRC has increased at an average 16.82% in the given five year data.

For the purpose of this study, per kilometre O&M cost of DMRC has been taken at 2010 prices and has been further escalated to arrive at 2012 prices. The O&M cost for the base year of operation i.e. year 2016 has been assumed at about Rs 166 Crore. A further micro analysis of the Repair and Maintenance cost of DMRC has been done to derive the unit R&M costs and is presented in the table below:

Table 3-4: Unit Repair and maintenance cost of DMRC

Particulars (In Rs Crore)	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
Total Repair & Maintenance	**9.59**	**14.08**	**25.49**	**40.81**	**65.43**	**59.74**
Building	2.52	6.47	13.00	15.09	18.83	20.64
Plant & Machinery	6.69	7.01	11.34	24.44	45.34	38.26
Others	0.37	0.60	1.15	1.28	1.25	0.84
Number of Stations	23.00	49.00	57.00	57.00	65.00	72.00
Number of Depots	3.00	3.00	3.00	3.00	3.00	3.00
Rolling Stock	100	160	280	280	300	320
Unit cost of Maintenance						
Building Rs Lakh per station	**0.11**	**0.13**	**0.23**	**0.26**	**0.29**	**0.29**
Plant & Machinery Rs Lakh per car	**0.07**	**0.04**	**0.04**	**0.09**	**0.15**	**0.12**
Other costs - % of Building & P&M Costs	**4.02%**	**4.47%**	**4.73%**	**3.23%**	**1.95%**	**1.42%**

Thus the above table depicts that the per station maintenance cost of buildings has increased but has stagnated at about Rs 29 lakh per station per annum. Similarly the plant and machinery cost which is directly proportional to the rolling stock requirements has increased steadily after the completion of the initial Defect Liability Period (DLP) and has become an average of Rs 12.5 Lakh per car per annum. The other costs pertaining to repair and maintenance has remained low in the later years and were average 2.2% of the building and plant and machinery cost in the last three years of the available data.

4 MONORAIL SYSTEM

4.1 About the system

The Monorail is a sleek, elevated transit system which can be built to efficiently serve areas where metro rail cannot penetrate. As it requires a very narrow right of way, and can navigate such areas which Metro Rail cannot, it can comfortably be built in an area dominated by high-rises and sharp turns.

The cost of monorail system lies between the cost of LRT and elevated Metro rail. It can be a feeder to metro rail. It also has applicability for specific corridors in second and third tier cities, particularly where metro rail is not justified or feasible and bus services are sub optimal option. Even in metropolitan cities, where Metro Rail covers the main arterial networks, it can play the role of feeder service in carefully identified corridors.

At present one monorail system is under construction in Mumbai- and its PHPDT in first and last year of Project life is estimated between 7000-8500 PHPDT. Similarly, the latest DPR of Kozhikode puts the first and last year peak PHPDT as 7000-11500 approximately. A three car mono rail system has been planned both for Mumbai and Kozhikode.

Monorail and elevated LRT are similar in that they operate on elevated guide ways but monorail operates on guide way requiring only one beam (normally concrete) and mono rail cars have rubber tires. The beam typically measures around three feet in width. Two ways system requires two beams separated 5 m apart. A three car system depending upon specification can carry between 400-500 passengers. Its traction is typically 750 volt DC. It can be configured to run as driver less system.

Monorail systems can realize a number of benefits when compared to elevated LRT:

- Better performance on steep grades. It is quieter rubber tires on concrete or steel guide-ways.
- Less imposing elevated structure as it comprises of narrow beams are less wide than LRT.
- Easier and less expensive construction as narrow beams requires less construction material and allows for use of pre-fabricated segments.

But true efficacy of monorail as a sustainable urban transport mode has many unanswered questions, *the biggest of them being switching and evacuation in an emergency.* IUT has tried to create both best case and optimum case scenario and few other cities are likely to follow the lead of Mumbai, Kozhikode, Delhi and Trivandrum.

4.2 CAPEX Information

It has been possible to source detailed cost data of Monorail from a) 3-corridor, 48 km proposed monorail project at Delhi 2007-08 feasibility report and b) The most recent capital cost data from DPR of proposed 14.2 Km Monorail at Kozhikode. Updated summary cost data for the 11.5 Km long Shastri Park – Trilokpuri corridor at Delhi has also been collected. The detailed cost estimates of 19.54 km under construction monorail at Mumbai is Rs. 2,716 crore, which comes to approximately 140 crore per km and is likely to rise higher.

The estimated costs for the Kozhikode Metro have been represented in the table below:

Table 4-1: Kozhikode Monorail Capital Expenditure Estimates

Description	Unit	Rate (INR in Crore at April 2012 prices)	Quantity	Cost (INR in Crore at April 2012 prices)	% of Total Cost
Land – Government	Ha	66.00	0.518	34.20	2.19
Land – Private	Ha	66.00	1.582	104.44	6.67
Fixed Infrastructure – Civil*				512.93	32.77
Fixed Infrastructure – Electrical Systems	R. Km.	6.70	14.20	95.08	6.07
Fixed Infrastructure – Depot & OCC	LS			79.80	5.10
Rolling Stock	Each	10	36	360	23.00
Signaling, Telecom & AFC**				204.90	13.09
General Charges (excluding land cost)	8%			102.29	8
Contingency	3%			45.59	3
Total				**1565.13**	**100**

**Elevated structure at 22.55 crore per km, Stations at 8.8 crore each and E&M at 1.47 crore, including lifts & elevators at stations. Other costs have been estimated at lump sum basis.*

***The signalling cost is taken at 9 crore per km, telecom at 2 crore per station and AFC at 2.3 crore.*

The capital cost details of 3-corridor Delhi Monorail of 47.8 km as per the cost estimated at 2007-08 price level is in the table below:

Table 4-2: Delhi Monorail (3 – Corridor/47.8 Km) Capital Expenditure Estimates

Description	Quantity	Cost (INR in Crore at 2007-08 price level)	% of Total Cost
Preparatory Expenses		1	0.0
Land – Government		1387	21.4
Land – Private		101	1.6
Fixed Infrastructure – Civil	47.8	1834	28.4
Fixed Infrastructure – Electrical Systems	47.8	450	7.0
Fixed Infrastructure - Depot & OCC	2	200	3.1
Rolling Stock		1379	21.3
Signalling, Telecom & AFC	Signalling - 47.8	580	9.0
Taxes & Duties		535	8.3
Total		6467	100
Total (Excluding Land & Taxes)		4545	

Summarized cost up to date of 11.5 km long 12 station monorail corridor between Shastri Park and Trilokpuri in East Delhi is as follows:

Table 4-3: Shastri Park - Trilokpuri Monorail Capital Expenditure Estimates

Description	Estimated Cost (INR in Crore at October 2011 price level)	% of Total Cost
Land (Government owned)	-	0
Civil Infrastructure	840	50.76
System	815	49.24
Total	1655	100

As the data pertaining to Delhi Monorail is of a feasibility report conducted in 2007-08 and updated recently, the same has not been considered for assumptions. In its place, the cost data of Kozhikode Monorail which is latest has been assumed as the basis of assumptions. As Kozhikode Monorail data is at April 2012 price, no escalation is required to be assumed.

4.3 Operation & Maintenance Cost Information

As no monorail system is presently operating in the country, the O&M costs data has been approximated by IUT using available numbers from project reports, emerging international trends and O&M cost benchmarks. A rudimentary O&M cost data for first year operations of proposed 47.8 km monorail was estimated at Rs. 82 crore for 2011-12. Year-wise projected O&M cost data for proposed 14.2 km Kozhikode monorail is available with IUT and is tabulated below:

Table 4-4: Kozhikode Monorail O&M Cost Estimates

Year	Staff (INR in Crore)	Maintenance Expenses (INR in Crore)	Energy (INR in Crore)	Total (INR in Crore)
2015 - 2016	16.33	9.33	4.00	29.67
2020 - 2021	44.00	21.00	10.00	75.00
2025 - 2026	68.00	26.00	15.00	109.00
2030 - 2031	105.00	32.00	23.00	160.00
2035 - 2036	160.00	42.00	33.00	235.00
2040 - 2041	246.00	53.00	49.00	348.00

With regards to the operations and maintenance costs of Monorail systems, it is important to note that energy costs are the biggest expense, which at minimum varies between 35 – 45 per cent of the total expenditure. The second important cost component is the staff cost and per kilometre staff of 25 as assumed for the Kozhikode metro is compared apt (Per km manpower for Delhi Metro is 40). The Monorail O&M cost Data of first year of Kozhikode (2015-16) has been used to formulate the assumptions for the model..

5 LIGHT RAIL SYSTEM

5.1 About the system

Light Rail or LRT is a preferred mode where ample right of way is available. Built at-grade or elevated (in portions of narrow right of way), the Light Rail System is a preferred mode of transport in areas with a maximum PHPDT of around 20,000. At grade LRT because of the inherent limitations of a mixed used traffic has a lower system capacity.

Since LRT is generally built at-grade, they take away the pavement size thereby leaving less space for other modes of commute and may also have handicapped movement due to the intersecting bus and personalised vehicle traffic. Unless segregated, they tend to ply at slower speeds as their speeds are restricted by other traffic flows, especially at junctions. In the Indian context, with the unplanned spread of the cities, providing the right of way at-grade may not be easy.

Typical light rail systems possess a similar mixture of characteristics as bus rapid transit. Light rail transit has a lower capacity and lower speed (At-grade) than heavy rail and metro rail systems. LRT vehicles are lighter and generally operate singly or in two-car trains. IUT has assumed a two car set and has also done a futuristic analysis with four car set. The space requirement for the system is approximately 7-9 m exclusive ROW. It is said to be more viable means of affecting modal shifts than enhanced bus service.

Elevated light rail is another mass rapid transit option. The principal difference between elevated LRT and LRT at grade is the right of way. Elevated LRT runs on raised track supported by steel or concrete structures. The elevated guide-ways are typically 5-6 m above grade. These can reach more than 10 m above grade to bypass existing roads and bridges. The guide-way columns are typically spaced 30 m apart along the right of way. The advantage to elevated LRT over conventional light rail is that less right of way is required because track is elevated.

Elevated LRTS is known for being more efficient and has higher carrying capacity than monorail. Modern Light Rail has in recent decades made a comeback in Europe, Australia, and Americas and in recent years even in Asia. IUT has made an endeavour to incorporate learning from the recent development in LRT particularly in their capital and O&M cost structure

5.2 CAPEX Information

In the name of LRT, India has a rickety tramway now running on truncated routes in Kolkata and is not relevant for comparison. A project report was made in 2007-08 for a 45 km 3 – corridor LRT system in Delhi and its capital cost estimates are as follows:

Table 5-1: Delhi LRT Capital Estimates

Description	Cost (INR in Crore at 2007-08 price levels)	% of Total Cost
Preparatory Expenses	10	0.25
Land – Government	628	16.65
Land – Private	28	0.76
Fixed Infrastructure – Civil	442	11.72
Fixed Infrastructure – Electrical Systems	300	7.94
Fixed Infrastructure - Depot & OCC	483	12.78
Rolling Stock	1456	28.55
Signaling, Telecom & AFC	84	2.23
Taxes & Duties	345	9.12
Total	3776	100

In recent decades modern LRT services both at grade and elevated have sprung up across various cities in Europe, Canada, USA (Baltimore being the most successful) and in more recent years in Australia and even some Asian cities. Working group reports on Urban Transport for the 12th Five Year Plan, which has provided cost assumptions for other principal modes of urban transport, has not provided any such guidance for LRT.

Only Delhi 2007-08 data is available and the same has been escalated to arrive at the cost at 2012-13 levels. The land cost estimated in the report which through back-end calculation including taxes and duties comes to approximately 17% and seems to have been considered on the higher side. Similarly, civil structures at 11.72% appear to be at lower side. Suitable adjustment has been done in assumptions to arrive at correct cost at the current level.

It has been ascertained from various sources and not much difference is there in per unit rolling stock cost of modern LRT with a monorail rolling stock or a metro rail rolling stock. Even in Kozhikode Monorail DPR, cost of one rolling stock has been assumed at Rs. 10 Crore. For the sake of comparison, cost of per unit rolling stock has been assumed at Rs. 10 Crore for all the 3 systems.

For the sake of comparison of LRT with elevated monorail and elevated metro, a hypothetical elevated LRT system too has been assumed, for which the capital cost structure has been derived interpolating and harmonising the cost data of monorail and elevated metro rail.

5.3 Operation & Maintenance Cost Information

For 3 corridors, 45 km LRTS at Delhi, the study carried out in 2007-08 estimated the first year cost of O&M at Rs. 112 Crore for the financial year 2011-12. In the absence of detailed information on the CAPEX and O&M costs domestically, IUT has also looked at the comparative numbers from international case-studies, and has tried to convert them to INR, using purchasing power parity and further modulation to suit Indian conditions.

For the purpose of O&M cost data of elevated LRT, an interpolation from past O&M cost data available for DMRC and prospective O&M cost data of Kozhikode Monorail has been suitably tweaked to arrive at LRT O&M cost.

6 BUS RAPID TRANSIT

6.1 About the system

The Bus Rapid Transit System or BRTS is generally a closed system mass rapid transit system with dedicated lanes for bus operations. Since its conception as a viable option in Latin America many cities have adopted it with varied results. Exceptions apart, passenger flow of 4,000 to 10,000 PHPDT is what can be achieved with BRTS, more so in Indian consideration, and has much lower costs than the other transit systems like metro rail, monorail and light rail, BRTS presents itself as a choice for regions with ample right of way to accommodate it. It can be a suitable choice for planned cities that are being developed, as the current status of congestion in the developed cities make such a development difficult.

BRT is an advanced bus system serving travel corridors with an operational advantage such as exclusive lanes and traffic preference on signals. BRT is faster and more reliable service than ordinary bus services. Bus Rapid Transit is supposed to have the flexibility with which it can be implemented. BRT systems possess a unique advantage of implementation as they ply on segregated Right of Ways (ROW)

The first, and still one of the best BRT systems in the world, is in Curitiba, Brazil. Opened in 1974, Curitiba's BRT features the following characteristics:

i. Physically segregated exclusive bus lanes
ii. Large, comfortable articulated or bi-articulated buses
iii. Fully enclosed bus stops, where passengers pay to enter the BRT station through a turnstile rather than paying the bus driver
iv. A bus station platform level with the bus floor
v. Bus priority at intersections, largely by restricting left hand turns by mixed traffic vehicles
vi. Private bus operators paid by the bus kilometre

BRTS has arrived late in India - even later than arrival of Delhi Metro Phase I. Two cities - Delhi & Ahmedabad have commissioned a few kilometres of BRTS. While the BRTS of Delhi has performed sub-optimally since inception, Ahmedabad's experience has been somewhat better. Today, a dozen cities are planning or implementing BRTS. But the efficacy of the system in cities where ROW segregation at grade has difficulties is yet to be established.

6.2 CAPEX Information

BRTS CAPEX estimates have been derived using data from detailed project reports of Ahmedabad Phase I, Phase II and of Rajkot. In addition, an estimated completion cost of BRTS in Delhi too is available, which is presented in the subsequent sections.

The CAPEX estimates for the Ahmedabad Phase I was for 58.3 km of BRTS corridor whereas its Phase II was for 26 km. The DPR for the Rajkot BRT was prepared for a route length of 10.7 Km. The table below provides breakup of CAPEX for a BRTS corridor:

Table 6-1: Comparative Tabular Representation of BRTS Capital Costs

Description	Unit	Ahmedabad BRTS Phase I (2007 Prices) in Rs. Lakh	Ahmedabad BRTS Phase II (2008 Prices) in Rs. Lakh	Rajkot BRTS (2007 Prices) in Rs. Lakh
Roadway Development	Per Km	630	810	513
Bus Stops	Each	35	40	10
Foot over Bridges	Each			20
Operational Infrastructure (Terminals & Depots)	Lump Sum	430	350	250
Bridges and Flyovers	Per km	3829	2289	1770
ITS application and External Tracking	Lump Sum	NA	4500	340
Bus Cost				30

The cost estimates above are dated but have been brought to the current level by increasing it at a rate of inflation during these years, for this purpose an inflation factor of 5% per annum. Also latest estimates for the per km infrastructure for BRTS as assumed by Working Group Report for 12th Five Year Plan is available- the working group report has assumed a Rs. 20 Crore per km cost of infrastructure creation for BRTS.

The total approved cost of Phase I and Phase II BRTS corridor in Ahmedabad was of Rs. 493 Crore and Rs. 488 Crore respectively. The Rajkot BRTS corridor had an approved cost of Rs. 110 Crore.

The capital cost analysis of Ahmedabad and Rajkot BRTS suggests, Phase I of the Ahmedabad BRTS was planned at a rate of Rs. 8.5 Crore per km whereas Phase II was planned at a rate of Rs. 18.76 Crore per km (which is close to working group on urban transport cost numbers). The DPR of Rajkot BRTS corridor suggests a per km cost of construction as Rs. 10.3 Crore. In addition, 3% of the gross total cost of construction has been assumed as contingency charges and another 0.5% as general consultancy and administrative charges.

The 14.5 km long BRTS corridor of Delhi from Ambedkar Nagar to Delhi Gate was planned at a cost of Rs. 215 Crore. The average cost of construction of BRTS corridor in Delhi was estimated at Rs. 14.83 Crore per km.

6.3 Operation & Maintenance Cost Information

Only BRTS corridor of Ahmedabad and Delhi are currently operational. A typical monthly maintenance cost of 5.8 km long operational BRTS corridor in Delhi is of about INR 30 lakh per month. Since the buses which runs on this corridor are either run by Delhi Transport Corporation (DTC) or are operated by private players under the cluster scheme of DIMTS, there is no information on the costs of bus operations on this corridor. The INR 30 lakh per month of maintenance cost of the Delhi BRT corridor broadly includes staff salaries, cost of operation control centre (OCC), repair & maintenance of information technology systems (signaling, CCTV surveillance etc.).

The Phase I of Ahmedabad BRTS has an operating length of 58 km on which the operating cost per passenger km is of Rs. 0.395.

The O&M data available for the operational BRTS corridors are difficult to conclude for consideration for this study thus for running the buses on BRTS corridor the O&M cost has been approximated to the general bus services with the following modifications: a) Additional costs due to OCC, and signalling systems will be added. b) Rolling stock efficiency in terms of lesser number of buses required, due to segregation of bus lane has been factored in.

7 ORDINARY BUS SERVICES

7.1 About the system

Ordinary Bus Service is a building block of any public transport system across the globe. The requirement of capital expenditure to kick start/maintain this system is one of the lowest among the other modes of urban transport and the bus operator does not have to contribute to the capital costs of creation of infrastructure.

Till very recently, ordinary bus was the only mode of public transport in Indian cities. Except Mumbai (before arrival and expansion of Delhi Metro), all principal cities heavily depended on this mode.

While bus operations should be a financially sustainable venture, the same in Indian conditions have fared rather poorly – sole exceptions in recent years being BMTC, Bengaluru and BEST, Mumbai. The perennial problem of Delhi bus systems has been the populist fare structure, disproportionately high man-power to bus ratio, increasing fuel cost and high repair, maintenance charges of over-aged buses. There have been some changes for the better in recent years with the introduction and provisioning of urban bus systems to cities and towns under the JNNURM.

In many Indian cities, buses do carry up to fifty per cent of all the people commuting by mechanised transport. In Mumbai, whose lifeline is the suburban rail network, the ridership of buses is equally impressive at 5-6 million per day. A unique feature of Mumbai's bus system is that it principally acts as east-west connector and bus routes have a symbiotic relationship with the suburban rail network. On the contrary, Delhi which now has metro rail system of substantial length and whose ridership is increasing fast (has crossed two million per day), DTC and Delhi Metro routes are not rationalised. Despite this, both metro rail and DTC have seen increase in ridership and the latter's daily commuter trips have reached 4.5 million.

An ordinary bus service can manage a passenger flow of 3,000 to 8,000 PHPDT. In medium and large sized cities, even today, ordinary buses remain and shall be the predominant mode of urban transport except in higher density corridors, where metro rail systems get created with time.

