ECONOMIC AND FINANCIAL ANALYSIS

A. Introduction

1. The metro rail network for the city of Jaipur is planned along the city's two arterial corridors—Line 1 for the east–west corridor, 12 kilometers (km), from Mansarovar to Badi Choparl; and Line 2 for the north–south corridor, 23 km, from Ambabadi to Sitapura. With financing by the Government of India and the government of Rajasthan, Line 1-Phase A, a 9.7 km elevated portion from Mansarovar to Chandpole, is nearing completion and full commercial operation is expected to begin in late 2013. The proposed project is to build Line 1-Phase B, a 2.3 km underground portion from Chandpole to Badi Chopar, by 2018. This portion is located within the central business district, and will provide safer and faster access to and from western parts of the city, help increase the share of public transport trips in the city, and reduce the high dependence on private modes for the daily commute in the city. The project will have a substantial economic benefit in terms of travel time savings for commuters to the city's central business district, reduced use of private modes, and reduced vehicle operating costs (VOCs) overall and reduced congestion and pollution. Other benefits will include reduced road accidents, reduced road upgrading and maintenance costs, and improved air quality.

B. Economic Analysis

2. The economic analysis was carried out for the project by comparing the with-project scenario involving Line 1-Phase B, which extends Line 1-Phase A to the central business district area, and the without-project scenario for Line 1-Phase A only, terminating at Chandpole station. Line 1-Phase B is ready to be implemented, and construction is expected to be completed in 4 years. The economic analysis is carried out for the proposed project over a period of 34 years from 2013, including 4 years of construction and 30 years of operation.

1. Demand Forecast

3. The travel demand assessment for the project is based on the transport study carried out for the project design.[1] The study developed a four-stage transport model based on household and road traffic surveys. The urban transport model developed and validated for Jaipur has been used to predict travel demand for the with- and without-project scenarios for the analysis period up to 2031. The travel forecast was made based on the land use and employment forecasts of the Jaipur Master Plan, 2011, which has projected a population of 8.1 million in 2031 for the area under Jaipur Development Authority. With physical restriction to development in the east, Jaipur has developed to the south and west. Since most commercial activities are located in the central business district (CBD), travel demand is heavily concentrated in the radial corridors to the west and south. The metro corridors are proposed to cater to these heavy traffic sections.

4. The metro is planned to operate 19 hours per day from 5 a.m. to 12 midnight, and observed peak traffic hours are 9 a.m.–12 p.m. and 5 p.m.–8 p.m. The forecast passenger trips on Line 1 for the east–west corridor, with Phases A and B completed, are in Table 1. The transport model estimated that the planned development of the Jaipur metro rail network (Lines 1 and 2) will increase the share of public transport to 30% compared with a public transport share of 18% without metro by 2031.

[1] Wilbur Smith Associates. 2009. *Traffic and Transport Study for Detail Project Report for Proposed Jaipur Metro*. Jaipur.

Table 1: Ridership Estimates on Line 1

Year	Maximum Sectional Load (PPHPD)	Daily Ridership[a]
2014	10,026	206,060
2021	15,104	281,460
2031	27,514	408,830

PPHPD = passengers in peak hour in peak direction.

[a] The transport model was developed by assigning the peak hour ridership on the network. The peak hour trips are taken as 10% of daily trip generation based on household surveys. The daily ridership is obtained by multiplying peak hour ridership by 10. For example, it is estimated that during the peak hour in 2014, 20,606 passengers will enter the metro line in both directions together with a daily ridership of 206,060 trips.

Source: Jaipur Metro Rail Corporation estimates.

5. The sectional loading projections indicate that during peak hours, 60% of the trip origins and destinations in the entire Line 1 are to or from the two stations in the CBD that will be constructed under this project (Line 1-Phase B). Therefore, the project is critical to realizing the travel projections on Line 1 as it provides connectivity to the CBD where economic activities are concentrated. The full loading, as projected for Line 1, will be realized only upon completion of the project, which is expected in 2018. The transport model provided travel forecasts up to 2031; beyond 2031, half the annual passenger growth over 2021–2031 is assumed. The passenger growth rate estimated for 2021–2031 is 3.8% per annum; beyond 2031, passenger growth is projected at 1.9% per annum, a conservative estimate, considering population and income growth.