7.2 CAPEX Information

The CAPEX as gathered from Delhi Transport Corporation are for all the buses and associated infrastructure which were built during the Commonwealth Games 2010. The costs which were paid for the procurement of rolling stock are as below:

Table 7-1: Commonwealth Games Bus Acquisition Costs

Description	Quantity	Landed Rates (Rs.)	Total Amount (Rs.)
AC Buses:			
AC LF Buses first tender	25	67,54,537/-	16,88,62,425/-
AC LF Buses second tender	426	59,37,253.30	292,92,69,906/-
AC LF Buses second tender	250	61,57,673/-	153,94,18,250/-
Non AC Buses:			
Non AC LF Buses first tender	625	41,34,468/-	258,40,42,500/-
Non AC LF Buses second tender	1500	49,98,509/-	749,77,63,500/-
Non AC LF Buses second tender	375	51,84,078/-	194,40,29,250/-

Another key parameter of capital expenditure involved in the operations of ordinary bus services are depots. The landed costs of the depots which were built for the CWG 2010 in Delhi by DTC are as below:

Table 7-2: Commonwealth Games Depot Construction Costs

No	Name of the Project	Landed Costs (in Rs. Crore)
1.	Construction of Bus Depot at Dwarka Sector-8	9.31
2.	Construction of Bus Depot at Dwarka Sector-2	9.78
3.	Construction of Bus Depot at Okhla-III	11.58
4.	Construction of Bus Depot at Narela	9.42
5.	Construction of Bus Depot at Kanjhawla-I	10.76
6.	Construction of Bus Depot at Kanjhawla-II	9.71
7.	Construction of Bus Depot at Rohini-IV	10.40
Total		71.96

Remarks- Deviation approved by Transport Dept. Letter No.F.16 (56)/PLG/TPT/09/485 dt.14.1.10

The average cost of the depots made by DTC as per the table above comes to Rs. 10.3 Crore for an average 150-200 parking capacity.

The price as suggested in the Working Group (WG) Report of the 12th Five Year Plan for the procurement of buses in million plus cities is of Rs. 38.8 Lakh and for other low population cities, it has been assumed at Rs. 25.2 Lakhs. Nonetheless today, wide choices have become available with regard to buses and the cost of a bus acquisition in case of latest Volvo city buses (already in operation in a few cities) can be as high as Rs. 80-100 lakhs.

The Working Group Report suggests the requirement of a depot for every 50 buses, with the cost per depot at Rs. 8 Crore. It also estimates one workshop for every 250 buses at Rs. 20 crore, as well as a terminal for every two million population for another Rs. 20 crore, The depots, workshops and terminal costs suggested in the WG report are inclusive of land acquisition and machinery costs.

The contingency expenses which are considered for preparation of transport infrastructure for the ordinary bus services are at 3% in addition to a 0.5% general consultancy.

7.3 Operation & Maintenance Cost Information

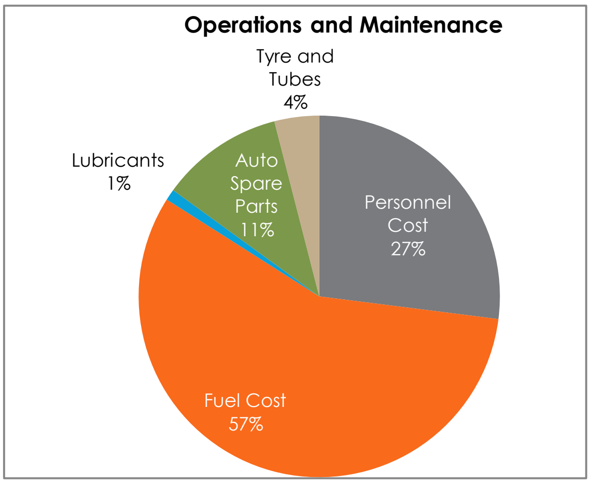
A lot of data asymmetry exists in the O&M cost data at this stage, though IUT has been able to capture a big picture of the same. The data for DTC, BEST, NMMC and DIMTS have been collected and are presented in disaggregated manner.

As per the assessment carried out by the members of Indian Institute of Technology, Delhi in the Working Group Committee for Urban Transport in the 12th Five Year Plan, the operations and maintenance cost of Delhi Transport Corporation is as per the table below:

Table 7-3: DTC - O&M Cost

Heads	2005-06		2006-07		2007-08		2008-09	
(in Rs. Lakh)	Expenses	% total	Expenses	% total	Expenses	% total	Expenses	% total
Personnel Cost	34,506	37%	37,213	35%	40,927	31%	61,553	35%
Material Cost	13,371	15%	12,908	12%	13,361	10%	13,990	8%
Taxes	686	1%	651	1%	816	1%	958	1%
Interest	35,663	39%	49,276	46%	66,857	51%	86,374	49%
Miscellaneous	2,704	3%	2,122	2%	3,438	3%	5,794	3%
Depreciation	5,213	6%	5,432	5%	5,719	4%	7,013	4%
Total	92,145	100%	107,594	100%	121,119	100%	125,685	100%

Under the cluster scheme of DIMTS, in its cluster 1 which is operational for last one year, per km cost of O&M is of **Rs. 5.5 per bus km**.



Another assessment which was carried out by Tata Consultancy Services (TCS) for the Brihan Electricity and State Transport (BEST), a major portion of O&M costs are incurred for covering personnel and fuel costs which is 84% of the total.

Other Operating and non operating expenses as assessed in the study carried out by TCS for BEST is presented in the table below (in paisa per bus km):

Table 7-4: BEST - O&M Costs

Components of Cost	SD	AC	Midi	DD	Overall
Variable Cost (VC)					
Fuel Oil	1020	1761	1032	1271	1040
Lubricating Oil	10	83	15	3	10
Tyres and Tubes	42	42	42	42	42
Materials (Garaging and Workshop)	125	387	192	322	138
Cost of Ticket Block	11	2	17	23	12
Passenger Tax	112	99	114	183	115
Conductors & Drivers (Salaries, Wages & DA, PF etc.)	1363	1296	2117	2310	1419

Total (A)	**2683**	**3671**	**3529**	**4154**	**2777**
Fixed Cost (FC)					
Transportation Engg Gen Establishment – Salaries	14	14	14	14	14
Garaging, Workshop, MM Stores – Salaries	382	382	382	570	391
Engg Miscellaneous Expenses	72	72	72	108	74
Registration and License Fees	8	60	7	2	8
Traffic Gen & Traffic Other outdoor staff – salaries	182	228	282	216	185
Ticket and Cash Est. Salaries	64	80	99	76	65
Traffic Misc. Expenses	137	137	137	137	137
Gen Admin Expenses	284	284	284	284	284
Provision for Depreciation and Additional Depreciation	220	905	505	227	231
Interest charges etc.	6	27	15	7	7
Interest on Internal Funds	71	293	164	74	75
Bus Lease Rental	67	0	0	0	62
Total (B)	**1506**	**2482**	**1960**	**1713**	**1532**
Total A+B	**4189**	**6153**	**5490**	**5867**	**4309**
Kms run – Annual in million	223	2	3	12	240
Kms run - Daily	610594	6442	8142	33247	658425
No of buses	**3042**	**51**	**63**	**235**	**3391**
Fixed Cost in Rs. per bus	**3024**	**3135**	**2534**	**2423**	**2975**
Total Cost in Rs. per bus	**8409**	**7772**	**7095**	**8300**	**8367**

Remarks: SD – Single Deck, AC- Air Conditioned, Midi – Mini Buses, DD – Double Deck

The report also projected the operating and non operating costs of BEST for a new procurement whose estimated costs are as per below:

Table 7-5: BEST O&M Cost Estimation 2006-11

	Unit	2006-07	2007-08	2008-09	2009-10	2010-11
Number of Buses		121	177	234	299	373
Operating cost						
Staff -Driver	Rs. in million	64.09	99.99	139.25	188.26	248.66
Fuel	Rs. in million	125.61	177.05	239.57	329.49	442.35
Lubricants	Rs. in million	1.18	1.75	2.33	3.01	3.79
Tyres and Tubes	Rs. in million	4.87	7.19	9.6	12.4	15.62
Material and Spares	Rs. in million	15.96	23.59	31.48	40.65	51.22
Non-Operating cost						
Interest on loan	Rs. in million	19.31	28.27	37.39	47.83	59.7
Depreciation	Rs. in million	27.15	39.76	52.57	67.26	83.96
MV Tax	Rs. in million	0.69	1.01	1.34	1.71	2.13
Misc. Expenses Traffic	Rs. in million	6.51	8.83	10.83	12.84	14.86
Misc. Expenses Engg	Rs. in million	12.06	16.37	20.06	23.79	27.53
Gen Admin Expenses	Rs. in million	5.4	8.3	11.53	15.48	20.29

As per the toolkit which was prepared by ADB for Public Private Partnership in Urban Bus Transport in Maharashtra, the O&M costs for 269 buses for year 2009 were estimated as per the table below:

Table 7-6: O&M Costs for 269 buses for 2009 (ADB Toolkit)

Heads	Cost (in Lakh)
Salaries	730
Other Administrative Expenses	50
Vehicle Maintenance	164
Fuel Expenses	539
Stationery	166
Total taxes and other workshop related expenses	731
Interest Expenses	207
Total Expenditure	2420

It has been possible to collect information of operations & maintenance costs of major metropolitan bus systems along with their physical performance data. The latest data available pertains to September, 2011. To bring the same to the latest a 9% increase was assumed for the manpower and 5% for the other costs. The following table forms the basis of assumptions for the bus systems (both ordinary buses and buses plying on BRTS corridor) based on the figures collected from various tables of latest available Central Institute of Road Transport (CIRT) journal.

Table 7-7: O&M Cost/ Physical Data for Bus Systems (CIRT, September 2011)

Description	BEST	DTC (City)	MTC - CN1	BMTC (STU)	Thane MTU
Cost (Rs. in lac)					
Personnel	24378.17	26640.68	15610.84	13126.95	1249.43
Fuel & lubricants - Rs. in lac	8692.86	11116.15	9140.61	14245.76	541.30
Tyres & Tubes - Rs. in lac	799.00	209.06	979.03	1026.11	64.60
Spare Parts - Rs. in lac	1263.02	712.87	640.60	897.90	35.09
Interest	3782.50	44774.84	1759.27	284.73	
Depreciation	2362.62	5671.41	2641.15	2601.09	
Total Taxes	**1654.55**	**313.95**	**243.82**	**2074.82**	**94.49**
Others	2617.06	4459.12	1268.21	1739.24	240.00
Total Cost - Rs. in Lac	**45549.78**	**93898.08**	**32283.53**	**35996.60**	**2224.91**
Operating Cost	40112.73	48809.29	30280.44	33637.05	2130.42
Physical					
Average No. of buses held	4698.00	5874.00	3435.00	6059.00	375.00
Average No. of buses-on-road	3918.00	4837.00	3065.00	5698.00	213.00
% Fleet Utilisation	83.40	82.30	89.20	94.00	56.80
Total Eff Kms (Lac)	629.68	871.75	890.37	1184.17	33.51
Daily Bus Utilisation					
i) Per bus held	145.70	161.30	281.70	212.40	97.10
ii) Per bus-on-road	174.70	195.90	315.80	225.90	171.00
Seat Kms (Lac)	42188.00	51433.00	64106.00	76971.00	2123.00
Passenger Kms (Lac)	31033.00	41316.00	58171.00	59883.00	1779.00
Passengers Carried (Lac)	3676.00	3836.07	5357.00	3895.41	234.11
Pass. Carried/bus-on-road/day	1020.00	862.00	1900.00	743.00	1195.00
Staff Position					
Total Staff	36462.00	39030.00	22857.00	32723.00	2352.00
Staff/bus-on-road	9.31	8.07	7.46	5.74	11.04
Eff. Kms/staff/day	18.77	24.28	42.34	39.33	15.49
Fuel Performance					
Kms/litre of HSD (KMPL)	2.86	2.92 CNG	4.30	3.97	2.43

It is evident from the above table that for the bus operations in major cities like Mumbai, Delhi, Bangalore, Chennai and Thane, the key component of the O&M cost involves staffs, fuel and lubricants, tyres and tubes and spare parts. The average fuel efficiency has been about 3.2 kilometres per litre in case of diesel operations whereas it is about 3 kilometres for the CNG based operations. The average cost of tyres and tubes and spare parts for every effective kilometre is approximately Rs 1.08 and Rs 1.07 respectively. Other cost of operation and maintenance is about 2% of the total O&M costs. These costs are 2011 prices and are suitably adjusted for the purpose of this study.

8 ASSUMPTIONS FOR LIFE CYCLE COST ANALYSIS

After critical analysis of the CAPEX and O&M costs of the five urban transport systems in the previous chapters of this report, a large fluctuation has been noticed in the costs incurred across different cities and in some cases even across different corridors in the same city. Due to this large variance across different cities, especially in the land cost, it was important that a hypothetical model be created for each mode.

Different modes are capable of operation in different configurations. For Rail based systems, since monorail is essentially modelled as an elevated system, we have chosen to develop the hypothetical models for all rail-based systems as elevated systems for providing key comparative differentiators.

The basis of this structure has been derived from an approximated mean of the data already available and escalation of the same. Some of the data available, which quote the latest figures, have been used directly as assumptions.

There are some general assumptions that are essential to the process of creation of the financial models for different modes of urban transport. In order to devise hypothetical models of the various modes it was essential to take care to ensure that the most logical variables be chosen to assist the functioning of such modes if they were to be practically tested.

This segment of the report focuses on the assumptions that have been derived for further processing the data into a format that has been utilised for estimating their life cycle costs.

8.1 Construction Duration, Phasing and Price Escalation

The construction period of any project is the period which tends to have the minimal cost impact operationally; however the capital cost impact of inordinately long construction period can be extremely high. Proper phasing and Price Escalation has impact on the total capital cost of any project, as each successive year spent in the construction impacts the total cost with a heavy increase in the overall cost. Such cost impacts are of inflation and additional financing cost. Time over run and cost overrun are intrinsically related.

For the purpose of calculation of the Life Cycle cost of the various modes the Annual escalation in prices has been considered at 5% after a lot of deliberation and after having studied various projects. For each year of the balance construction left thus the cost to be incurred in the next year gets escalated for 5%.

In the case of the bus based systems the construction period has been taken at 3 years. Bus Systems have limited construction requirements. The major time consumers in this case are the time taken in the construction of the Depot, Workshops, Terminals and Bus Shelters. The time required for the procurement of the rolling stock is another constraint that has to be considered also which in turn is dependent on the requirement and availability in the market as there are only two suppliers (Tata Motors and Ashok Leyland) of normal buses and the buses sold by Volvo cost in the higher range of Rs. 80 Lakh to 1 core. In the case of BRTS, the ROW may also require extensive redevelopment. In a twenty kilometre stretch for BRTS it is safe to assume provisioning of one kilometre of road over bridge or road under pass for segregation of traffic and its cost has been factored

Rail based systems generally have a longer duration requirement. Experience suggests that a minimum one year is needed for preliminary works like land acquisition, various regulatory approvals and preliminary designs. For this model the default duration has been taken at 5 years for construction of Rail based system. Other than Delhi Metro no other rail based system has been completed in this country in five years but it has been assumed that with time and the country's movement along the learning curve, a 20 km rail based urban transport project can be completed in five years duration.

8.2 Requirement of Rolling Stock and Buses

The requirement of Rolling Stock for rail based systems (metro rail, mono rail and light rail) and Bus Coaches for bus based systems (for BRTS and ordinary Bus service) are dependent on carrying capacity, headway, average speed, distance between stations and bus shelters etc.

8.2.1 Headway

The Headway parameter is important for the systems to improve the efficiency of the fleet of rolling stock of different systems. It also is used to verify the technical feasibility of the systems at various PHPDT levels. While calculating the Rolling Stock Requirement the Headway parameter has been kept as a variable that changes dependent on the number of train sets (or buses) needed to be dispatched from a point within an hour. It is important to note that this is required for the system to be able to move the required number of passengers; however it is not necessary for the hypothetical situation that this variable headway fall in the range that is technically feasible for that particular system.

The technical feasibility has been calculated based upon the congestion on the network, the level of complexity of the technology and the current world standards. The minimum technically feasible headway for the various systems has been assumed as under:

Table 8-1: Assumed Headway for the Urban Transport Systems

System	Headway (in minutes)
Metro Rail	2.50
Monorail	2.50
Light Rail (Elevated)	2.50
Light Rail (At Grade)	2.50
BRTS	0.60
Ordinary Buses	1.00

Some explanation is due for the headway adopted above. It is possible for ordinary buses to run with headway of one minute. In the case of BRTS a two double bus composition has been assumed and headway of 0.6 minute has been assumed as the team has observed the same being achieved at different intersections of Delhi BRTS. In case of Delhi Metro headway of 1.5 minutes has been proposed in the operations of its Phase III. But it has been observed that in general headway of 2.5 minutes to 3 minutes is best suited for rail based system. Thus headway of 2.5 minutes has been considered for all rail based systems.

8.2.2 Average Speed

The average speed of the various systems is dependent on the acceleration and deceleration speeds, the complexity of the system, signalling quality, the right of way segregation, the congestion on the system - both direct and indirect, the number of pauses in operation/stops that are required, the distance between stops and the duration of stops. Taking into account various parameters listed before, the following average speeds have been assumed based on facts available with the team.

Table 8-2: Assumed Average Speeds for the Urban Transport Systems

System	Average Speed (Km/hr.)
Metro Rail	35
Monorail	30
Light Rail (Elevated)	30
Light Rail (At Grade)	25
BRTS	25
Ordinary Buses	15

It is to be clearly understood that for highest of the urban transport systems, Metro Rail, the average speed assumed is what is already achieved by DMRC. Mono Rail and Light rail have been clubbed together at 30 km per hour. Similarly for the purpose of comparison Light Rail at Grade and BRTS speed has been assumed to be uniform at 25 km per hour. For ordinary buses the speed has been assumed as 15 km in mixed traffic condition. It is clarified that for all the three surface systems- ordinary buses, BRTS and Light Rail (At Grade) liberal average speed has been assumed.

8.2.3 Distance between Stations/Shelters

The distance between the Stations and Shelters refers to the average distance that should be maintained between two consecutive stations or shelters. This data has been used for calculation of the total number or stations/ bus shelters that will be required to be built along a particular route length, thereby arriving at the capital expense needed to be incurred for the same. The distances chosen for this study by IUT are as below.

Table 8-3: Assumed Distance between Stations/Shelters for the Urban Transport Systems

System	Distance between Stations/Shelters (Km)
Metro Rail	1.00
Monorail	0.75
Light Rail (Elevated)	0.75
Light Rail (At Grade)	0.75
BRTS	0.75
Ordinary Buses	0.50

Till date after operationalization of the Phase II of Delhi Metro including the Airport Express line, the total operational route length of the system is 193 km with 145 stations, thus the average distance between the stations is nearly 1.33 km. If the Airport Express line is excluded then the total route length is about 170.3 km with 139 stations thus average distance between stations will remain 1.23 km only. For this study a conservative 1 km distance between Metro Rail stations has been considered. The Jacob circle – Wadala – Chembur section of the Mumbai Monorail is of approximately 19.54 km with 18 stations which corresponds to an average distance of 1.09 km between monorail stations. For this study a conservative 0.75 km distance between monorail stations has been considered. The proposed 45 km light rail system for Delhi has 39 stations planned on it which reflect on an average about 1.15 km distance between stations. For this study 0.75 km station distance has been considered to perform a conservative calculation. The Ahmedabad BRTS corridor network is 74.5 km in length and has 75 bus shelters on it. This conveys that the average shelter distance on this BRTS corridor is about 1 km, but for this study an average 0.75 km shelter distance has been considered. The bus shelter distance on an average varies from 0.5 km to 1 km cities to cities but for this study 0.5 km has been considered as a distance between bus shelters for ordinary bus services.

The above distances between the stations/shelters have been considered on the conservative side to get a life cycle cost which can be applied in general to varying nature of traffic corridors.

8.2.4 Carrying Capacity

The rail car/bus coach capacities have a major impact on the carrying capacity. In order to achieve a particular PHPDT, the capacities of rail based systems rolling stock/ buses decide the number of units that would be required. For the purpose of this study, the capacities for the various systems have been assumed based on the actual figures available and verifiable in the systems in use today. The capacities for the various systems and the source for their choice have been provided below. The capacities chosen below have been assumed at peak carrying capacity of 6 persons per square meters.

Table 8-4: Assumed Carrying Capacity for the Urban Transport Systems (Per coach/car)

System	Persons	Remarks
Metro Rail	275	Based on Bombardier MOVIA Coach Capacity available from DMRC
Monorail	128	Based on design specification by Hitachi for their medium sized systems
Light Rail	242	Based on design specifications for Siemens S70
Buses	80	Based on specifications available in Rajkot BRTS DPR

Though the manufacturers of these rail cars and buses suggest that up to 8 persons per square meter can be considered for crush load capacity calculation but for this study a medium range carrying capacity of the rolling stock at the rate of 6 persons per square meters has been considered.