6. The transport model estimates consider the planned development of metro lines 1 and 2 and bus rapid transit lines. The predominant travel on Line 1 under implementation is traffic with both origin and destination in the east–west corridor. The analysis of trips boarding and alighting at each station along the Line 1 corridor indicate that the number of trips boarding at the Sindhi camp transfer station (the transfer station between Lines 1 and 2) in the peak direction is just 3.7% of the sectional loading on the Chandipole–Badi Chaupar section; in the opposite direction, it is about 13.4%; in both directions together in the peak hour, it is about 4.9%. Even if considering that 50% are transfer trips, the impact of Line 2 on Line 1-Phase B (Chandipole–Badi Chaupar section) is hardly 2.5% of trips, so any delay in the development of Line 2 will not significantly affect the ridership on Line 1. The same is indicated in the analysis of transfer trips on Line 2 at the Sindhi camp station for Line 1 Section B. Jaipur Metro Rail Corporation (JMRC) is planning to construct Line 2, and bus rapid transit lines are under implementation. Therefore, this aspect is considered in the sensitivity analysis.

7. The trips transferred to Line 1 are from all modes, and the share of trips transferred from different modes to Line 1 is estimated by the transport model. The estimates indicate that the mode share of trips assigned to metro are 23.9% from two-wheelers, 13.4% from cars, 5.1% from auto-rickshaws, 6.2% from taxis, and 51.4% from buses. Based on the road traffic along the Line 1-Phase B section, the reduction in the number of vehicles is estimated at 40.6%.

2. Project Economic Costs

8. The costs to be incurred for the project comprise construction, equipment, incremental rolling stock, and operation and maintenance (O&M). The estimated cost of the project is based on detailed engineering design. It includes civil works costs; equipment costs for electrical, signal, telecom, and rolling stock; social and environmental impact mitigation costs; utility shifting costs; quality control and construction supervision costs; and physical contingencies. The O&M costs as well as replacement costs were also estimated for each year within the analysis period. The cost estimate from the detailed project report updated to 2013 prices, excluding taxes and duties, was used to derive the project economic costs. The costs over the project analysis period were estimated using constant 2013 economic prices at the domestic price level. A shadow exchange factor of 1.037 derived from trade data was used to convert the imported cost component to the domestic price level.

9. The O&M costs include (i) staff costs, (ii) maintenance cost of the system and overheads, and (iii) energy costs. The staff and maintenance costs are based on actual expenses for a similar metro project in Delhi. The staff cost is assumed to grow at 2% per annum in real terms. The energy costs have been estimated based on the unit energy cost in Jaipur. The maintenance and energy costs were assumed to grow at 1% per annum in real terms.

3. Project Economic Benefits

10. The metro rail network will provide a fast and reliable mode of travel along the corridor, and will result in a substantial modal shift from road-based vehicles. The transport model provided an estimate of trips transferred to metro from different modes (such as car, taxi, Auto-rickshaw, and bus). The trips transferred to metro will result in a reduction in vehicular trips of about 40% along road sections in the Line 1-Phase B corridor during peak hours in the analysis period. The analysis considered benefits from (i) savings in VOCs of vehicles reduced on the east–west corridor with the metro; (ii) savings in VOCs of the remaining vehicles on the east–west corridor owing to increased speed, resulting from the reduction in traffic on the corridor; and (iii) travel time savings for trips using the metro and for the remaining vehicle users, caused by increased speed on the corridor. The VOC savings were calculated using unit VOCs for different vehicle categories on the road network estimated using the highway development model (HDM) in the without- and with-project scenarios. Without the project, the VOCs will be Rs10.2 in 2018 and maximum of Rs15.0 from 2031 onward at ultimate capacity. With the project, the VOCs will be Rs7.8 in 2018, Rs10.3 in 2031, and Rs15.0 in 2041.