8.2.5 Train Set configuration

The vehicle configuration has been derived based on the carrying capacities attributed to the various systems. The same has been done by using the carry capacities ascertained in the report by the Working Group for the 12th Five Year Plan. Also consideration has been given to the standard configurations used across the systems as currently operational world over. Changing the configuration will directly affect the load carrying capacity of the system; however only to the degree that it is not restricted by the technical configuration feasibility. For getting a better understanding of the situation, a maximum PHPDT capacity of all the modes have been calculated and is presented in the table below:

Table 8-5: Maximum PHPDT capacity of different modes at varying train configuration

System	Coach Configuration of the Train	Train Set Capacity	Maximum PHPDT
Metro Rail	4	1100	26,400
	6	1650	39,600
	8	2200	52,800
Mono Rail	3	384	9,216
	6	768	18,432
	9	1,152	27,648
Light Rail	2	484	11,616
	4	968	23,232
BRTS	1	80	8,000
	2	160	16,000
Ordinary Buses	1	80	4,800

In general practice, it has been observed that the rail based system runs on a minimum headway of 2.5 minutes or more. But in few of the cases (upcoming DMRC Phase III could be the case) after enhancing the signalling and telecom system, a headway as minimum as 1.5 minutes can also be achieved. For the purpose of this study, a minimum headway of 2.5 minutes has been taken. From the above table it is evident that a metro rail with 8 car configuration train set can carry a maximum PHPDT of 52,800 whereas if the headway is brought down to 1.5 minutes the same would escalate up to 88,000. Similarly, in the case of monorail with a 9 car configuration of train set, a maximum PHPDT of 27,650 can be achieved at 2.5 minute headway which can increase further up to 46,000 if the headway can be reduced to 1.5 minutes. In case of light rail with 4 coach configuration of the train set, a maximum PHPDT of 23,250 can be achieved at 2.5 minute headway and which can further increase up to 38,720 if the headway can be reduced up to 1.5 minutes.

The configurations used in the formulation of this model for the Life Cycle Cost Analysis are as below.

Table 8-6: Assumed Vehicle Configurations for Urban Transport Systems

System	Carrying Capacity (Persons)	Configuration
Metro Rail	1,100	4 Coach
Monorail	384	3 Coach
Light Rail	484	2 Coach
BRTS	160	2 Coach
Ordinary Buses	80	1 Coach

8.2.6 Requirement of Rolling Stock

Based on the assumptions made regarding headway, average speed, distance between stations/shelters, carrying capacity of coaches and train set configurations, the total rolling stock requirements for the hypothetical case has been derived and is presented in the table below:

Table 8-7: Rolling stock requirement for the Hypothetical Case

Modes	Capacity of coaches	Units of Rail Cars/buses required
MRTS	275	92
Monorail	128	213
LRTS (Elevated)	242	116
LRTS (at Grade)	242	124
BRTS	80	370
Bus	80	413

The detailed calculations relating to the above derivations have been attached as The result of the above analysis is summarised in the table below.

Table 9-9: Summarized view of impact of mode capacity limitations on the LCC per seat

System	No. of Coaches in the Train	Train Set Capacity	Maximum PHPDT	LCC per seat (in INR Lakh)
Metro Rail	4	1100	26,400	21.30
	6	1650	39,600	17.03
	8	2200	52,800	15.07
Mono Rail	3	384	9,216	36.38

	6	768	18,432	25.80
	9	1,152	27,648	22.28
Light Rail elevated	2	484	11,616	33.01
	4	968	23,232	19.10
Light Rail At-grade	2	484	11,616	19.90
	4	968	23,232	13.23
BRTS	1	80	8,000	26.65
	2	160	16,000	24.99
Ordinary Buses	1	80	4,800	17.99

Headway for Rail Based Systems has been assumed at 2.5 minutes, whereas for BRTS it has been assumed at 0.6 minutes and for Ordinary Buses at 1 minute.

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

It may be noted that with the increasing mode capacity and hence PHPDT, LCC for Monorail and LRT fall substantially in comparison to Metro rail, BRTS and Bus Services.

Annexure I – Rolling Stock Requirement Assessment of this report.

8.3 Depot & Workshops

Depots and Workshops are essential to the functioning of all urban transport systems. All the systems require a demarcated and equipped area for upkeep and maintenance of their rolling stock and coaches. The depot needs to be equipped with the daily maintenance and basic repair facilities, and also requires sufficient space to accommodate the desired number of vehicles. The cost of a depot varies based on the rolling stock quantity to be homed there and the type of equipment required.

Workshops on the other hand are specialised care centres for the rolling stock and often are part of the depot itself. Workshops cater to needs of complex periodic repair including intermediate and complete overhaul. The choice of workshop specifications and size is a function of the requirement of quality, quantity and price of the output.

For the purpose of this study, IUT has chosen to adopt the standards currently in vogue and has used them to derive a ratio based on a variety of parameter to compute the number of depots that will be needed for a particular system. The parameters derived are as below:

Table 8-8: Assumed Depot and Workshop Requirements for Urban Transport Systems

	Parameter
Depot cum Workshop Requirement for Rail Based System	2 Depot for every 30 km
Depot Requirement for Bus Based System	1 Depot for every 50 Buses
Workshop Requirement for Bus Based System	1 Workshop for every 250 Buses

Source: Recommendations of Working Group on Urban Transport for 12th Five Year Plan

Also, based on current standards as chosen by the various DPRs and facts available with IUT, a ratio has been derived to deduce the 'number of car to facility cost' ratio, thereby calculating the cost of facilities required for accommodating the rolling stock requirements for the assumed systems. As the study is for 20 km of route kilometre, in the case of rail based systems one depot cum workshop has been assumed.

8.4 System Wise CAPEX assumptions

The assumptions taken for the selected systems are presented in the subsequent sections.

8.4.1 Metro Rail

Delhi Metro Phase III cost assumptions are the latest available information and the same can be used for the CAPEX calculation of the hypothetical 20 km long metro corridor for this study. It presents the following picture:

Table 8-9: Assumed CAPEX of Metro Rail for LCCA based on DMRC Ph-III assumptions

Item	Unit	Assumed Cost	Remarks for the Assumed Cost

		(INR in Crore)	
Land		**@ 10%**	
Underground section by Cut & Cover excluding Station length	R. Km.	105.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Elevated viaduct section	R. Km.	32.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
At-Grade	R. Km.	9.00	Escalated @5% the 2005 cost for at grade alignment of Kochi
OCC Building	LS	50.00	INR 50 Crore, allocated for OCC of HMRL network
Station Buildings			
Underground Station	Each	120.00	Though cost of underground station has come down in Ph-III from the 2010 Ph-II cost of DMRC, but an escalation @5% on the 2010 cost of underground station has been assumed
Elevated stations	Each	16.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Underground station (E&M, Lifts, Escalators, DG sets, UPS, TVS, ECS etc.)	Each	54.00	Escalated @5% the 2010 cost for UG E&M of DMRC Phase III
Elevated station (E&M, Lifts, Escalators, DG sets etc.)	Each	7.00	Escalated @5% the 2010 cost for UG E&M of DMRC Phase III
Depot	LS	43.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Ballast less/Ballasted track for elevated , UG and at grade alignment	R. Km.	7.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Under Ground Section	R .Km.	14.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Elevated & at grade section	R. Km.	8.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Lift (for elevated stations)	Each	0.30	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Escalator (for elevated stations)	Each	1.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Signalling and Telecom.			
Signalling	R. Km.	13.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Telecom	Each Stn.	3.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Underground stations	Each Stn.	3.90	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Elevated stations	Each Stn.	3.40	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
R & R incl. Hutments and road restoration etc.	**R. Km.**	**3.20**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Misc. Utilities, other civil works such as median, road signage etc.	**R. Km.**	**3.80**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Electrical Utilities	**R. Km.**	**2.90**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and

			escalated by 5% per annum
Telecom Utilities	**R. Km.**	**0.50**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Rolling Stock (SG)	**Each**	**10.00**	Procurement of Mumbai Metro rolling stock in 2010 @ Rs. 9.4 Crore per car and similarly for DMRC in 2011 @Rs9 Crore per km
General Charges incl. Design charge on all items except land		**@ 3%**	
Contingencies		**@ 3%**	

The above DMRC data is for a hybrid system – a mix of underground and elevated. However, this report intends to compare the lifecycle cost of monorail, LRTS and metro rail. As such, for the purpose of hypothetical construct a simple, harmonised elevated 20 km stretch of metro rail has been assumed with the following cost parameters.

Table 8-10: Assumed CAPEX for 20 km Elevated Metro Rail system for LCCA

Description	Unit	Assumed Cost (INR in crore)	Remarks
Land		**@ 10%**	For uniform comparison the land cost has been assumed at 10% for all three systems. In practice there will be variations from city to city and from corridor to corridor.
Elevated viaduct section	R. Km.	32.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
OCC Building	LS	50.00	INR 50 Crore, allocated for OCC of HMRL network
Station Buildings	**Each**	**16.00**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Elevated station (E&M, Lifts, etc.)	Each Stn.	7.00	Escalated @5% the 2010 cost for elevated E&M of DMRC Phase III
Depot	LS	50.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Permanent Way	**R. Km.**	**7.00**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Elevated	R. Km.	8.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Lift	Each	0.30	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Escalator	Each	1.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Signalling	R. Km.	13.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Telecom	Each Stn.	3.00	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Automatic fare collection	**Each Stn.**	**3.40**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
R & R	**R. Km.**	**3.20**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Misc. Civil Utilities	**R. Km.**	**3.80**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Electrical Utilities	**R. Km.**	**2.90**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Telecom Utilities	**R. Km.**	**0.50**	An average of the 2010 costs of Ph-II and Ph-III of Delhi metro and escalated by 5% per annum
Rolling Stock (SG)	**Each**	**10.00**	Procurement of Mumbai Metro rolling stock in 2010 @ Rs. 9.4 Crore per car and similarly for

		DMRC in 2011 @Rs9 Crore per km
General Charges (except land)	**@ 3%**	
Contingencies	**@ 3%**	

Source: DMRC Ph-II completion & Ph-III Assumptions and IUT assumptions

8.4.2 Mono Rail

Since no monorail system is operational so far, only DPR figures were available for analysis of CAPEX. The CAPEX assumed for the hypothetical 20 km long monorail corridor is based on the DPR assumptions of Kozhikode and some interpolations and assumptions as below:

Table 8-11: Assumed CAPEX of Monorail system for LCCA based on Kozhikode DPR

Description	Unit	Assumed cost of MR (INR in Crore)	Remarks for Assumed Cost
Land		**@10%**	rounded Cost assumption of Kozhikode MR
Fixed Infrastructure – Civil	**R. Km.**	**36.00**	rounded Cost assumption of Kozhikode MR
Elevated Structure	R. Km.	22.50	rounded Cost assumption of Kozhikode MR
Elevated Stations	Each	9.00	rounded Cost assumption of Kozhikode MR
Fixed Infrastructure – Depot & OCC	**LS**	**80.00**	rounded Cost assumption of Kozhikode MR
Fixed Infrastructure – Electrical Systems		**6.50**	rounded Cost assumption of Kozhikode MR
E&M (including lifts and escalators)	Per Stn.	1.50	rounded Cost assumption of Kozhikode MR
Traction and other Electrical Utility	R. Km.	5.50	rounded Cost assumption of Kozhikode MR
Rolling Stock	**Each**	**10.00**	rounded Cost assumption of Kozhikode MR
Signaling, Telecom & AFC		**14.50**	rounded Cost assumption of Kozhikode MR
Signaling	R. Km.	9.00	rounded Cost assumption of Kozhikode MR
Telecom	Per Stn.	2.00	rounded Cost assumption of Kozhikode MR
AFC	Per Stn.	2.50	rounded Cost assumption of Kozhikode MR
General Charges (excluding land cost)		**@5%**	lowered rate - technology is already under implementation in India
Contingency		**@3%**	rounded Cost assumption of Kozhikode MR

The assumptions made for Monorail unit cost of construction for 20 km stretch is as follows.

Table 8-12: Assumed CAPEX for 20 km Monorail system for LCCA

Description	Unit	Assumed Cost (INR in Crore)	Remarks
Land		**@ 10%**	Land cost assumed uniformly for all the three systems.
Elevated viaduct section	R. Km.	22.50	The Monorail civil costs are 60-70% of the elevated metro rail civil costs
OCC Building	LS	40.00	Pared down from the metro rail OCC figure
Station Buildings	**Each**	**9.00**	Smaller station buildings have been assumed for monorail as compared to metro rail

Elevated station (E&M, Lifts, etc.)	Each Stn.	2.50	Pared down from Metro rail costs – assumed at higher level than Kozhikode
Depot	LS	120.00	Monorail cars required for a 20km stretch are 210, substantially higher than 126 for elevated LRT at 126 and 80 in MRTS, hence the requirement for a larger depot.
Permanent Way	**R. Km.**		Assumed as part of alignment cost
Elevated	R. Km.	5.50	Pared down from metro rail
Lift	Each	0.30	Same for all three systems
Escalator	Each	1.00	Same for all three systems
Signalling	R. Km.	9.00	Taken lower than metro rail, but in practice to get a headway of 3 or below signaling costs has been increased to same level of 13 crore per km of metro rail
Telecom	Each Stn.	2.00	Lower than metro rail
Automatic fare collection	**Each Stn.**	**2.50**	AFC cost for monorail expected to be lower due to lower number of gates
R & R	**R. Km.**	**2.00**	Taken at lump sum
Misc. Civil Utilities	**R. Km.**	**2.00**	Taken at lump sum
Electrical Utilities	**R. Km.**	**2.50**	Taken at lump sum
Telecom Utilities	**R. Km.**	**0.50**	Taken at lump sum
Rolling Stock (SG)	**Each**	**10.00**	After evaluating rolling stock prevailing prices, rolling stock for all three systems has been assumed at the same amount of 10 crore per car unit
General Charges (except land)		**@ 3%**	
Contingencies		**@ 3%**	

Source: Kozhikode Monorail DPR and IUT assumptions.

8.4.3 Light Rail

There is no light rail system present in the country and recently no DPR has been prepared for the same. The latest available DPR was prepared about 5 years ago for a 45 km stretch in Delhi. Based on the Delhi DPR, the updated cost is as below.

Table 8-13: Assumed CAPEX of Delhi LRT proposal with updated cost

Description	Delhi LRT (INR in Crore at 2007-08 price levels)	Assumed cost of LRT (R. Km.) (INR in Crore)	Assumed Total Cost at 2012 levels (INR in Crore) for 45 Km	Remarks for Assumed Cost
Land	@19.12%	@15%	675.00	Assuming at grade alignment the land cost will be higher than the elevated structure, 15% has been assumed for at-grade. The 19% assumption in DPR was on higher side and has been tapered down.
Fixed Infrastructure – Civil	442.00	13.00	585.00	Escalated annually at 5%
Fixed Infrastructure – Electrical Systems	300.00	9.00	405.00	Escalated annually at 5%

Fixed Infrastructure - Depot & OCC	483.00	14.00	630.00	Escalated annually at 5%
Rolling Stock	1,456.00	52.00	2,340.00	For the purpose of this table has been escalated at 10% p.a. in line of cost increase trend of rolling stock in recent years. In actual calculation per unit rolling stock cost has been assumed at Rs. 10 Crore at the same level as Monorail rolling stock cost and Metro Rail rolling stock cost.
Signaling, Telecom & AFC	84.00	2.00	90.00	Escalated annually at 5%
Taxes & Duties	345.00	10.00	450.00	Escalated annually at 5%
Total	3,776.00	100.00	5,175.00	
Total R. Km.	83.91		115	

Based on the assumptions made above, the total capital expenditure cost for a 20 km long light rail system at-grade would be approximately Rs. 2,300 Crore.

However, for the purpose of arriving at per km cost for LRT – at grade the following assumption has been made:

Table 8-14: Assumed CAPEX of At Grade Light Rail System for LCCA

Description	Unit	Assumed Cost (INR in Crores)	Remarks
Land		@ 10%	
Fixed Infrastructure - Civil	R. Km	13.00	
Fixed Infrastructure - Electricals	R. Km	9.00	
Depot	Lump sum	100.00	
OCC	Lump sum	40.00	
Rolling Stock	Each	10.00	
Signaling	R. Km	2.00	
General Charges		@ 3%	
Contingencies		@ 3%	

The capital cost calculation of elevated Light Rail has been done because it will be more appropriate to compare elevated metro rail and elevated monorail with the elevated light rail. The cost arrived at is as follows:

Table 8-15: Assumed CAPEX of Elevated Light Rail Transit System for LCCA

Description	Unit	Assumed Cost (INR in Crore)	Remarks
Land		**@ 10%**	Land cost assumed uniformly for all the three systems
Elevated viaduct section	R. Km.	21.00	Assumed closer to monorail
OCC Building	LS	40.00	Assumed same as monorail
Station Buildings	**Each**	**10.00**	Smaller station buildings have been assumed as compared to metro rail, kept closer to monorail
Elevated station (E&M, Lifts, etc.)	Each Stn.	2.50	Assumed same as monorail
Depot	LS	70.00	Based on a rolling stock requirement for 126 cars

Permanent Way	**R. Km.**	**5.00**	Pared down from the cost of permanent way for metro rail
Elevated	R. Km.	5.50	Same as monorail
Lift	Each	0.30	Same for all three systems
Escalator	Each	1.00	Same for all three systems
Signalling	R. Km.	8.00	Light rail has the lowest signaling systems costs among all the rail-based systems
Telecom	Each Stn.	2.00	Same as monorail
Automatic fare collection	**Each**	**2.50**	Same as monorail as similar number of gates are expected
R & R	**R. Km.**	**2.00**	Taken at lump sum
Misc. Civil Utilities	**R. Km.**	**2.00**	Taken at lump sum
Electrical Utilities	**R. Km.**	**2.50**	Taken at lump sum
Telecom Utilities	**R. Km.**	**0.50**	Taken at lump sum
Rolling Stock (SG)	**Each**	**10.00**	After evaluating rolling stock prevailing prices, rolling stock for all three systems has been assumed at the same amount of 10 crore per car unit
General Charges (except land)		**@ 3%**	
Contingencies		**@ 3%**	

Having arrived at construction costs of the three systems, their unit cost competitive table has been given below.

Table 8-16: Comparative Assumptions for Elevated Rail-based Systems (INR in Crores)

Description	Unit	Metro Rail	Mono Rail	Light Rail	Remarks
Land		**@ 10%**	**@ 10%**	**@ 10%**	Land cost assumed uniformly for all the three systems
Elevated viaduct section	R. Km.	32.00	22.50	21.00	For Metro rail, DMRC PH-II completion cost and PH-III estimate has been used. For Monorail it has been rounded off from the Kozhikode Monorail DPR estimate. The Light Rail figures have been approximated.
OCC Building	LS	50.00	40.00	40.00	For Metro rail, the HMRL OCC Building cost has been assumed, while for the monorail and light rail a discounted figure has been taken.
Station Buildings	**Each**	**16.00**	**9.00**	**10.00**	For Metro rail, the DRMC Ph-II completion costs & the Ph-III estimates have been considered. The Kozhikode Monorail DPR estimate has been used for derivation of the Monorail cost. LRT Station cost has been kept closer to monorail.
Elevated station (E&M, Lifts, etc.)	Each Stn.	7.00	2.50	2.50	The Metro rail cost has been derived from the DMRC cost for Ph-II completion and Ph-III estimate. The Monorail and Light Rail costs have been pared down from derived Metro rail costs.
Depot	LS	50.00	120.00	70.00	The metro rail cost is a derivation from DMRC Ph-II & Ph-III estimate. Monorail & Light Rail depot has been kept at 80% of the Metro Rail cost.

Permanent Way	**R. Km.**	**7.00**		**5.00**	The DMRC Ph-II Completion & Ph-III estimates have been considered for the Metro rail cost. The Monorail cost is included in the cost of alignment. Light Rail has been considered at a discounted rate from Metro Rail.
Elevated	R. Km.	8.00	5.50	5.50	The DMRC Ph-II Completion & Ph-III estimates have been considered for the Metro rail cost. The Monorail cost has been based on the Kozhikode DPR. Light Rail has been considered as the same as monorail.
Lift	Each	0.30	0.30	0.30	Assumed uniformly for all three systems
Escalator	Each	1.00	1.00	1.00	Assumed uniformly for all three systems
Signalling	R. Km.	13.00	9.00	8.00	The DMRC Ph-II Completion & Ph-III estimates have been considered for the Metro rail cost. The Monorail cost has been based on the Kozhikode DPR. As Light Rail is proposed as a two-coach system it has been kept lower than monorail.
Telecom	Each Stn.	3.00	2.00	2.00	The DMRC Ph-II Completion & Ph-III estimates have been considered for the Metro rail cost. The Monorail cost has been based on the Kozhikode DPR. Due to similar system size, the monorail cost has been used as the light rail cost.
Automatic fare collection	**Each Stn.**	**3.40**	**2.50**	**2.50**	The DMRC Ph-II Completion & Ph-III estimates have been considered for the Metro rail cost. The Monorail cost has been based on the Kozhikode DPR. Due to similar system size, the monorail cost has been used as the light rail cost.
R & R	**R. Km.**	**3.20**	**2.00**	**2.00**	Assumed at lump sum
Misc. Civil Utilities	**R. Km.**	**3.80**	**2.00**	**2.00**	Assumed at lump sum
Electrical Utilities	**R. Km.**	**2.90**	**2.50**	**2.50**	Assumed at lump sum
Telecom Utilities	**R. Km.**	**0.50**	**0.50**	**0.50**	Assumed at lump sum
Rolling Stock (SG)	**Each**	**10.00**	**10.00**	**10.00**	After evaluation of prevailing rolling stock prices, rolling stock for all three systems has been assumed at the same amount of 10 crore per car unit
General Charges (except land)		**@ 3%**	**@ 3%**	**@ 3%**	
Contingencies		**@ 3%**	**@ 3%**	**@ 3%**	

Based on the above cost data, the total cost per km and the total cost for a 20km stretch for the rail-based systems have been computed as below:

Table 8-17: Assumed per km and 20 km stretch cost for rail-based systems (INR in Crores)

System	Cost/Km	Cost for 20 Km
Metro Rail	160.92	3218.33
Monorail	204.92	4098.47
LRT – At Grade	117.87	2357.32
LRT Elevated	157.08	3141.54

The calculations considered above do not include the taxes and duties; however their influence has been recorded in the final model as annexed in Annexure III – THE LCCA Calculation Tables of this report.

8.4.4 Bus Rapid Transit

There are two BRTS systems which are operational in the country, one in Delhi and the other one in Ahmedabad, whereas there are several DPRs which are available. The assumptions were made after critical analysis of the costs assumed in Delhi, Ahmedabad and Rajkot. The assumptions are as below:

Table 8-18: Assumed CAPEX of Bus Rapid Transit system for LCCA

Description	Unit	Assumed cost of BRT (INR in Crore)	Remarks for Assumed Cost
Roadway Development	R. Km.	8.55	Average cost of Ahmedabad Ph-I, Ph-II and Rajkot escalated @ 5%
Bus Stops	Each	0.40	Average cost of Ahmedabad Ph-I, Ph-II and Rajkot escalated @ 5%
Foot over Bridges	Each	0.25	Average cost of Ahmedabad Ph-I, Ph-II and Rajkot escalated @ 5%
Depots	Each	10.00	As Assumed in the Working Group report on Urban Transport
Workshops and Terminals	Each	20.00	As Assumed in the Working Group report on Urban Transport
OCC	LS	10.00	Provided for separately
Bridges and Flyovers	R. Km.	31.80	Average cost of Ahmedabad Ph-I, Ph-II and Rajkot escalated @ 5%
ITS application and External Tracking	LS	29.50	Average cost of Ahmedabad Ph-I, Ph-II and Rajkot escalated @ 5%
Bus Cost	Each	0.40	As Assumed in the Working Group report on Urban Transport

With above assumptions the cost of a 20 km long BRT system inclusive of bus costs would be approximately Rs. 1022.55 Crore. If we exclude the bus cost, the total CAPEX involved in development of 20 km BRT system will be down to Rs. 400 Crore.

8.4.5 Ordinary Bus Service

The CAPEX for ordinary bus services have been assumed using the latest infrastructure development cost of Delhi Transport Corporation for the CWG 2010. The assumed costs are as below:

Table 8-19: Assumed CAPEX of Ordinary Bus system for LCCA

Description	Unit	Assumed Cost (INR in Crore)	Remarks
Bus Stops	Each	0. 30	
Depots	Each	10.00	
Workshops and Terminals	Each	25.00	
ITS application and External Tracking	Lump Sum	50.00	
Bus Cost			
Standard	Each	40.00	
AC Low Floor	Each	60.00	
Non AC Low Floor	Each	50.00	
Land Cost		@5%	
General Consultancy		@2%	
Contingency Charges		@3%	

With above assumptions the cost of a 20 km long ordinary bus system inclusive of bus costs would be approximately Rs. 300 Crore. If we exclude the bus cost, the total CAPEX involved in development of 20 km ordinary bus system becomes close to approximately Rs. 120 Crore.

As various costs such as the cost of road and flyovers are not involved in the development of ordinary bus services in the city, the cost of development is lowest as compared to the other selected urban transport modes. The development of roads in the mega cities and other metro cities could be assumed at a rate of Rs. 4 Crore per km. For other cities the cost of development of roads could be assumed at a rate of Rs. 2 Crore per km. Apart from road, to allow free flow of traffic (at railway crossings, major signals etc.), flyovers and road over bridges are also required whose developmental costs could be assumed at Rs. 25 Crore per Km.

8.5 System Wise Operation & Maintenance Cost Assumptions

The assumptions which were taken in this study for deriving the operations and maintenance cost of the urban transport systems are divided mainly among three critical parameters:

Energy Costs	Staff Costs	Repair and Maintenance Costs	Replacements

The assumptions taken for the components of the operations and maintenance costs for the selected systems are presented in the subsequent sections.

8.6 Energy Cost

Fuel is one of the most essential operational expenses in the operational cycle of the urban transport systems. For enterprise use, Electricity and Diesel are generally the two most common fuels.

8.6.1 Rail Based Systems

For rail based systems, electricity is the fuel of choice based on the technology and the environmental impact scenario. Metro Rail, Mono Rail and modern LRT all three run on electric traction.

The average crush load for Metro Rail, Mono Rail and Light Rail coaches has been considered as 50 tons, 28 tons and 35 tons based on the specifications provided by the manufacturers. From the DPR of various rail based system it was established that Traction

Energy Consumption per 1000 GTKM is 70 KWh. The example below reflects the calculations to derive the traction energy consumption:

Average Weight of a metro car with Normal and Crush Load has been taken as 50 Tonnes. Thus per car per km energy consumption is = 50*70/1000 = 3.5 KWh. The Regeneration potential of a rolling stock has been defined as 20%, thus average per car km energy consumption for metro rail systems is = 3.5*(1-20%) = 2.38 KWh.

Similarly energy consumption per car km for monorail and light rail has been considered as 1.57 KWh and 1.96 KWh respectively.

Auxiliary Power consumption per station per day as per latest rail based DPR is 200 KW which is expected to become 300 KW by 2021. We are considering a consumption of 250 Kw per station per day for 2015. Load factor which has been considered is 100% for 24hr., 85% for 22 hr., 75% for 20 hr. (As per discussion with DMRC) of operations has been considered. Since in this study every day operation of 19 hours has been considered thus the Weighted Average Load factor is assumed as 70%.

Similarly the latest prepare DPRs suggest auxiliary power consumption for metro rail systems per Depot per day as 2000 KW which expected to become 2500 KW by 2021 and about 1050 KWh for mono rail and light rail systems. In this study a power consumption of 2200 KWh and 1050 KWh has been considered for metro rail and monorail/light rail systems respectively with a load factor of 60% in year 2015.

For this study, IUT has adopted the initial electricity supply rate of Rs. 4 per KW (2012 prices). The same has been escalated at a rate of 5% per annum.

8.6.2 Bus Based Systems

Buses in India usually run on either Compressed Natural Gas (CNG) or Diesel. Between Diesel and CNG, CNG is currently the more economical and more environmentally friendly source of energy; however it is also the more recent entrant as a fuel of choice and has as yet seen restricted use. Because of this the study has used the diesel prices and the initial Diesel pricing for this study has been chosen at Rs. 45 per litre, with an annual price increase at 5%. The price chosen has been derived by taking an average of the prices currently prevalent in the major metropolitan cities of the country. But in case of price deregulation diesel prices can go substantially up there by affecting the cost efficiency of BRTS and Ordinary Bus Services.

Between 1998 and 2003, the judiciary of India, both the Supreme Court and High Court have promoted the adoption of Natural Gas as the medium for public transport in India. Under the influence of the Supreme Court and High Courts, the cities of Delhi, Bangalore, Hyderabad, Chennai, Ahmedabad, Kanpur, Lucknow, Sholapur, Mumbai and Kolkata were asked to submit action plans for improvement of air quality in the cities. Implementation of CNG was a common strategy adopted by all the cities. The cities which did not have access to CNG like Bangalore and Chennai, had listed LPG programmes to reduce the pollution levels of the city.

Despite restricted adoption of Natural Gas as a fuel substitute in the majority of the country, IUT has considered a model incorporating CNG as the fuel choice to ensure that the future scenarios are amiably depicted. The CNG price chosen for this study is Rs. 40 per kg with an escalation of 5%. However in actual calculation in the financial model it is the diesel prices which have been used and not the CNG prices.

8.7 Human Resource Cost

Human Resource and Energy Expenses together comprise bulk of O&M expenses of urban transport systems.

The five urban transport systems are each in their own way complex and have intricate organisational hierarchies. For the purpose of this study, IUT has chosen to simplify the reference to the human capital by generating a staff requirement per km ratio in the case of both rail based and bus based systems. This has been done by first generating the total staff requirement based on allocated job responsibility or job function and then dividing it by the total length of the system.

In the case of rail-based systems, data from DMRC was collated and used to derive a benchmark for use with the models created for Metro, Monorail and Light Rail. CIRT data was used to derive figures chosen for BRTS and Ordinary Buses.

Another important consideration in relation to Human Resources is the remuneration, for this purpose, a system average has been chosen based on the 6th Pay Commission. The remuneration has been kept at an average of Rs. 9 lakhs per annum with a yearly increment of 9%.

The staff requirement per km derived for the various systems has been provided in the table below:

Table 8-20: Assumed Human Resource Requirement for the Urban Transport Systems

System	Staff Requirement (Per km)
Metro Rail	31.70
Monorail	25.20
Light Rail	19.85
BRTS	92.50
Ordinary Buses	103.25

The staff requirement for the bus based system is based on buses that are being required. For every bus a staff requirement of 5 has been assumed which has been detailed out in Annexure II – Human Resource Requirement Detail of this report. E.g. the staff requirement for 370 buses in case of BRTS is estimates as 1,850 which is 92.5 staffs per km (if the corridor length is 20 km as assumed in the hypothetical case). Similar are the calculations for ordinary bus services.

8.8 Repair and Maintenance Cost

8.8.1 R&M Cost for Rail Based Systems

The repair and maintenance cost figures of Delhi Metro which was available for this study in a granular detail as provided in section Operation & Maintenance Cost Information of this report has been considered as the base. The base figure which has been assumed for this study to get the repair and maintenance costs is presented in the table below:

Table 8-21: Unit Cost of Repair & Maintenance (2010 Prices) of DMRC

Unit Cost of Repair & Maintenance (2010 Prices) of DMRC		
Building	**26.74**	Rs Lakh per Station
Plant & Machinery	**11.40**	Rs Lakh per Car
Other R&M	**2.2%**	Of Building, Plant & Machinery Costs
Other O&M Costs	**11%**	of Energy, Staff and R&M costs

The rates as presented in the above table has been escalated at the assumed inflation rate of 5% to arrive at the 2012 prices of the R&M for metro rail system and the same is presented in the table below:

Table 8-22: Assumed Unit Cost of R&M for Metro Rail System (2012 prices)

Assumed Unit Cost of Repair & Maintenance (2012 prices)		
Building	**29.48**	Rs Lakh per Station
Plant & Machinery	**12.57**	Rs Lakh per Car
Other R&M	**2.3%**	Of Building, Plant & Machinery Costs
Other O&M Costs	**11%**	of Energy, Staff and R&M costs

To arrive at the mono rail and light rail system which have lower R&M cost, the above considered R&M costs of Metro Rail system have been discounted by 25%. The assumed R&M cost for mono rail and light rail systems are presented in the table below:

Table 8-23: Assumed Unit Cost of R&M for Mono/Light Rail System (2012 prices)

Mono Rail and light rail		
Building	**22.11**	Rs Lakh per Station
Plant & Machinery	**9.43**	Rs Lakh per Car
Other R&M	**2.3%**	Of Building, Plant & Machinery Costs
Other O&M Costs	**11%**	of Energy, Staff and R&M costs

8.8.2 R&M Cost for Bus Based Systems

Based on the analysis of the R&M cost of bus based system from the data compiled from CIRT journals, the summary of R&M cost is presented in the table below:

Table 8-24: Unit cost of Repair and Maintenance (2011 prices CIRT analysis)

Component	Cost	Unit
Building/roads	2.00	Rs Lakh per bus stop
Tyres & Tubes	1.08	Rs per effective Km
Spare Parts	1.07	Rs per effective Km
Other R&M costs	2%	of building spare and Tyres

The R&M costs derived above has been extrapolated for 2012 prices using the inflation rate assumed in this study. The assumed R&M cost of bus based system is presented in the table below:

Table 8-25: Assumed Unit Cost of R&M for Bus Based Systems

Component	Cost	Unit
Building/roads	2.10	Rs Lakh per bus stop
Tyres & Tubes	1.13	Rs per effective Km
Spare Parts	1.12	Rs per effective Km
Other R&M costs	2%	of building spare and Tyres

In addition to the above R&M costs, another component of other O&M cost at the rate of 11% of the Staff, Energy and R&M cost has been considered in this study.

8.9 Replacement Cost

Due to constant wear and tear, it is essential that life duration be determined for the various components of each system, so that they may be replaced post completion of this period to ensure that they do not become a safety hazard and a drain on resources due to frequent breakdown and maintenance requirements.

The table below lists the replacement time in years, the components to be replaced and the percentage of replacement essential to further increase the life of the system as assumed by IUT for this study.

Table 8-26: Assumed Time and Percentage Replacement for Rail Based Systems

Replacement	Time (in years)	Rail Based Systems
E&M Works	10	100.00%
Permanent Way	50	100.00%
Traction & power	20	100.00%
Signalling and Telecom	15	100.00%
Automatic fare collection	15	100.00%
Rolling Stock	25	20.00%

Table 8-27: Assumed Time and Percentage Replacement for Bus Based Systems

Replacement	Time (in years)	Bus Based Systems
Roadways	20	50.00%
Bus Stops	20	50.00%
Foot over bridge	20	50.00%

Replacement	Time (in years)	Bus Based Systems
ITS application	10	100.00%
Buses	10	100.00%

8.10 Financial Assumptions

For arriving at the Life Cycle Cost IUT has assumed various financial assumptions for both development and O&M stage. Key factors influencing the total cost are elaborated below:

8.10.1 Taxes & Duties

Different urban transport systems in the country have had differential experience with regard to applicable Taxes & Duties Structure. But invariably in all the cases preferential tax treatment has been provided and the projects often have been provided with either a partial or complete waiver from the payment of applicable taxes and duties and such waivers have come both from central and state governments. However, the country does not have any uniform policy prescription in this regard. In the interest of harmonisation and ensuring level playing field, in the life cycle cost calculation taxes and duties at prevalent level have been assumed. IUT has chosen to include all relevant taxes and duties at full weightage in the study. The taxes and duties for rail-based systems and bus based systems differ in their structure and quantum.

8.10.1.1 Customs Duty

A customs duty is assumed as under:

Table 8-28: Assumed Customs Duty for Urban Transport Systems

System Type	Customs Duty	Remarks
Rail Based Systems	18.62	Based on Latest estimates
Bus Based Systems	18.62	Based on Latest estimates

8.10.1.2 Excise Duty

Excise duty assumed is as under and is based on Latest Estimates:

Table 8-29: Assumed Excise Duty for Urban Transport Systems

System Type	Excise Duty	Remarks
Rail Based Systems	8.24	Based on Latest Estimates
Bus Based Systems	26.00	Based on Latest Estimates

8.10.1.3 VAT

VAT or Value Added Tax assumed as follows:

Table 8-30: Assumed VAT for Urban Transport Systems

System Type	VAT	Remarks
Rail Based Systems	12.50	Based on Latest Estimates
Bus Based Systems	12.50	Based on Latest Estimates

8.10.1.4 Sales Tax

Sales tax where applicable is assumed as follows:

Table 8-31: Assumed Sales Tax for Urban Transport Systems

System Type	Sales Tax	Remarks
Rail Based Systems	6.25	Based on Latest Estimates
Bus Based Systems	6.25	Based on Latest Estimates

8.10.1.5 Works Contract Tax

The Works Contract Tax has been levied as per the table below:

Table 8-32: Assumed Works Contract Tax for Urban Transport Systems

System Type	Works Contract Tax	Remarks
Rail Based Systems	6.25	Based on Latest Estimates
Bus Based Systems	6.25	Based on Latest Estimates

8.10.2 Escalation Rate

In order to bring the prices up to the 2012 levels all costs have been subjected to a uniform escalation at 5% though it is possible that there are year to year variations.

8.10.3 Interest Rate

Interest rate assumptions have provided special difficulties because for certain rail based systems loan has been provided for very long term and at a concessional rate whereas for bus based systems, the new low floor buses have been provided to various cities under JNUURM almost as a grant. Instead of assuming a market driven interest rate, a nominal 5% interest rate has been assumed for all the systems.

8.10.4 Discount Rate

The discount rate is the rate at which the future costs are discounted to ascertain their present value. IUT has assumed a uniform 10% discount rate for this study

8.10.5 Debt Equity Ratio

The Debt Ratio deals with the financing strategy adopted. It tells us the ratio of investment sought for the project in terms of equity and debt. In this case IUT has chosen different ratios based on the type of system, whether Rail based or Bus Based.

8.10.5.1 Debt Equity Ratio for Rail Based Systems

For rail-based systems the debt equity ratio adopted is 70:30 and debt repayment period has been assumed to be 15 years.

8.10.5.2 Debt Equity Ratio for Bus Based Systems

The ratio chosen for bus-based systems is 70:30 but the debt repayment period has been assumed to be 10 years.

8.11 Depreciation

The Depreciation has been charged at different rates for different components of the systems. The charge has been levied at a uniform rate across the life-cycle of the urban transport systems from the time they begin operations.

The table below lists the different rates assumed for different components of the various systems. The table also lists the rate of depreciation to be charged post the refurbishment to extend the life of the system.

Table 8-33: Assumed Depreciation for the Urban Transport Systems

Depreciation Rail Based		Bus Based	
E&M Works	10.00%	Road	5.0%
Permanent Way	2.00%	Bus Stops & FOB	5.0%
Traction & power	5.00%	Civil	2.0%
Signalling and Telecom	6.67%	ITS application	10.0%
Automatic fare collection	6.67%	Buses	10.0%
Rolling Stock	4.00%		
Civil	2.00%		

Table 8-34: Assumed Depreciation for the Rail based Systems post Refurbishment

Depreciation Rail Based	Estimated Life (years)	
E&M Works	15	6.67%
Permanent Way	15	6.67%
Traction & power	15	6.67%
Signalling and Telecom	15	6.67%
Automatic fare collection	15	6.67%
Rolling Stock	15	6.67%

9 LIFE CYCLE COST ANALYSIS

This chapter provides the results which were obtained from the LCC analysis performed for all the selected five systems. The preliminary section of the chapter explains the results obtained for the hypothetical case assumed in the beginning of the analysis whereas the later part of the chapter converts the analysis to bring in to account the design capacity of the modes in varying train compositions (in the case of guided modes), the PHPDT and the demand level i.e. actual possible usage.

9.1 Results of the Hypothetical Case

The LCC analysis for the systems has been based on the hypothetical premise of 15,000 PHPDT, 20 kilometre corridor and 30 years of projected costs.

In order to ascertain the LCC per seat, it was essential that the number of seats available be calculated. This has been ascertained by multiplying the capacity of each vehicle set with the total sets required for the functioning of the system as ascertained in *Annexure I – Rolling Stock Requirement Assessment.*

Per seat LCC obtained for the systems are in the table below:

Table 9-1: Results of the per seat LCC for the Hypothetical Case

Systems	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	25,300	7,792.49	**30.80**
Monorail	27,264	7,676.58	**28.16**
LRTS (Elevated)	28,072	6,539.18	**23.29**
LRTS (At Grade)	30,008	4,578.65	**15.26**
BRTS	29,600	6,574.69	**22.21**
Buses	33,040	5,727.82	**17.34**

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

It may be noted that LRTS (At grade) has the least per seat life cycle cost of Rs 15.26 lakh. The LCC of both bus (Rs. 17.34 lakhs) and BRT (Rs 22.21 lakhs) is higher than that of LRTS (At grade). The LCC of Metro rail is high because it is a high capacity mode, much beyond the assumption of 15000 PHPDT made for the hypothetical case.

9.2 Scenarios under the Hypothetical Case at different Demand Levels

The Life cycle cost of each mode would depend on its usage i.e. demand level. Hence specific cases of impact on life cycle cost of various modes at different demand levels are evaluated in the succeeding paragraphs.

9.2.1 Scenario I – 5,000 PHPDT

Systems	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	9,900	6,347.61	64.12
Monorail	9,216	4,873.77	52.88
LRTS (Elevated)	9,196	4,934.55	53.66
LRTS (At Grade)	10,164	2,905.39	28.59
BRTS	9,920	3,167.30	31.93
Buses	10,960	1,960.63	17.89

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

It may be noted that at per seat LCC of Rs 17.89 Lakhs Buses qualify as the cheapest mode. It may further be noted that LRT (At grade) (Rs 28.59 is cheaper than BRTS (Rs 31.93 lakhs). Both Monorail and LRTS elevated have almost identical LCC at this level of traffic, while Metro Rail is the costliest alternative.

9.2.2 Scenario II – 10,000 PHPDT

Systems	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	17,600	7,070.02	40.17
Monorail	18,048	6,248.68	34.62
LRTS (Elevated)	18,392	5,718.73	31.09
LRTS (At Grade)	19,844	3,723.89	18.77
BRTS	20,000	4,929.13	24.65
Buses	22,080	3,844.51	17.41

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

At 10,000 PHPDT, the LCC of all the modes except bus comes down substantially. Bus service is the cheapest mode, but bus service is unable to meet the demand, It may further be noted that LRTS (At grade) continues to be cheaper than BRTS.

9.2.3 Scenario III – 12,000 PHPDT

Systems	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	20,900	7,376.61	35.29
Monorail	22,272	6,899.05	30.98
LRTS (Elevated)	21,780	6,006.35	27.58
LRTS (At Grade)	23,716	4,045.82	17.06
BRTS	23,840	5,590.41	23.45
Buses	26,400	4,576.22	17.33

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

At 12,000 PHPDT, the LCC of all modes except bus comes down further; indeed bus service cannot meet the demand. At this level, the LRT (At grade) becomes cheaper than bus service. It may further be noted that LRT (At Grade) continues to be cheaper than BRTS. However, the number of coaches in a train will need to be higher in case of Monorail and LRT, to meet the increase in demand.

9.2.4 Scenario IV – 17,000 PHPDT

Systems	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	28,600	8,094.73	28.30
Monorail	31,488	8,326.95	26.44
LRTS (Elevated)	31,460	6,826.81	21.70
LRTS (At Grade)	33,396	4,866.28	14.57
BRTS	33,760	7,313.48	21.66
Buses	37,360	6,459.54	17.29

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

At a PHPDT of 17,000 the LCC of all modes except bus comes down further. The bus service cannot meet the demand. The LRT (At Grate) become considerably cheaper than both the bus service and BRT. In order to meet the increased demand the number of coaches in the case of Monorail and LRT will have to be increased to meet the demand.

9.2.5 Scenario V – 27,000 PHPDT

Systems	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)*
Metro Rail	47,300	9,805.52	20.73
Monorail	49,536	11,131.55	22.47
LRTS (Elevated)	49,852	8,391.29	16.83
LRTS (At Grade)	53,240	6,533.71	12.27
BRTS	53,440	10,720.88	20.06
Buses	59,440	10,242.01	17.23

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

At 27,000 PHPDT, the LCC of all modes except bus comes down even further. The bus services cannot satisfy the contract. For the first time Metro rail becomes cheaper than the monorail. At this level LRT (both) elevated and at grade becomes considerably cheaper than both the bus service and BRT. However, the number of coaches in a train in a train in the case of Monorail and LRT will have to be increased to meet the demand.

9.3 Summary of Per Seat LCC of Selected Systems

The analysis has shown that LRTS (At Grade) has the least per seat life cycle cost of Rs 15.26 lakh. The LCC of both bus (Rs 17.34 lakhs) and BRT (Rs 22.21 lakhs) is higher than that of LRTS (At Grade). The LCC of Metro rail is high because it is a high capacity mode, much beyond the assumption of 15000 PHPDT made for the hypothetical case. Therefore for a proper comparison, the LCC of various modes has been calculated at different PHPDT levels i.e. demand or usage level. The result is summarized in the table below. At this hypothetical stage it has been assumed that capacity of various modes is not a limitation. This aspect of modal capacity and feasibility has been examined later in this section

PHPDT	Metro Rail	Monorail	LRTS (Elevated)	LRTS (At Grade)	BRTS	Buses
3000	80.80	69.45	73.10	39.42	41.27	**17.75**

5000	56.94	49.24	49.32	27.59	31.81	**17.78**
7000	45.03	39.32	38.34	22.83	27.81	**17.51**
10000	36.12	32.77	28.92	18.26	24.59	**17.36**
12000	31.88	29.47	25.74	**16.63**	23.40	17.29
15000	27.98	26.93	21.86	**14.91**	22.17	17.30
20000	23.14	24.05	18.85	**13.31**	21.01	17.22
25000	19.97	22.33	16.76	**12.30**	20.21	17.24
30000	18.39	21.14	15.37	**11.64**	19.75	17.19
35000	16.89	20.34	14.33	**11.20**	19.37	17.19
40000	16.05	19.74	13.60	**10.88**	19.14	17.16
45000	15.39	19.29	13.04	**10.62**	18.92	17.18
50000	14.67	18.91	12.59	**10.39**	18.77	17.19

It may be noted from the above table that LRTS (At grade) remains the cheapest mode at various levels of demand. In all cases LCC reduces substantially as the PHPDT (i.e. demand) increases except in the case of buses. Furthermore in terms of life cycle cost elevated LRTS also becomes cheaper than BRTS above 15,000 PHPDT.

The table further shows that elevated LRTS is cheaper than Metro rail at all levels of PHPDT i.e. demand level. Between Metro rail and Monorail, the table shows that Monorail is cheaper than Metro rail up to 15000 PHPDT. However Metro rail is cheaper than Monorail above 15,000 PHPDT. However, a comparison between Metro rail and Monorail is irrelevant because firstly monorail is a medium capacity mode and secondly monorail is recommended for special locations where the road right of way is limited and elevated Metro rail or elevated LRTS will be unsuitable for environmental reasons.

9.4 Impact of Capacity Limitations

In actual practice, all modes have an upper limit to capacity; for example bus with a capacity of 80 persons operating at 1 minute headway can carry a maximum of 4,800 PHPDT and not 15,000 PHPDT as assumed in the hypothetical case. Similarly, Metro rail is a very high capacity mode compared to Monorail, LRTS and BRTS. The limiting capacity of each mode depends on factors such as the number of coaches in a train and the frequency of service. The maximum capacity of a mode as per the coach configuration of the train is presented in *Table 8-5: Maximum PHPDT capacity of different modes at varying train configuration* of the report, reproduced below.

Table 9-2: Maximum PHPDT capacity of different modes at varying train configuration

System	Coach Configuration of the Train	Train Set Capacity	Maximum PHPDT
Metro Rail	4	1100	26,400
	6	1650	39,600
	8	2200	52,800
Mono Rail	3	384	9,216

	6	768	18,432
	9	1,152	27,648
Light Rail	2	484	11,616
	4	968	23,232
BRTS	1	80	8,000
	2	160	16,000
Ordinary Buses	1	80	4,800

Headway for Rail Based Systems has been assumed at 2.5 minutes, whereas for BRTS it has been assumed at 0.6 minutes and for Ordinary Buses at 1 minute.

The LCC of the various modes for variable capacity and actual possible usage is shown in the tables below. The mode is considered 'Not Feasible' when the PHPDT exceeds the mode capacity.

Table 9-3: Metro Rail– per Seat LCC (in Rs Lakhs) at different PHPDT

PHPDT	4 Coach Metro Rail	6 Coach Metro Rail	8 Coach Metro Rail
16000	29.05	28.41	27.91
18500	26.96	25.48	25.37
21000	23.76	24.01	23.43
23500	22.23	22.78	21.89
26000	21.30	21.23	20.65
28500	NOT FEASIBLE	20.41	20.15
31000	NOT FEASIBLE	18.67	19.22
33500	NOT FEASIBLE	18.14	18.41
36000	NOT FEASIBLE	17.68	17.73
38500	NOT FEASIBLE	17.03	17.14
41000	NOT FEASIBLE	NOT FEASIBLE	16.90
43500	NOT FEASIBLE	NOT FEASIBLE	15.93
46000	NOT FEASIBLE	NOT FEASIBLE	15.55
48500	NOT FEASIBLE	NOT FEASIBLE	15.21
51000	NOT FEASIBLE	NOT FEASIBLE	15.07
53500	NOT FEASIBLE	NOT FEASIBLE	NOT FEASIBLE
56000	NOT FEASIBLE	NOT FEASIBLE	NOT FEASIBLE

Following an approach similar to the one explained earlier for Metro Rail, per seat LCC analysis of Monorail System with a 3, 6 and 9 coach train configuration has also been performed and is presented in the table below:

Table 9-4: Mono Rail - Per Seat LCC (in Rs Lakhs) at different PHPDT

PHPDT	3 Coach Mono Rail	6 Coach Mono Rail	9 Coach Mono Rail
3000	75.26	65.07	65.01
6000	47.56	45.24	42.42
9000	36.38	35.74	35.23
12000	NOT FEASIBLE	31.41	31.06
15000	NOT FEASIBLE	27.47	27.78
18000	NOT FEASIBLE	25.80	26.01
21000	NOT FEASIBLE	NOT FEASIBLE	24.10

24000	NOT FEASIBLE	NOT FEASIBLE	22.98
27000	NOT FEASIBLE	NOT FEASIBLE	22.28
30000	NOT FEASIBLE	NOT FEASIBLE	NOT FEASIBLE
33000	NOT FEASIBLE	NOT FEASIBLE	NOT FEASIBLE

The per seat LCC calculated for elevated Light Rail system with a 2 and 4 coach train configuration at varying PHPDT is presented in the table below:

Table 9-5: Elevated Light Rail - Per Seat LCC (in Rs Lakhs) at different PHPDT

PHPDT	2 Coach Elevated LR	4 Coach Elevated LR
3000	79.98	69.59
6000	45.79	44.09
9000	33.01	33.62
12000	NOT FEASIBLE	27.03
15000	NOT FEASIBLE	23.71
18000	NOT FEASIBLE	20.63
21000	NOT FEASIBLE	19.10
24000	NOT FEASIBLE	NOT FEASIBLE
27000	NOT FEASIBLE	NOT FEASIBLE
30000	NOT FEASIBLE	NOT FEASIBLE

The results for at grade Light Rail System with the same train configuration as considered for elevated Light Rail System is presented in the table below:

Table 9-6: At Grade Light Rail - Per Seat LCC (in Rs Lakhs) at different PHPDT

PHPDT	2 Coach At-Grade LR	4 Coach At-Grade LR
3000	41.03	34.69
6000	26.12	24.58
9000	19.90	19.42
12000	NOT FEASIBLE	17.17
15000	NOT FEASIBLE	15.38
18000	NOT FEASIBLE	14.04
21000	NOT FEASIBLE	13.23
24000	NOT FEASIBLE	NOT FEASIBLE
27000	NOT FEASIBLE	NOT FEASIBLE
30000	NOT FEASIBLE	NOT FEASIBLE

Per seat LCC for BRTS on which buses can have one or two coach configurations has also been tested at varying PHPDT and the results are as below:

Table 9-7: BRTS - Per Seat LCC (in Rs Lakhs) at different PHPDT

PHPDT	1 Coach BRTS	2 Coach BRTS
4000	35.55	35.98
6000	29.78	29.87
8000	26.65	26.53
10000	NOT FEASIBLE	24.65
12000	NOT FEASIBLE	23.45
14000	NOT FEASIBLE	22.54
16000	NOT FEASIBLE	21.99
18000	NOT FEASIBLE	NOT FEASIBLE

20000	NOT FEASIBLE	NOT FEASIBLE
22000	NOT FEASIBLE	NOT FEASIBLE

Finally for the fifth selected urban transport mode i.e. ordinary bus services, per seat LCC analysis has also been performed but only for a single coach bus configuration. The results of the same are presented in the table below:

Table 9-8: Ordinary Bus Service - Per Seat LCC (in Rs Lakhs) at different PHPDT

PHPDT	1 Coach Ordinary Bus
1000	20.14
1500	18.82
2000	18.24
2500	17.94
3000	17.93
3500	17.76
4000	17.60
4500	17.99
5000	NOT FEASIBLE
5500	NOT FEASIBLE

The result of the above analysis is summarised in the table below.

Table 9-9: Summarized view of impact of mode capacity limitations on the LCC per seat

System	No. of Coaches in the Train	Train Set Capacity	Maximum PHPDT	LCC per seat (in INR Lakh)
Metro Rail	4	1100	26,400	21.30
	6	1650	39,600	17.03
	8	2200	52,800	15.07
Mono Rail	3	384	9,216	36.38
	6	768	18,432	25.80
	9	1,152	27,648	22.28
Light Rail elevated	2	484	11,616	33.01
	4	968	23,232	19.10
Light Rail At-grade	2	484	11,616	19.90
	4	968	23,232	13.23
BRTS	1	80	8,000	26.65
	2	160	16,000	24.99
Ordinary Buses	1	80	4,800	17.99

Headway for Rail Based Systems has been assumed at 2.5 minutes, whereas for BRTS it has been assumed at 0.6 minutes and for Ordinary Buses at 1 minute.

*LCC per seat (in INR Lakh) at NPV for the assumed lifespan of 30 years

It may be noted that with the increasing mode capacity and hence PHPDT, LCC for Monorail and LRT fall substantially in comparison to Metro rail, BRTS and Bus Services.

ANNEXURE I – ROLLING STOCK REQUIREMENT ASSESSMENT

An excel model was developed to assess the rolling stock requirement for the systems. The table below represents the model.

Modes	Metro Rail	Monorail	LRTS (Elevated)	LRTS (At Grade)	BRTS	Buses
Corridor Length (Km)	20	20	20	20	20	20
Average Speed (Km/Hr.)	35	30	30	25	25	15
PHPDT (Persons)	15000	15000	15000	15000	15000	15000
Carrying Capacity	1100	384	484	484	160	80
Rakes/ Coaches (Single Direction)	14	39	31	31	94	188
Headway (In Minutes)	4.40	1.54	1.94	1.94	0.64	0.32
Rakes/ Coaches (Recirculates)	5	13	10	6	19	-
Rakes/ Coaches (Both Direction)	21	65	52	56	169	375
Rakes/ Coaches (Traffic Reserve)	1	3	4	4	8	19
Rakes/ Coaches (Repair & Maintenance)	1	3	4	4	8	19
Total Required	23	71	58	62	185	413

In the above table, given the *Corridor Length, Average Speed, PHPDT* and *Carrying Capacity*, the rest of the parameters are determined and used to calculate total rolling stock requirement.

The rakes/coaches required to accommodate the PHPDT in a single direction is derived by dividing the *PHPDT* with the *Carrying Capacity*. This derived figure in turn is used to calculate the theoretical headway by dividing 60 minutes with the vehicles that need to ply.

Given the above vehicle requirement in a single direction and the headway, the number of rakes/coaches that can be re-circulated is calculated. The formula for this calculation is in the box below:

Rakes/Coaches Re-circulated = (60/Headway) * {1-(Corridor Length/Average Speed)}

By summing the result of the above calculation with the previously calculated vehicular requirement in a single direction, the *Rake/Coaches (Both Direction)* is derived.

A reserve of 5% is maintained as *Traffic Reserve* and *Repair & Maintenance Reserve* individually.

The final Rolling Stock requirement is calculated by summing the *Traffic Reserve*, *Repair & Maintenance Reserve* and the *Rakes/Coaches (Both Direction)*.

For the purpose of these calculations the carrying capacity and vehicle configuration have been chosen as depicted in the table below:

Mode	Configuration	Capacity (persons)	Remarks
MRTS	4 Coach	1,100	Approximated based on Bombardier MOVIA Coach Capacity for DMRC @ 6 pax/m sq.
Monorail	3 Coach	384	Approximated based on Hitachi's Medium Size specifications @ 6 pax/m sq.
LRTS	2 Coach	484	Approximated based on Siemens S70 specifications @ 6 pax/m sq.
BRTS	2 Coach	160	As per Rajkot DPR
Bus	1 Coach	80	As per Rajkot DPR

A heavy size Hitachi monorail coaches are also available which can carry up to 175 person per coach considering 6 person per square meters and can carry up to 525 passengers in a 3 coach configuration train (axle load of 11 tons whereas it is 10 tons for the medium size specification).

ANNEXURE II – HUMAN RESOURCE REQUIREMENT DETAIL

The Human Resource Requirement that has been generated is derived using a basic staffing grid that has been created by IUT for this purpose. For rail-based systems this grid has been created using the data available from DMRC. For bus-based systems, the grid has been created using assumptions based on the data available from CIRT. The Grids have been depicted below in tabular form.

Train Operation	Unit	DMRC	Assumed Metro	Assumed Mono/LR
Station Controller	per Station	**4.15**	4.00	1.00
Train Operation (TO)	per 100 train hours	**26.50**	26.00	5.00
DI/ALS	per 15 TO's	**1.00**	1.00	1.00
Station Manager	per station	**1.00**	1.00	1.00
Customer Relation Assistance	per Station	**3.75**	3.50	1.00
Crew Controller	per 100 TOs	**1.00**	1.00	1.00
Revenue Cell	Lakh ridership daily	**1.50**	1.35	0.50
Assistant Traffic Controller	per line up to 25 station	**1.20**	1.00	1.00
Time Table Controller	per shift	**1.00**	1.00	1.00
Chief Controller/ Assistant Chief Controller	per shift	**1.00**	1.00	1.00
Marketing Cell	each line	**2.00**	2.00	1.00
Maintenance	**Unit**	**DMRC**	**Assumed Metro**	**Assumed Mono/LR**
P.way	per km	**1.00**	1.00	0.50
Works	per km	**0.75**	0.75	0.50
E&M	per km	**4.50**	4.35	2.50
Traction	per km	**3.00**	2.90	2.00
S&T/ AFC Wing	per km	**6.10**	5.90	2.75
Rolling Stock Wing	per car	**1.30**	1.25	1.00
Stores	per km	**0.40**	0.40	0.30
HR	per 100 employee	**0.30**	0.30	0.30
Finance	per 100 employee	**0.50**	0.50	0.50

Human Resource Requirement Grid for Bus Based Systems:

Bus Operations & Maintenance	Unit	Assumed
Traffic	per Bus	3.50
Workshop & Maintenance	per Bus	1.00
Administration & Account	per Bus	0.50

ANNEXURE III – THE LCCA CALCULATION TABLES

BANGALORE METRO RAIL CORPORATION LIMITED

Hypothetical Case

Life Cycle Cost - General Framework for Analysis		
Total Route Length	**20**	km
Peak Hour Per Direction Traffic	**15,000**	Nos
Life Cycle Cost Analysis Duration	**30**	years

RESULTS OF THE HYPOTHETICAL CASE

Systems	Technical Feasibility	Number of Seats	LCC (NPV in INR Crore)	LCC per seat (in INR Lakh)
Metro Rail	OK	25,300	7,792.49	**30.80**
Monorail	Not Feasible	27,264	7,676.58	**28.16**
LRTS (Elevated)	Not Feasible	28,072	6,539.18	**23.29**
LRTS (At Grade)	Not Feasible	30,008	4,578.65	**15.26**
BRTS	OK	29,600	6,574.69	**22.21**
Buses	Not Feasible	33,040	5,727.82	**17.34**

1. All Prices Mentioned in this excel sheet is to be read in Indian National Rupee in Crores unless mentioned otherwise
2. Please edit the assumptions only in cells formatted as: ##
3. Please use the Drop Down Menues to select the figures in the assumption cells otherwise a Spreadsheet ERROR will appear

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COMMON ASSUMPTIONS FOR ALL THE FIVE MODES

General Assumptions					
Total Route Length	20	km			
Peak Hour Per Direction Traffic	15,000	nos			
Life Cycle Cost Analysis Duration	30	years			
Construction Duration Rail Based	5	years	Con Dur Bus Based	3	years

	Headway (in Min)	Avg. Speed (kmph)	Station Dist. (in km)	Car/Bus Capacity	Train Config
Metro Rail	2.50	35	1.00	275.00	4 Coach
Monorail	2.50	30	0.75	128.00	3 Coach
LRTS (Elevated)	2.50	30	0.75	242.00	2 Coach
LRTS (At Grade)	2.50	25	0.75	242.00	2 Coach
BRTS	0.60	25	0.75	80.00	2 Coach
Buses	1.00	15	0.50	80.00	1 Coach

Other Capex Assumptions		Taxes & Duties	Rail Based	Bus Based
General Charges (except Land)	3%	Custom Duty	18.62%	18.62%
Contingencies	3%	Excise Duty	8.24%	26.00%
Land Cost for Rail Based	10%	VAT	12.50%	12.50%
Land Cost for BRTS	5%	Sales Tax	6.25%	6.25%
Land Cost for Ordinary Bus	5%	Works Contract Tax	6.25%	6.25%

Replacement	Time (years)	% Replaced		BRTS/Ord Bus
Replacement Time (years)				10
E&M Works	10.00	100.00%	Roadways	50.00%
Permanent Way	50.00	100.00%	Bus Stops	50.00%
Traction & power	20.00	100.00%	Footover	50.00%
Signalling and Telecom	15.00	100.00%	ITS application	100.00%
Automatic fare collection	15.00	100.00%		
Rolling Stock	25.00	20.00%	Buses	100.00%

Financial Assumptions					
Annual Escalation in Prices	5%	Interest Rate	5%		
Discount Rate	10%				
Debt Ratio for Rail based = D/(D+E)	70%	for	15	years	
Debt Ratio for Bus based = D/(D+E)	70%	for	10	years	
Depots and Workshops					
Number of Depot for rail based system	1	for	30	km	
Number of Depot for Bus based system	1	for	50	buses	
Number of Workshops for Bus based system	1	for	250	buses	
Human Resource					
Average Remuneration of Staffs	9.00	Rs lakh			
Annual Increase in Remuneration	9%				
Fuel Pricing (Year 2012)					
Electricity Price (Rs per KW)	4.00	Annual escalation	5%		
Diesel Price (Rs per liter)	45.00	Annual escalation	5%		
CNG Prices (Rs per kg)	40.00	Annual escalation	5%		
Fuel Choice	Diesel				
Depreciation Rail Based	**No**	**Bus Based**		**15 year life after refurbishment**	
E&M Works	10.00%	Road	5.0%	After Refurbishment	6.67%
Permanent Way	2.00%	Bus Stops & FOB	5.0%	After Refurbishment	6.67%
Traction & power	5.00%	Civil	2.0%	After Refurbishment	6.67%
Signalling and Telecom	6.67%	ITS application	10.0%	After Refurbishment	6.67%
Automatic fare collection	6.67%	Buses	10.0%	After Refurbishment	6.67%
Rolling Stock	4.00%			After Refurbishment	6.67%
Civil	2.00%				

CAPEX ASSUMPTIONS

Item (in Rs Crore)	Unit	Metro Rail	Total Metro	Mono Rail	Total Mono	Light Rail	Total Light
Land		@10%	321.36	@10%	378.24	@10%	281.11
Alignment and Formation							
Elevated viaduct section	R. Km.	32.00	640.00	22.50	450.00	21.00	420.00
OCC Building	LS	50.00	50.00	40.00	40.00	40.00	40.00
Station Buildings							
Elevated stations	Each	16.00	320.00	9.00	243.00	10.00	270.00
E&M Works							
Elevated station (E&M, Lifts, etc.)	Each	7.00	140.00	2.50	67.50	2.50	67.50
Depot	LS	50.00	50.00	120.00	120.00	70.00	70.00
Permanent Way	R. Km.	7.00	140.00		-	5.00	100.00
Traction & power							
Elevated	R. Km.	8.00	160.00	5.50	110.00	5.50	110.00
Lift	Each	0.30	24.00	0.30	16.20	0.30	16.20
Escalator	Each	1.00	80.00	1.00	54.00	1.00	54.00
Signalling and Telecom							
Signalling	R. Km.	13.00	260.00	9.00	180.00	8.00	160.00
Telecom	Each Stn.	3.00	60.00	2.00	54.00	2.00	54.00
Automatic fare collection	Each	3.40	68.00	2.50	67.50	2.50	67.50
R & R	R. Km.	3.20	64.00	2.00	40.00	2.00	40.00
Misc. Civil Utilities	R. Km.	3.80	76.00	2.00	40.00	2.00	40.00
Electrical Utilities	R. Km.	2.90	58.00	2.50	50.00	2.50	50.00
Telecom Utilities	R. Km.	0.50	10.00	0.50	10.00	0.50	10.00
Rolling Stock	Each	10.00	920.00	10.00	2,130.00	10.00	1,160.00
General Charges (except land)		@3%	93.60	@3%	110.17	@3%	81.88
Contingencies		@3%	106.05	@3%	124.82	@3%	92.77
Total			3,641.01		4,285.42		3,184.95
R. Km.			182.05		214.27		159.25

Item (in Rs Crore)	Unit	BRTS	Total BRTS	BUS	Total BUS
Land Cost		@5%	56.76	@5%	16.34
Roadway Development	R. Km.	8.55	171.00		-
Bus Stops	Each	0.40	10.80	0.30	12.00
Foot over Bridges	Each	0.25	6.75		-
Operational Infrastructure (Terminals & Depots)					
Depots	Each	10.00	70.00	10.00	80.00
Workshops and Terminals	Each	20.00	20.00	25.00	50.00
Operation Control Center (OCC)	LS	10.00	10.00		-
Bridges and Flyovers	R. Km.	31.80	636.00		-
ITS application and External Tracking	LS	29.50	29.50	10.00	10.00
Bus Cost	Each	0.40	148.00	0.40	165.20
General Charges (except land)		@3%	33.06	@3%	9.52
Contingencies		@3%	35.76	@3%	10.29
Total Cost			1,227.62		353.34
R. Km.			61.38		17.67

PHASING ASSUMPTIONS

Rail Based Systems

	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5					
Land Phasing	60%	40%	0%	0%	0%	0%	0%	0%	0%	0%
CAPEX Phasing	15%	20%	25%	20%	20%	0%	0%	0%	0%	0%

Bus Based Systems

	Yr 1	Yr 2	Yr 3							
Land Phasing	60%	40%	0%	0%	0%	0%	0%	0%	0%	0%
CAPEX Phasing	30%	30%	40%	0%	0%	0%	0%	0%	0%	0%

ROLLING STOCK REQUIREMENTS

Mode	Corridor Length (Km)	Station/Shelter Frequency (Km)	Station/ Shelter Required	Average Speed (Km/Hr)	PHPDT (Persons)	Carrying Capacity	Rakes/ Coaches Required	Headway (In Minutes)	Rakes/ Coaches (Recirculated)	Rakes/ Coaches (Both Direction)	Rakes/ Coaches (Traffic Reserve)	Rakes/ Coaches (Repair & Maintenance)	Total Required
Metro Rail	20	1.00	20	35	15,000	1,100	14	4.40	5.84	21.00	1.00	1.00	23.00
Monorail	20	0.75	27	30	15,000	384	39	1.54	13.02	65.00	3.00	3.00	71.00
LRTS (Elev¢	20	0.75	27	30	15,000	484	31	1.94	10.33	52.00	3.00	3.00	58.00
LRTS (At Gr	20	0.75	27	25	15,000	484	31	1.94	6.20	56.00	3.00	3.00	62.00
BRTS	20	0.75	27	25	15,000	160	94	0.64	18.75	169.00	8.00	8.00	185.00
Buses	20	0.50	40	15	15,000	80	188	0.32	-	375.00	19.00	19.00	413.00

Notes:				
1	All Capacities considered are Fully Loaded (Standing + Sitting)			
	Unit size details are as follows:			
	Mode	Configuration	Capacity (persons)	Remarks
	MRTS	4 Coach	1,100	Bombardier MOVIA Coach Capacity for DMRC @ 6 pax/m sq
	Monorail	3 Coach	384	Approximated based on Hitachi's Medium Size Spec @ 6 pax/m sq
	LRTS	2 Coach	484	Approximated based on Siemens S70 specifications @ 6 pax/m sq
	BRTS	2 Coach	160	(Low Floor - Hi Speed)
	Bus	1 Coach	80	(Low Floor - Hi Speed)
2	Frequency - Gap between unit deployment in minutes to allow movement of Peak Hour per Direction Traffic			

6 per per sq m

Modes	Capacity of coaches	Units of Rail Cars/buses required
MRTS	275	92
Monorail	128	213
LRTS (Elevated)	242	116
LRTS (at Grade)	242	124
BRTS	80	370
Bus	80	413

ENERGY DEMAND CALCULATIONS

Time of Day			Traffic	Rail Car/bus Km				
			(both Dir)	Metro Rail	Mono Rail	Light Rail	BRTS	Buses
5	to	6	3,000	218	469	248	750	750
6	to	7	9,000	655	1,406	744	2,250	2,250
7	to	8	19,500	1,418	3,047	1,612	4,875	4,875
8	to	9	27,000	1,964	4,219	2,231	6,750	6,750
9	to	10	30,000	2,182	4,688	2,479	7,500	7,500
10	to	11	27,000	1,964	4,219	2,231	6,750	6,750
11	to	12	19,500	1,418	3,047	1,612	4,875	4,875
12	to	13	12,000	873	1,875	992	3,000	3,000
13	to	14	9,000	655	1,406	744	2,250	2,250
14	to	15	9,000	655	1,406	744	2,250	2,250
15	to	16	12,000	873	1,875	992	3,000	3,000
16	to	17	19,500	1,418	3,047	1,612	4,875	4,875
17	to	18	27,000	1,964	4,219	2,231	6,750	6,750
18	to	19	30,000	2,182	4,688	2,479	7,500	7,500
19	to	20	27,000	1,964	4,219	2,231	6,750	6,750
20	to	21	19,500	1,418	3,047	1,612	4,875	4,875
21	to	22	12,000	873	1,875	992	3,000	3,000
22	to	23	9,000	655	1,406	744	2,250	2,250
23	to	24	3,000	218	469	248	750	750
Average Daily Rail Car/bus Km				**23,567**	**50,627**	**26,778**	**81,000**	**81,000**
Average Annual Rail Car/bus Km				**8,601,955**	**18,478,855**	**9,773,970**	**29,565,000**	**29,565,000**

Energy Consumption **70 KWh** **per** **1000 GTKM**

	Energy Consumption				
	Metro Rail	**Mono Rail**	**Light Rail**	**BRTS**	**Buses**
Crush Load (in Tonnes)	50	28	35		
Electricity per rail car km	2.80	1.57	1.96		
Mileage of Buses Km/Litre				3.50	3.50
Auxiliary Energy Consumption (per annum/Station)	**1,213,625**				
Auxiliary Energy Consumption (per annum/Depot)	**11,563,200**	**5,518,800**	**5,518,800**		

Annual Energy/ Fuel Consumption (in '000)	**Metro Rail**	**Mono Rail**	**Light Rail**	**BRTS**	**Buses**
Annual Traction Power Consumption (KWh)	24,085	28,975	19,157		
Annual Auxiliary Power Consumption (KWh)	35,836	38,287	38,287		
Annual Diesel Oil (liters)				8,447	8,447
	20.97	23.54	20.11	38.01	38.01

STAFF REQUIREMENTS

Rail Based Systems							
Train Operation	**DMRC**	**Assumed Metro**	**Unit**	**Metro**	**Assumed Mono/LR**	**Monorail**	**Light Rail**
Station Controller	4.15	4.00	per Station	80.00	1.00	27.00	27.00
Train Operation (TO)	26.50	26.00	per 100 train hours	77.00	5.00	43.00	34.00
DI/ALS	1.00	1.00	per 15 TO's	6.00	1.00	3.00	3.00
Station Managers	1.00	1.00	per station	20.00	1.00	27.00	27.00
Customer Relation Assistance	3.75	3.50	per Station	70.00	1.00	27.00	27.00
Crew Conroller	1.00	1.00	per 100 Tos	1.00	1.00	1.00	1.00
Revenue Cell	1.50	1.35	Lakh ridership daily	5.00	0.50	2.00	2.00
Assistant Traffic Controller	1.20	1.00	per line up to 25 station	1.00	1.00	1.00	1.00
Time Table Controller	1.00	1.00	per shift	2.00	1.00	2.00	2.00
Chief Controller/ Assistant Chief Controller	1.00	1.00	per shift	2.00	1.00	2.00	2.00
Marketing Cell	2.00	2.00	each line	2.00	1.00	1.00	1.00
Maintenance	**DMRC**	**Assumed Metro**	**Unit**	**Metro**	**Assumed Mono/LR**	**Monorail**	**Light Rail**
P.way	1.00	1.00	per km	20.00	0.50	10.00	10.00
Works	0.75	0.75	per km	15.00	0.50	10.00	10.00
E&M	4.50	4.35	per km	87.00	2.50	50.00	50.00
Traction	3.00	2.90	per km	58.00	2.00	40.00	40.00
S&T/ AFC Wing	6.10	5.90	per km	118.00	2.75	55.00	55.00
Rolling Stock Wing	1.30	1.25	per car	115.00	1.00	213.00	116.00
Stores	0.40	0.40	per km	8.00	0.30	6.00	6.00
HR	0.30	0.30	per 100 employee	3.00	0.30	2.00	2.00
Finance	0.50	0.50	per 100 employee	4.00	0.50	3.00	3.00
Total Staffs Required				**694.00**		**525.00**	**419.00**
Staff Required per km				**34.70**		**26.25**	**20.95**

Bus Based System				
Bus Operations	**Assumed**	**Unit**	**BRTS**	**Ordinary Bus**
Traffic	3.50	per Bus	1,295.00	1,445.50
Workshop & Maintenance	1.00	per Bus	370.00	413.00
Administration & Account	0.50	per Bus	185.00	206.50
Total Staffs Required			**1,850.00**	**2,065.00**
Staff Required per km			**92.50**	**103.25**

REPAIR AND MAINTENANCE

Rail Based Systems			
Metro Rail			
Unit Cost of Repair & Maintenance (2010 Prices) of DMRC			
	Building	26.74	Rs Lakh per Station
	Plant & Machinery	11.40	Rs Lakh per Car
	Other	2.2%	Of Building, Plant & Machinery Costs
Assumed Unit Cost of Repair & Maintenance escalated @ inflation			
	Building	**29.48**	Rs Lakh per Station
	Plant & Machinery	**12.57**	Rs Lakh per Car
	Other R&M	**2.3%**	Of Building, Plant & Machinery Costs
Other O&M Costs		**11%**	of Energy, Staff and R&M costs
Mono Rail			
Assumed at 75% of the Unit Cost of Repair & Maintenance of metro rail escalated @ inflation			
	Building	**22.11**	Rs Lakh per Station
	Plant & Machinery	**9.43**	Rs Lakh per Car
	Other R&M	**2.3%**	Of Building, Plant & Machinery Costs
Other O&M Costs		**11%**	of Energy, Staff and R&M costs
Light Rail			
Assumed at 75% of the Unit Cost of Repair & Maintenance of metro rail escalated @ inflation			
	Building	**22.11**	Rs Lakh per Station
	Plant & Machinery	**9.43**	Rs Lakh per Car
	Other R&M	**2.3%**	Of Building, Plant & Machinery Costs
Other O&M Costs		**11%**	of Energy, Staff and R&M costs

Bus Based System			
BRTS			
Unit cost of Repair and Maintenance (2011 prices CIRT analysis)			
	Building/roads	2.00	Rs Lakh per bus stop
	Tyres & Tubes	1.08	Rs per effective Km
	Spare Parts	1.07	Rs per effective Km
	Other	2%	of building spare and tyre
Assumed Unit Cost of Repair & Maintenance escalated @ inflation			
	Building/roads	**2.10**	Rs Lakh per bus stop
	Tyres & Tubes	**1.13**	Rs per effective Km
	Spare Parts	**1.12**	Rs per effective Km
	Other	**2%**	of building spare and tyre
Ordinary Bus			
Unit cost of Repair and Maintenance (2011 prices CIRT analysis)			
	Building/roads	2.00	Rs Lakh per bus stop
	Tyres & Tubes	1.08	Rs per effective Km
	Spare Parts	1.07	Rs per effective Km
	Other	2%	of building spare and tyre
Assumed Unit Cost of Repair & Maintenance escalated @ inflation			
	Building/roads	**2.10**	Rs Lakh per bus stop
	Tyres & Tubes	**1.13**	Rs per effective Km
	Spare Parts	**1.12**	Rs per effective Km
	Other	**2%**	of building spare and tyre
Other O&M cost - BRTS and Buses		**11%**	of energy, staff and R&M costs

LCCA FOR METRO RAIL SYSTEMS

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX																														
Land	192.8	135.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alignment and Formation	103.5	144.9	190.2	159.8	167.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Station Buildings	48.0	67.2	88.2	74.1	77.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E&M Works	28.5	39.9	52.4	44.0	46.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanent Way	21.0	29.4	38.6	32.4	34.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	39.6	55.4	72.8	61.1	64.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	48.0	67.2	88.2	74.1	77.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	10.2	14.3	18.7	15.7	16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R & R	9.6	13.4	17.6	14.8	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Misc. Civil Utilities	11.4	16.0	20.9	17.6	18.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical Utilities	8.7	12.2	16.0	13.4	14.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Telecom Utilities	1.5	2.1	2.8	2.3	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	138.0	193.2	253.6	213.0	223.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
General Charges (except land)	14.0	19.7	25.8	21.7	22.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingencies	15.9	22.3	29.2	24.6	25.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex	**690.8**	**832.1**	**915.0**	**768.6**	**807.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CAPEX for Replacements																														
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	438.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	714.3	0.0	0.0	0.0	0.0
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	992.6	0.0	0.0	0.0	0.0
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	942.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	200.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex for Replacement	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**438.5**	**0.0**	**0.0**	**0.0**	**0.0**	**1,143**	**0.0**	**0.0**	**0.0**	**0.0**	**1,706**	**0.0**	**0.0**	**0.0**	**0.0**
Taxes & Duties																														
Custom Duty	53.1	74.4	97.6	82.0	86.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.7	0.0	0.0	0.0	0.0	212.8	0.0	0.0	0.0	0.0	317.8	0.0	0.0	0.0	0.0
Excise Duty	29.5	41.3	54.1	45.5	47.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	140.6	0.0	0.0	0.0	0.0
VAT	52.0	72.8	95.5	80.2	84.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.8	0.0	0.0	0.0	0.0	142.9	0.0	0.0	0.0	0.0	213.4	0.0	0.0	0.0	0.0
Sales Tax	28.7	40.1	52.6	44.2	46.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.4	0.0	0.0	0.0	0.0	71.4	0.0	0.0	0.0	0.0	106.7	0.0	0.0	0.0	0.0
Works Tax	28.7	40.1	52.6	44.2	46.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.4	0.0	0.0	0.0	0.0	71.4	0.0	0.0	0.0	0.0	106.7	0.0	0.0	0.0	0.0
Total Taxes & Duties	**191.9**	**268.6**	**352.6**	**296.1**	**310.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**227.4**	**0.0**	**0.0**	**0.0**	**0.0**	**498.6**	**0.0**	**0.0**	**0.0**	**0.0**	**885.2**	**0.0**	**0.0**	**0.0**	**0.0**
Operations & Maintenance																														
Staff Cost	0.0	0.0	0.0	0.0	0.0	96.1	104.8	114.2	124.5	135.7	147.9	161.2	175.7	191.5	208.7	227.5	248.0	270.3	294.6	321.1	350.1	381.6	415.9	453.3	494.1	538.6	587.1	639.9	697.5	760.3
Energy Cost	0.0	0.0	0.0	0.0	0.0	30.6	32.1	33.7	35.4	37.2	39.0	41.0	43.0	45.2	47.5	49.8	52.3	54.9	57.7	60.6	63.6	66.8	70.1	73.6	77.3	81.2	85.2	89.5	94.0	98.7
Repair & Maintenance Cost																														
Building	0.0	0.0	0.0	0.0	0.0	7.5	7.9	8.3	8.7	9.1	9.6	10.1	10.6	11.1	11.7	12.3	12.9	13.5	14.2	14.9	15.6	16.4	17.2	18.1	19.0	20.0	21.0	22.0	23.1	24.3
Plant & Machinery	0.0	0.0	0.0	0.0	0.0	14.8	15.5	16.3	17.1	17.9	18.8	19.8	20.8	21.8	22.9	24.0	25.2	26.5	27.8	29.2	30.7	32.2	33.8	35.5	37.3	39.2	41.1	43.2	45.3	47.6
Other Repair & Maintenance Cost	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6
Other Miscellaneous O&M Costs	0.0	0.0	0.0	0.0	0.0	16.4	17.7	19.0	20.5	22.1	23.8	25.6	27.6	29.7	32.1	34.6	37.3	40.3	43.5	47.0	50.7	54.8	59.2	64.0	69.2	74.8	80.9	87.6	94.8	102.6
Total O&M Costs	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**165.9**	**178.5**	**192.1**	**206.7**	**222.6**	**239.7**	**258.3**	**278.4**	**300.1**	**323.6**	**349.0**	**376.6**	**406.4**	**438.8**	**473.8**	**511.7**	**552.9**	**597.4**	**645.8**	**698.2**	**755.0**	**816.7**	**883.6**	**956.2**	**1,035**
Non-Operating Expenses																														
Interest Expenses	12.1	38.7	69.3	98.8	126.3	135.8	126.4	117.1	107.7	98.3	89.0	79.6	70.2	60.9	51.5	49.8	47.6	37.2	26.8	16.4	29.4	45.7	42.0	38.3	34.7	58.8	81.0	73.4	65.7	58.0
Depreciation Expenses																														
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Station Buildings	0.0	0.0	0.0	0.0	0.0	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
E&M Works																														
CAPEX	0.0	0.0	0.0	0.0	0.0	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	71.4	71.4	71.4	71.4	71.4
Permanent Way																														
CAPEX	0.0	0.0	0.0	0.0	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power																														
CAPEX	0.0	0.0	0.0	0.0	0.0	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.2	66.2	66.2	66.2	66.2
Signalling and Telecom																														
CAPEX	0.0	0.0	0.0	0.0	0.0	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	23.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8	62.8
Automatic fare collection																														
CAPEX	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
Rolling Stock																														
CAPEX	0.0	0.0	0.0	0.0	0.0	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Total Non-Operating Costs	**12.1**	**38.7**	**69.3**	**98.8**	**126.3**	**135.8**	**126.4**	**117.1**	**107.7**	**98.3**	**89.0**	**79.6**	**70.2**	**60.9**	**51.5**	**49.8**	**47.6**	**37.2**	**26.8**	**16.4**	**29.4**	**45.7**	**42.0**	**38.3**	**34.7**	**58.8**	**81.0**	**73.4**	**65.7**	**58.0**
Salvage Value																														
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	327.8
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	383.0
Station Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	177.6
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	357.2
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.7
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	661.7
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	314.2
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.8
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	226.3
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2,592**
Total Cost	895	1,139	1,337	1,163	1,244	302	305	309	314	321	329	338	349	361	375	1,065	424	444	466	490	2,183	599	639	684	733	3,406	898	957	1,022	-1,499

Present Value of Costs	**Total (in Rs Crore)**	**Per Seat (in Rs Lakh)**
Metro Rail Systems	**7,792.5**	**30.8**

Debt Repayment Schedule

Opening Balance	1,056	848	641	433	225	951	878	804	730	656	1,698	1,544	1,391	1,237	1,084	1,056	848	641	433	225	951	878	804	730	656	1,698	1,544	1,391	1,237	1,084
Addition of Debt due to CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Addition of Debt due to CAPEX Replacement	0	0	0	0	800	0	0	0	0	1,195	0	0	0	0	0	0	0	0	0	800	0	0	0	0	1,195	0	0	0	0	0
Debt Repayment CAPEX	187	187	187	187	0	0	0	0	0	0	0	0	0	0	0	187	187	187	187	0	0	0	0	0	0	0	0	0	0	0
Debt Repayment CAPEX Replacement	20	20	20	20	74	74	74	74	74	153	153	153	153	153	0	20	20	20	20	74	74	74	74	74	153	153	153	153	153	0
Closing Balance	848	641	433	225	951	878	804	730	656	1,698	1,544	1,391	1,237	1,084	1,084	848	641	433	225	951	878	804	730	656	1,698	1,544	1,391	1,237	1,084	1,084
Interest Amount	**48**	**37**	**27**	**16**	**29**	**46**	**42**	**38**	**35**	**59**	**81**	**73**	**66**	**58**	**0**	**48**	**37**	**27**	**16**	**29**	**46**	**42**	**38**	**35**	**59**	**81**	**73**	**66**	**58**	**0**

LCCA FOR MONO RAIL SYSTEMS

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX																														
Land	226.9	158.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alignment and Formation	73.5	102.9	135.1	113.4	119.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Station Buildings	36.5	51.0	67.0	56.3	59.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E&M Works	28.1	39.4	51.7	43.4	45.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	27.0	37.8	49.7	41.7	43.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	35.1	49.1	64.5	54.2	56.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	10.1	14.2	18.6	15.6	16.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R & R	6.0	8.4	11.0	9.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Misc. Civil Utilities	6.0	8.4	11.0	9.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical Utilities	7.5	10.5	13.8	11.6	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Telecom Utilities	1.5	2.1	2.8	2.3	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	319.5	447.3	587.1	493.1	517.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
General Charges (except land)	16.5	23.1	30.4	25.5	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingencies	18.7	26.2	34.4	28.9	30.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex	**813.0**	**979.4**	**1,076**	**904.6**	**949.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CAPEX for Replacements																														
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	432.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	704.9	0.0	0.0	0.0	0.0
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	677.5	0.0	0.0	0.0	0.0
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	689.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	198.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex for Replacement	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**432.8**	**0.0**	**0.0**	**0.0**	**0.0**	**888.2**	**0.0**	**0.0**	**0.0**	**0.0**	**1,382**	**0.0**	**0.0**	**0.0**	**0.0**
Taxes & Duties																														
Custom Duty	78.2	109.5	143.7	120.7	126.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.6	0.0	0.0	0.0	0.0	165.4	0.0	0.0	0.0	0.0	257.4	0.0	0.0	0.0	0.0
Excise Duty	39.9	55.9	73.4	61.6	64.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	113.9	0.0	0.0	0.0	0.0
VAT	66.2	92.7	121.7	102.2	107.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.1	0.0	0.0	0.0	0.0	111.0	0.0	0.0	0.0	0.0	172.8	0.0	0.0	0.0	0.0
Sales Tax	34.1	47.7	62.6	52.6	55.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0	55.5	0.0	0.0	0.0	0.0	86.4	0.0	0.0	0.0	0.0
Works Tax	34.1	47.7	62.6	52.6	55.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	0.0	0.0	0.0	0.0	55.5	0.0	0.0	0.0	0.0	86.4	0.0	0.0	0.0	0.0
Total Taxes & Duties	**252.4**	**353.4**	**463.9**	**389.6**	**409.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**224.4**	**0.0**	**0.0**	**0.0**	**0.0**	**387.4**	**0.0**	**0.0**	**0.0**	**0.0**	**716.9**	**0.0**	**0.0**	**0.0**	**0.0**
Operations & Maintenance																														
Staff Cost	0.0	0.0	0.0	0.0	0.0	72.7	79.2	86.4	94.1	102.6	111.9	121.9	132.9	144.9	157.9	172.1	187.6	204.5	222.9	242.9	264.8	288.6	314.6	342.9	373.8	407.4	444.1	484.1	527.6	575.1
Energy Cost	0.0	0.0	0.0	0.0	0.0	34.3	36.1	37.9	39.8	41.7	43.8	46.0	48.3	50.7	53.3	55.9	58.7	61.7	64.7	68.0	71.4	75.0	78.7	82.6	86.8	91.1	95.7	100.4	105.5	110.7
Repair & Maintenance Cost																														
Building	0.0	0.0	0.0	0.0	0.0	7.6	8.0	8.4	8.8	9.3	9.7	10.2	10.7	11.3	11.8	12.4	13.0	13.7	14.4	15.1	15.8	16.6	17.5	18.3	19.3	20.2	21.2	22.3	23.4	24.6
Plant & Machinery	0.0	0.0	0.0	0.0	0.0	25.6	26.9	28.3	29.7	31.2	32.7	34.3	36.1	37.9	39.8	41.7	43.8	46.0	48.3	50.7	53.3	55.9	58.7	61.7	64.8	68.0	71.4	75.0	78.7	82.7
Other Repair & Maintenance Cost	0.0	0.0	0.0	0.0	0.0	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4
Other Miscellaneous O&M Costs	0.0	0.0	0.0	0.0	0.0	3.2	3.4	3.6	3.9	4.2	4.5	4.8	5.2	5.5	5.9	6.4	6.9	7.4	7.9	8.5	9.2	9.9	10.6	11.4	12.3	13.2	14.3	15.4	16.6	17.9
Total O&M Costs	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**144.2**	**154.4**	**165.3**	**177.1**	**189.9**	**203.5**	**218.3**	**234.2**	**251.3**	**269.8**	**289.8**	**311.3**	**334.6**	**359.6**	**386.7**	**416.0**	**447.7**	**481.8**	**518.8**	**558.8**	**602.0**	**648.8**	**699.4**	**754.1**	**813**
Non-Operating Expenses																														
Interest Expenses	14.2	45.6	81.6	116.3	148.7	159.8	148.8	137.8	126.8	115.7	104.7	93.7	82.7	71.6	60.6	57.2	53.2	41.2	29.2	17.1	25.1	37.6	34.5	31.4	28.3	47.8	65.7	59.4	53.1	46.8
Depreciation Expenses																														

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9
Station Buildings	0.0	0.0	0.0	0.0	0.0	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
E&M Works																														
CAPEX	0.0	0.0	0.0	0.0	0.0	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	43.3	70.5	70.5	70.5	70.5	70.5
Permanent Way																														
CAPEX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power																														
CAPEX	0.0	0.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.2	45.2	45.2	45.2	45.2
Signalling and Telecom																														
CAPEX	0.0	0.0	0.0	0.0	0.0	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0	46.0
Automatic fare collection																														
CAPEX	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
Rolling Stock																														
CAPEX	0.0	0.0	0.0	0.0	0.0	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6	94.6
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Total Non Operating Costs	**14.2**	**45.6**	**81.6**	**116.3**	**148.7**	**159.8**	**148.8**	**137.8**	**126.8**	**115.7**	**104.7**	**93.7**	**82.7**	**71.6**	**60.6**	**57.2**	**53.2**	**41.2**	**29.2**	**17.1**	**25.1**	**37.6**	**34.5**	**31.4**	**28.3**	**47.8**	**65.7**	**59.4**	**53.1**	**46.8**
Salvage Value																														
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	385.8
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	272.0
Station Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	134.9
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	352.5
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	451.7
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	229.8
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.3
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	208.2
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2,101**
Total Cost	**1,080**	**1,378**	**1,622**	**1,411**	**1,508**	**304**	**303**	**303**	**304**	**306**	**308**	**312**	**317**	**323**	**330**	**1,004**	**365**	**376**	**389**	**404**	**1,717**	**485**	**516**	**550**	**587**	**2,749**	**714**	**759**	**807**	**-1,241**

Present Value of Costs	Total (in Rs Crore)	Per Seat (in Rs Lakh)
Metro Rail Systems	**7,676.6**	**28.2**

Debt Repayment Schedule	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Opening Balance	0	569	1,255	2,009	2,642	3,307	3,086	2,866	2,645	2,425	2,204	1,984	1,764	1,543	1,323	1,102	1,185	944	703	463	222	782	721	659	597	536	1,377	1,251	1,125	999
Addition of Debt due to CAPEX	569	686	754	633	665	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Addition of Debt due to CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	303	0	0	0	0	622	0	0	0	0	968	0	0	0	0
Debt Repayment CAPEX	0	0	0	0	0	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220	0	0	0	0	0	0	0	0	0	0
Debt Repayment CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	20	20	62	62	62	62	62	126	126	126	126	126
Closing Balance	569	1,255	2,009	2,642	3,307	3,086	2,866	2,645	2,425	2,204	1,984	1,764	1,543	1,323	1,102	1,185	944	703	463	222	782	721	659	597	536	1,377	1,251	1,125	999	873

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Interest Amount	**14**	**46**	**82**	**116**	**149**	**160**	**149**	**138**	**127**	**116**	**105**	**94**	**83**	**72**	**61**	**57**	**53**	**41**	**29**	**17**	**25**	**38**	**34**	**31**	**28**	**48**	**66**	**59**	**53**	**47**

LCCA FOR ELEVATED LIGHT RAIL SYSTEMS

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX																														
Land	168.7	118.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alignment and Formation	69.0	96.6	126.8	106.5	111.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Station Buildings	40.5	56.7	74.4	62.5	65.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E&M Works	59.6	83.5	109.6	92.0	96.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanent Way	15.0	21.0	27.6	23.2	24.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	27.0	37.8	49.7	41.7	43.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	32.1	44.9	59.0	49.5	52.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	10.1	14.2	18.6	15.6	16.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R & R	6.0	8.4	11.0	9.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Misc. Civil Utilities	6.0	8.4	11.0	9.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electrical Utilities	7.5	10.5	13.8	11.6	12.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Telecom Utilities	1.5	2.1	2.8	2.3	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	174.0	243.6	319.7	268.6	282.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
General Charges (except land)	12.3	17.2	22.6	19.0	19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingencies	13.9	19.5	25.6	21.5	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex	**643.2**	**782.5**	**872.0**	**732.5**	**769.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CAPEX for Replacements																														
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	917.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,494	0.0	0.0	0.0	0.0
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	677.5	0.0	0.0	0.0	0.0
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	630.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	198.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex for Replacement	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**917.5**	**0.0**	**0.0**	**0.0**	**0.0**	**829.3**	**0.0**	**0.0**	**0.0**	**0.0**	**2,172**	**0.0**	**0.0**	**0.0**	**0.0**
Taxes & Duties																														
Custom Duty	59.2	82.9	108.8	91.4	95.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.8	0.0	0.0	0.0	0.0	154.4	0.0	0.0	0.0	0.0	404.4	0.0	0.0	0.0	0.0
Excise Duty	30.5	42.7	56.0	47.1	49.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	179.0	0.0	0.0	0.0	0.0
VAT	51.5	72.2	94.7	79.6	83.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.7	0.0	0.0	0.0	0.0	103.7	0.0	0.0	0.0	0.0	271.5	0.0	0.0	0.0	0.0
Sales Tax	27.6	38.7	50.8	42.7	44.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.3	0.0	0.0	0.0	0.0	51.8	0.0	0.0	0.0	0.0	135.7	0.0	0.0	0.0	0.0
Works Tax	27.6	38.7	50.8	42.7	44.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.3	0.0	0.0	0.0	0.0	51.8	0.0	0.0	0.0	0.0	135.7	0.0	0.0	0.0	0.0
Total Taxes & Duties	**196.5**	**275.1**	**361.1**	**303.4**	**318.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**475.8**	**0.0**	**0.0**	**0.0**	**0.0**	**361.7**	**0.0**	**0.0**	**0.0**	**0.0**	**1,126**	**0.0**	**0.0**	**0.0**	**0.0**
Operations & Maintenance																														
Staff Cost	0.0	0.0	0.0	0.0	0.0	58.0	63.2	68.9	75.1	81.9	89.3	97.3	106.1	115.6	126.0	137.4	149.7	163.2	177.9	193.9	211.3	230.4	251.1	273.7	298.3	325.2	354.4	386.3	421.1	459.0
Energy Cost	0.0	0.0	0.0	0.0	0.0	29.3	30.8	32.3	33.9	35.6	37.4	39.3	41.3	43.3	45.5	47.8	50.2	52.7	55.3	58.1	61.0	64.0	67.2	70.6	74.1	77.8	81.7	85.8	90.1	94.6
Repair & Maintenance Cost																														
Building	0.0	0.0	0.0	0.0	0.0	7.6	8.0	8.4	8.8	9.3	9.7	10.2	10.7	11.3	11.8	12.4	13.0	13.7	14.4	15.1	15.8	16.6	17.5	18.3	19.3	20.2	21.2	22.3	23.4	24.6
Plant & Machinery	0.0	0.0	0.0	0.0	0.0	14.0	14.7	15.4	16.2	17.0	17.8	18.7	19.6	20.6	21.7	22.7	23.9	25.1	26.3	27.6	29.0	30.5	32.0	33.6	35.3	37.0	38.9	40.8	42.9	45.0
Other Repair & Maintenance Cost	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6
Other Miscellaneous O&M Costs	0.0	0.0	0.0	0.0	0.0	12.0	12.9	13.8	14.8	15.9	17.0	18.3	19.6	21.1	22.6	24.3	26.1	28.1	30.2	32.5	35.0	37.7	40.6	43.7	47.1	50.8	54.7	59.0	63.7	68.7

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026
Total O&M Costs	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**121.4**	**130.1**	**139.4**	**149.4**	**160.2**	**171.9**	**184.4**	**198.0**	**212.6**	**228.4**
Non-Operating Expenses															
Interest Expenses	11.3	36.2	65.2	93.2	119.5	128.5	119.7	110.8	102.0	93.1	84.2	75.4	66.5	57.6	48.8
Depreciation Expenses															
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Station Buildings	0.0	0.0	0.0	0.0	0.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
E&M Works															
CAPEX	0.0	0.0	0.0	0.0	0.0	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanent Way															
CAPEX	0.0	0.0	0.0	0.0	0.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power															
CAPEX	0.0	0.0	0.0	0.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom															
CAPEX	0.0	0.0	0.0	0.0	0.0	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection															
CAPEX	0.0	0.0	0.0	0.0	0.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock															
CAPEX	0.0	0.0	0.0	0.0	0.0	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Total Non-Operating Costs	**11.3**	**36.2**	**65.2**	**93.2**	**119.5**	**128.5**	**119.7**	**110.8**	**102.0**	**93.1**	**84.2**	**75.4**	**66.5**	**57.6**	**48.8**
Salvage Value															
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Station Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total Cost	**851**	**1,094**	**1,298**	**1,129**	**1,207**	**250**	**250**	**250**	**251**	**253**	**256**	**260**	**264**	**270**	**277**

	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Total O&M Costs	**245.4**	**263.7**	**283.6**	**305.0**	**328.2**	**353.2**	**380.2**	**409.5**	**441.1**	**475.3**	**512.3**	**552.3**	**595.7**	**642.6**	**693.5**
Non-Operating Expenses															
Interest Expenses	55.9	62.1	51.1	40.1	29.1	36.0	46.5	42.4	38.3	34.2	65.6	94.5	85.4	76.2	67.1
Depreciation Expenses															
Alignment and Formation	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
Station Buildings	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
E&M Works															
CAPEX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	91.7	149.4	149.4	149.4	149.4	149.4
Permanent Way															
CAPEX	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Traction & power															
CAPEX	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.2	45.2	45.2	45.2	45.2
Signalling and Telecom															
CAPEX	15.8	15.8	15.8	15.8	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0	42.0
Automatic fare collection															
CAPEX	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3	13.3
Rolling Stock															
CAPEX	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Total Non-Operating Costs	**55.9**	**62.1**	**51.1**	**40.1**	**29.1**	**36.0**	**46.5**	**42.4**	**38.3**	**34.2**	**65.6**	**94.5**	**85.4**	**76.2**	**67.1**
Salvage Value															
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	286.7
Alignment and Formation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	255.4
Station Buildings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	149.9
E&M Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	747.2
Permanent Way	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.5
Traction & power	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	451.7
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	210.1
Automatic fare collection	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.3
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	174.7
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2,397**
Total Cost	**1,695**	**326**	**335**	**345**	**357**	**1,580**	**427**	**452**	**479**	**510**	**3,876**	**647**	**681**	**719**	**-1,637**

Present Value of Costs	**Total (in Rs Crore)**	**Per Seat (in Rs Lakh)**
Metro Rail Systems	**6,539.2**	**23.3**

Debt Repayment Schedule	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Opening Balance	0	450	998	1,608	2,121	2,660	2,482	2,305	2,128	1,950	1,773	1,596	1,418	1,241	1,064
Addition of Debt due to CAPEX	450	548	610	513	538	0	0	0	0	0	0	0	0	0	0
Addition of Debt due to CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Debt Repayment Schedule	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Opening Balance	887	1,351	1,131	911	691	471	970	888	807	725	644	1,981	1,799	1,616	1,433
Addition of Debt due to CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Addition of Debt due to CAPEX Replacement	642	0	0	0	0	580	0	0	0	0	1,520	0	0	0	0

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Debt Repayment CAPEX	0	0	0	0	0	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	0	0	0	0	0	0	0	0	0	0
Debt Repayment CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	43	43	43	82	82	82	82	82	183	183	183	183	183
Closing Balance	450	998	1,608	2,121	2,660	2,482	2,305	2,128	1,950	1,773	1,596	1,418	1,241	1,064	887	1,351	1,131	911	691	471	970	888	807	725	644	1,981	1,799	1,616	1,433	1,250
Interest Amount	**11**	**36**	**65**	**93**	**120**	**129**	**120**	**111**	**102**	**93**	**84**	**75**	**66**	**58**	**49**	**56**	**62**	**51**	**40**	**29**	**36**	**46**	**42**	**38**	**34**	**66**	**94**	**85**	**76**	**67**

LCCA FOR AT GRADE LIGHT RAIL SYSTEMS

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX																														
Land	113.7	79.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fixed Infrastructure (Civil)	39.0	54.6	71.7	60.2	63.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fixed Infrastructure (Electrical)	27.0	37.8	49.6	41.7	43.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Depots	12.0	16.8	22.1	18.5	19.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operations Control Center	6.0	8.4	11.0	9.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	186.0	260.4	341.8	287.1	301.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	6.0	8.4	11.0	9.3	9.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
General Charges (except land)	8.3	11.6	15.2	12.8	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingencies	9.4	13.1	17.2	14.5	15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex	**407.4**	**490.7**	**539.6**	**453.3**	**475.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CAPEX for Replacements																														
Fixed Infrastructure (Electrical) & Depots	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	600.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	977.5	0.0	0.0	0.0	0.0
Operations Control Center	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	117.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex for Replacement	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**600.1**	**0.0**	**0.0**	**0.0**	**0.0**	**235.7**	**0.0**	**0.0**	**0.0**	**0.0**	**977.5**	**0.0**	**0.0**	**0.0**	**0.0**
Taxes & Duties																														
Custom Duty	44.1	61.8	81.1	68.1	71.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	111.7	0.0	0.0	0.0	0.0	43.9	0.0	0.0	0.0	0.0	182.0	0.0	0.0	0.0	0.0
Excise Duty	22.2	31.1	40.9	34.3	36.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.4	0.0	0.0	0.0	0.0	9.7	0.0	0.0	0.0	0.0	80.5	0.0	0.0	0.0	0.0
VAT	34.5	48.3	63.4	53.3	55.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0	0.0	29.5	0.0	0.0	0.0	0.0	122.2	0.0	0.0	0.0	0.0
Sales Tax	17.3	24.2	31.7	26.6	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.5	0.0	0.0	0.0	0.0	14.7	0.0	0.0	0.0	0.0	61.1	0.0	0.0	0.0	0.0
Works Tax	17.3	24.2	31.7	26.6	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.5	0.0	0.0	0.0	0.0	14.7	0.0	0.0	0.0	0.0	61.1	0.0	0.0	0.0	0.0
Total Taxes & Duties	**135.4**	**189.5**	**248.8**	**209.0**	**219.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**311.2**	**0.0**	**0.0**	**0.0**	**0.0**	**112.5**	**0.0**	**0.0**	**0.0**	**0.0**	**506.9**	**0.0**	**0.0**	**0.0**	**0.0**
Operations & Maintenance																														
Staff Cost	0.0	0.0	0.0	0.0	0.0	58.0	63.2	68.9	75.1	81.9	89.3	97.3	106.1	115.6	126.0	137.4	149.7	163.2	177.9	193.9	211.3	230.4	251.1	273.7	298.3	325.2	354.4	386.3	421.1	459.0
Energy Cost	0.0	0.0	0.0	0.0	0.0	29.3	30.8	32.3	33.9	35.6	37.4	39.3	41.3	43.3	45.5	47.8	50.2	52.7	55.3	58.1	61.0	64.0	67.2	70.6	74.1	77.8	81.7	85.8	90.1	94.6
Repair & Maintenance Cost																														
Building	0.0	0.0	0.0	0.0	0.0	7.6	8.0	8.4	8.8	9.3	9.7	10.2	10.7	11.3	11.8	12.4	13.0	13.7	14.4	15.1	15.8	16.6	17.5	18.3	19.3	20.2	21.2	22.3	23.4	24.6
Plant & Machinery	0.0	0.0	0.0	0.0	0.0	14.9	15.7	16.4	17.3	18.1	19.0	20.0	21.0	22.0	23.1	24.3	25.5	26.8	28.1	29.5	31.0	32.6	34.2	35.9	37.7	39.6	41.6	43.6	45.8	48.1
Other Repair & Maintenance Cost	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.6	1.6
Other Miscellaneous O&M Costs	0.0	0.0	0.0	0.0	0.0	12.1	13.0	13.9	14.9	16.0	17.2	18.4	19.8	21.2	22.8	24.5	26.3	28.3	30.4	32.7	35.2	37.9	40.8	44.0	47.4	51.1	55.0	59.3	64.0	69.1
Total O&M Costs	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**122.5**	**131.2**	**140.6**	**150.7**	**161.6**	**173.3**	**185.9**	**199.5**	**214.2**	**230.1**	**247.2**	**265.6**	**285.5**	**307.1**	**330.3**	**355.4**	**382.6**	**412.0**	**443.7**	**478.0**	**515.2**	**555.4**	**598.9**	**646.0**	**697.0**
Non-Operating Expenses																														
Interest Expenses	7.1	22.8	40.9	58.3	74.5	80.1	74.6	69.0	63.5	58.0	52.5	46.9	41.4	35.9	30.4	35.4	39.6	32.7	25.8	18.9	18.6	20.7	18.8	16.8	14.9	28.9	41.8	37.5	33.3	29.1
Depreciation Expenses																														

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Fixed Infrastructure (Civil)	0.0	0.0	0.0	0.0	0.0	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
Fixed Infrastructure (Electrical) & Depots																														
CAPEX	0.0	0.0	0.0	0.0	0.0	28.9	28.9	28.9	28.9	28.9	28.9	28.9	28.9	28.9	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	97.8	97.8	97.8	97.8	97.8
Operations Control Center																														
CAPEX	0.0	0.0	0.0	0.0	0.0	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Rolling Stock																														
CAPEX	0.0	0.0	0.0	0.0	0.0	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1	55.1
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom																														
CAPEX	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Total Non-Operating Costs	**7.1**	**22.8**	**40.9**	**58.3**	**74.5**	**80.1**	**74.6**	**69.0**	**63.5**	**58.0**	**52.5**	**46.9**	**41.4**	**35.9**	**30.4**	**35.4**	**39.6**	**32.7**	**25.8**	**18.9**	**18.6**	**20.7**	**18.8**	**16.8**	**14.9**	**28.9**	**41.8**	**37.5**	**33.3**	**29.1**
Salvage Value																														
Land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	193.3
Fixed Infrastructure (Civil)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.3
Fixed Infrastructure (Electrical) & Depots	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	488.8
Operations Control Center	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
Rolling Stock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Signalling and Telecom	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.4
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**970.3**
Total Cost	**550**	**703**	**829**	**720**	**770**	**203**	**206**	**210**	**214**	**220**	**226**	**233**	**241**	**250**	**260**	**1,194**	**305**	**318**	**333**	**349**	**722**	**403**	**431**	**461**	**493**	**2,029**	**597**	**636**	**679**	**-244**

Present Value of Costs	Total (in Rs Crore)	Per Seat (in Rs Lakh)
Metro Rail Systems	**4,578.7**	**15.3**

Debt Repayment Schedule	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Opening Balance	0	285	629	1,006	1,324	1,657	1,546	1,436	1,325	1,215	1,105	994	884	773	663	552	862	723	585	447	308	434	395	356	317	278	878	793	708	624
Addition of Debt due to CAPEX	285	344	378	317	333	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Addition of Debt due to CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	420	0	0	0	0	165	0	0	0	0	684	0	0	0	0
Debt Repayment CAPEX	0	0	0	0	0	110	110	110	110	110	110	110	110	110	110	110	110	110	110	110	0	0	0	0	0	0	0	0	0	0
Debt Repayment CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	28	28	28	39	39	39	39	39	85	85	85	85	85
Closing Balance	285	629	1,006	1,324	1,657	1,546	1,436	1,325	1,215	1,105	994	884	773	663	552	862	723	585	447	308	434	395	356	317	278	878	793	708	624	539
Interest Amount	**7**	**23**	**41**	**58**	**75**	**80**	**75**	**69**	**64**	**58**	**52**	**47**	**41**	**36**	**30**	**35**	**40**	**33**	**26**	**19**	**19**	**21**	**19**	**17**	**15**	**29**	**42**	**38**	**33**	**29**

LCCA FOR BUS RAPID TRANSIT SYSTEMS

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX																														
Land Cost	34.1	23.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Roadway Development	51.3	53.9	75.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Stops	3.2	3.4	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foot over Bridges	2.0	2.1	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operational Infrastructure (Terminals & Depots)																														
Depots	21.0	22.1	30.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Workshops and Terminals	6.0	6.3	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operation Control Center (OCC)	3.0	3.2	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bridges and Flyovers	190.8	200.3	280.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ITS application and External Tracking	8.9	9.3	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Cost	44.4	46.6	65.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
General Charges (except land)	9.9	10.4	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingencies	10.7	11.3	15.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex	**385.3**	**392.7**	**516.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CAPEX for Replacements																														
Roadway Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	170.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	277.3	0.0	0.0	0.0	0.0	0.0	0.0
Bus Stops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.5	0.0	0.0	0.0	0.0	0.0	0.0
Foot over Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0
ITS application and External Tracking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	95.7	0.0	0.0	0.0	0.0	0.0	0.0
Bus Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	294.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	480.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex for Replacement	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**541.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**881.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Taxes & Duties																														
Custom Duty	1.6	1.7	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	0.0	0.0	0.0	0.0	0.0	0.0
Excise Duty	83.7	87.8	123.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	125.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	204.3	0.0	0.0	0.0	0.0	0.0	0.0
VAT	41.3	43.4	60.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	67.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	110.2	0.0	0.0	0.0	0.0	0.0	0.0
Sales Tax	20.7	21.7	30.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	55.1	0.0	0.0	0.0	0.0	0.0	0.0
Works Contract Tax	16.9	17.8	24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Taxes & Duties	**164.2**	**172.5**	**241.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**248.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**405.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Operations & Maintenance																														
Staff Cost	0.0	0.0	0.0	215.6	235.0	256.2	279.2	304.4	331.8	361.6	394.2	429.6	468.3	510.5	556.4	606.5	661.1	720.6	785.4	856.1	933.1	1,017.1	1,108.7	1,208.4	1,317.2	1,435.7	1,565.0	1,705.8	1,859.3	2,026.7
Energy Cost	0.0	0.0	0.0	44.0	46.2	48.5	50.9	53.5	56.2	59.0	61.9	65.0	68.3	71.7	75.3	79.0	83.0	87.1	91.5	96.1	100.9	105.9	111.2	116.8	122.6	128.7	135.2	141.9	149.0	156.5
Repair & Maintenance Cost																														
Building	0.0	0.0	0.0	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3
Tyre, tube and spare parts	0.0	0.0	0.0	7.7	8.1	8.5	8.9	9.4	9.9	10.4	10.9	11.4	12.0	12.6	13.2	13.9	14.6	15.3	16.1	16.9	17.7	18.6	19.5	20.5	21.5	22.6	23.7	24.9	26.2	27.5
Other Repair & Maintenance Cost	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6
Other Miscellaneous O&M Costs	0.0	0.0	0.0	29.5	31.9	34.6	37.4	40.5	43.9	47.5	51.5	55.8	60.5	65.6	71.1	77.1	83.6	90.7	98.4	106.8	115.9	125.8	136.6	148.3	161.0	174.8	189.9	206.3	224.1	243.5
Total O&M Costs	**0.0**	**0.0**	**0.0**	**297.7**	**322.1**	**348.7**	**377.5**	**408.8**	**442.7**	**479.6**	**519.6**	**563.1**	**610.3**	**661.6**	**717.4**	**778.0**	**843.8**	**915.3**	**993.1**	**1,077**	**1,169**	**1,269**	**1,378**	**1,496**	**1,624**	**1,764**	**1,916**	**2,081**	**2,261**	**2,457**
Non-Operating Expenses																														
Interest Expenses	6.7	20.4	36.3	43.0	38.5	34.0	29.4	24.9	20.4	15.9	11.3	6.8	2.3	9.5	18.0	16.1	14.2	12.3	10.4	8.5	6.6	4.7	2.8	15.8	28.1	25.0	21.9	18.9	15.8	12.7
Depreciation Expenses																														
Roadway Development																														
CAPEX	0.0	0.0	0.0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	22.4	22.4	22.4	22.4	22.4	22.4	22.4

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
Bus Stops & Foot over Bridges																														
CAPEX	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Depots, Workshop & Terminal, Bridge and OCC	0.0	0.0	0.0	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5
ITS application and External Tracking																														
CAPEX	0.0	0.0	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Bus Cost																														
CAPEX	0.0	0.0	0.0	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	15.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	29.5	48.0	48.0	48.0	48.0	48.0	48.0	48.0
Other Miscellaneous	0.0	0.0	0.0	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Total Non-Operating Costs	**6.7**	**20.4**	**36.3**	**43.0**	**38.5**	**34.0**	**29.4**	**24.9**	**20.4**	**15.9**	**11.3**	**6.8**	**2.3**	**9.5**	**18.0**	**16.1**	**14.2**	**12.3**	**10.4**	**8.5**	**6.6**	**4.7**	**2.8**	**15.8**	**28.1**	**25.0**	**21.9**	**18.9**	**15.8**	**12.7**
Salvage Value																														
Land Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.9
Roadway Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	288.9
Bus Stops & Foot over Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.1
Depots, Workshop & Terminal, Bridge and OCC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	357.5
ITS application and External Tracking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	121.1
Bus Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.0
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.4
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**1,023**
Total Cost	**556**	**585**	**794**	**341**	**361**	**383**	**407**	**434**	**463**	**495**	**531**	**570**	**613**	**1,461**	**735**	**794**	**858**	**928**	**1,004**	**1,086**	**1,176**	**1,274**	**1,381**	**2,799**	**1,653**	**1,789**	**1,938**	**2,100**	**2,277**	**1,446**

Present Value of Costs	Total (in Rs Crore)	Per Seat (in Rs Lakh)
Metro Rail Systems	**6,574.7**	**22.2**

Debt Repayment Schedule																														
Opening Balance	0.0	269.7	544.6	906.0	815.4	724.8	634.2	543.6	453.0	362.4	271.8	181.2	90.6	0.0	378.8	340.9	303.1	265.2	227.3	189.4	151.5	113.6	75.8	37.9	593.2	531.5	469.8	408.1	346.4	284.7
Addition of Debt due to CAPEX	269.7	274.9	361.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Addition of Debt due to CAPEX Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	378.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	617.1	0.0	0.0	0.0	0.0	0.0	0.0
Debt Repayment CAPEX	0.0	0.0	0.0	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Debt Repayment CAPEX Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9	61.7	61.7	61.7	61.7	61.7	61.7	61.7
Closing Balance	269.7	544.6	906.0	815.4	724.8	634.2	543.6	453.0	362.4	271.8	181.2	90.6	0.0	378.8	340.9	303.1	265.2	227.3	189.4	151.5	113.6	75.8	37.9	593.2	531.5	469.8	408.1	346.4	284.7	223.0
Interest Amount	**6.7**	**20.4**	**36.3**	**43.0**	**38.5**	**34.0**	**29.4**	**24.9**	**20.4**	**15.9**	**11.3**	**6.8**	**2.3**	**9.5**	**18.0**	**16.1**	**14.2**	**12.3**	**10.4**	**8.5**	**6.6**	**4.7**	**2.8**	**15.8**	**28.1**	**25.0**	**21.9**	**18.9**	**15.8**	**12.7**

LCCA FOR ORDINARY BUS SYSTEMS

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX																														
Land Cost	9.8	6.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Roadway Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Stops	3.6	3.8	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foot over Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operational Infrastructure (Terminals & Depots)																														
Depots	24.0	25.2	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Workshops and Terminals	15.0	15.8	22.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Operation Control Center (OCC)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bridges and Flyovers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ITS application and External Tracking	3.0	3.2	4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Cost	49.6	52.0	72.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
General Charges (except land)	2.9	3.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Contingencies	3.1	3.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex	**110.9**	**113.0**	**148.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
CAPEX for Replacements																														
Roadway Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Stops	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.5	0.0	0.0	0.0	0.0	0.0	0.0
Foot over Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ITS application and External Tracking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.4	0.0	0.0	0.0	0.0	0.0	0.0
Bus Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	329.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	535.8	0.0	0.0	0.0	0.0	0.0	0.0
Total Capex for Replacement	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**360.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**587.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Taxes & Duties																														
Custom Duty	0.6	0.6	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0
Excise Duty	24.0	25.2	35.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.4	0.0	0.0	0.0	0.0	0.0	0.0
VAT	11.9	12.5	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	73.5	0.0	0.0	0.0	0.0	0.0	0.0
Sales Tax	5.9	6.2	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.7	0.0	0.0	0.0	0.0	0.0	0.0
Works Contract Tax	2.4	2.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Taxes & Duties	**44.8**	**47.0**	**65.9**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**160.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**260.6**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Operations & Maintenance																														
Staff Cost	0.0	0.0	0.0	240.7	262.3	286.0	311.7	339.7	370.3	403.6	440.0	479.6	522.7	569.8	621.1	677.0	737.9	804.3	876.7	955.6	1,041	1,135	1,237	1,348	1,470	1,602	1,746	1,904	2,075	2,262
Energy Cost	0.0	0.0	0.0	44.0	46.2	48.5	50.9	53.5	56.2	59.0	61.9	65.0	68.3	71.7	75.3	79.0	83.0	87.1	91.5	96.1	100.9	105.9	111.2	116.8	122.6	128.7	135.2	141.9	149.0	156.5
Repair & Maintenance Cost																														
Building	0.0	0.0	0.0	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.7	2.8	3.0	3.1	3.3	3.5
Tyre, tube and spare parts	0.0	0.0	0.0	7.7	8.1	8.5	8.9	9.4	9.9	10.4	10.9	11.4	12.0	12.6	13.2	13.9	14.6	15.3	16.1	16.9	17.7	18.6	19.5	20.5	21.5	22.6	23.7	24.9	26.2	27.5
Other Repair & Maintenance Cost	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6
Other Miscellaneous O&M Costs	0.0	0.0	0.0	32.3	35.0	37.9	41.0	44.4	48.2	52.2	56.6	61.3	66.5	72.2	78.3	84.9	92.1	100.0	108.5	117.8	127.9	138.9	150.8	163.8	177.9	193.3	210.0	228.2	248.0	269.5
Total O&M Costs	**0**	**0**	**0**	**326**	**353**	**382**	**414**	**448**	**486**	**527**	**571**	**619**	**671**	**728**	**790**	**857**	**930**	**1,009**	**1,095**	**1,189**	**1,291**	**1,401**	**1,522**	**1,653**	**1,796**	**1,951**	**2,119**	**2,303**	**2,502**	**2,720**
Non Operating Expenses																														
Interest Expenses	1.9	5.9	10.4	12.4	11.1	9.8	8.5	7.2	5.9	4.6	3.3	2.0	0.7	6.3	12.0	10.7	9.5	8.2	6.9	5.7	4.4	3.2	1.9	10.5	18.7	16.7	14.6	12.6	10.5	8.5
Depreciation Expenses																														
Roadway Development																														
CAPEX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Stops & Foot over Bridges																														

	Year 1 2012	Year 2 2013	Year 3 2014	Year 4 2015	Year 5 2016	Year 6 2017	Year 7 2018	Year 8 2019	Year 9 2020	Year 10 2021	Year 11 2022	Year 12 2023	Year 13 2024	Year 14 2025	Year 15 2026	Year 16 2027	Year 17 2028	Year 18 2029	Year 19 2030	Year 20 2031	Year 21 2032	Year 22 2033	Year 23 2034	Year 24 2035	Year 25 2036	Year 26 2037	Year 27 2038	Year 28 2039	Year 29 2040	Year 30 2041
CAPEX	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Depots, Workshop & Terminal, Bridge and OCC	0.0	0.0	0.0	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
ITS application and External Tracking																														
CAPEX	0.0	0.0	0.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Bus Cost																														
CAPEX	0.0	0.0	0.0	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Replacement	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Other Miscellaneous	0.0	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total Non Operating Costs	**1.9**	**5.9**	**10.4**	**12.4**	**11.1**	**9.8**	**8.5**	**7.2**	**5.9**	**4.6**	**3.3**	**2.0**	**0.7**	**6.3**	**12.0**	**10.7**	**9.5**	**8.2**	**6.9**	**5.7**	**4.4**	**3.2**	**1.9**	**10.5**	**18.7**	**16.7**	**14.6**	**12.6**	**10.5**	**8.5**
Salvage Value																														
Land Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
Roadway Development	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bus Stops & Foot over Bridges	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.4
Depots, Workshop & Terminal, Bridge and OCC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.1
ITS application and External Tracking	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.0
Bus Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	160.7
Other Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6
Total Salvage Value	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**305.7**
Total Cost	**158**	**166**	**225**	**338**	**364**	**392**	**422**	**456**	**492**	**531**	**574**	**621**	**672**	**1,255**	**802**	**868**	**939**	**1,017**	**1,102**	**1,195**	**1,295**	**1,405**	**1,524**	**2,512**	**1,814**	**1,967**	**2,134**	**2,315**	**2,513**	**2,423**

Present Value of Costs	**Total (in Rs Crore)**	**Per Seat (in Rs Lakh)**
Metro Rail Systems	**5,727.8**	**17.3**

Debt Repayment Schedule																														
Opening Balance	0	78	157	261	235	209	183	156	130	104	78	52	26	0	253	227	202	177	152	126	101	76	51	25	396	354	313	272	231	190
Addition of Debt due to CAPEX	78	79	104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Addition of Debt due to CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	253	0	0	0	0	0	0	0	0	0	411	0	0	0	0	0	0
Debt Repayment CAPEX	0	0	0	26	26	26	26	26	26	26	26	26	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Debt Repayment CAPEX Replacement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	25	25	25	25	25	25	25	25	41	41	41	41	41	41	41
Closing Balance	78	157	261	235	209	183	156	130	104	78	52	26	0	253	227	202	177	152	126	101	76	51	25	396	354	313	272	231	190	149
Interest Amount	**2**	**6**	**10**	**12**	**11**	**10**	**8**	**7**	**6**	**5**	**3**	**2**	**1**	**6**	**12**	**11**	**9**	**8**	**7**	**6**	**4**	**3**	**2**	**11**	**19**	**17**	**15**	**13**	**11**	**8**