11. The speed-flow relationships developed as part of the transport model were used to derive the travel time along the corridor during the analysis period in the without- and with-project scenarios. For travelers on the metro line, the net travel time saving was calculated based on the likely mode of travel without the metro line. The time savings were valued using the value of time derived from the household survey for travelers using different modes. The value of time used for different modes is Rs55.3 per hour for car passengers, Rs41.5 per hour for two-wheeler passengers, and Rs19.5 per hour for bus passengers. The value of time is assumed to grow in line with per capita income growth in real terms. The per capita income in Rajasthan grew at an average of 6.3% in real terms from FY2005 to FY2010.[2] For the analysis, 3% per annum real per capita income growth is considered for the first 10 years and 2% per annum beyond 10 years.

[2] Government of India, Reserve Bank of India. 2013. *Handbook of Statistics on The Indian Economy 2012-13*. Delhi.

12. Additionally, savings will derive from the decrease in road accidents and reduced air pollution resulting from lower vehicle-km. A total of 2,007 road accidents and 436 fatalities occurred in Jaipur in 2010—0.144 fatalities and 0.665 road accidents per 1 million vehicle-km. The fall in road accidents is calculated by multiplying the fatality and road accident rate with the reduction in vehicle-km resulting from the shift to metro. The social cost of accidents is calculated considering the per capita income and accident-related costs.[3] The environmental impact assessment has quantified a reduction of about 20,000 tons of carbon dioxide (CO_2) equivalent per annum resulting from the entire Line 1 for the east–west corridor, of which about 30% can be attributed to Line 1-Phase B. A value of $10/ton of CO_2 equivalent reduction was adopted for benefit estimation. This has been included in the analysis.[4] Indirect benefits, such as sustaining economic activity in the CBD, and reduced noise pollution and pollution effect on the local population, are not quantified or included in the analysis.

4. Project Economic Analysis

13. Economic analysis was carried out for the project by comparing the societal cost of transportation with and without the project. The metro line has the capacity to maintain the level of service with additional coaches, as travel demand increases and provision is made for the procurement of additional coaches. Replacement costs for equipment caused by wear and tear during the analysis period were considered. With the nature of equipment proposed to be provided, it is expected that only 50% of the signaling and telecom and 25% of electrical works would require replacement after 20 years. The project civil works consist of an underground tunnel, which is assumed to have a life of 100 years and rolling stock with a life of 30 years. The salvage value at the end of analysis period has been calculated using the straight-line depreciation method.

14. The economic analysis results and annual cost–benefit streams are in Table 2. The economic internal rate of return (EIRR) for the project (Line 1-Phase B) is estimated at 13.8%, indicating that the project is viable in social cost–benefit terms. With almost 60% of the trips having their origin and destination in the CBD, the project is critical to achieving the estimated ridership on the entire Line 1. The economic sustainability of the city is dependent on providing an efficient public transport system, and the proposed project will provide a fast and reliable transport alternative to the city center.

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[3] In the absence of detailed information for accident costing, the ratios derived from: Ricardo G. Sigua. 2005. *Estimation of socio-economic cost of road accidents In metro manila*. Manila: Journal of the Eastern Asia Society for Transportation Studies (Vol. 6, pp. 3183 – 3198) and per capita income were used for accident cost estimation. The values estimated are Rs2.6 million for fatalities, Rs0.56 million for serious injuries, Rs54,400 for minor injuries, and Rs32,500 for property damage.

[4] The reduction in CO_2 emissions was calculated using the equation Emission = Activity rate x Emission Factor. Activity rate, expressed in terms of kilometer travelled for each type of vehicle was computed based on the forgone trips of two-wheelers, auto-rickshaws, cars, taxis, and public transport in favor of the metro rail and predicted average passenger-km traveled. Greenhouse gas emission factors were adopted and converted to CO_2 equivalent. Government of India, Ministry of Environment and Forests. 2008. *Draft Report on Emission Factor Development for Indian Vehicles.* Delhi: The Automotive Research Association of India.

Table 2: Results of Economic Analysis for Line 1-Phase B

(Rs million)

	Project Costs			Project Benefits				
Year	Capital Cost	Operation and Maintenance Cost	Vehicle Operating Costs	Time saving for passengers of remaining project corridor traffic	Time savings for passengers shifting to metro	Reduced Pollution	Accident Savings	Net Benefits
2014	1,137.4							(1,137.4)
2015	1,364.9							(1,364.9)
2016	2,616.0							(2,616.0)
2017	5,118.3							(5,118.3)
2018	1,137.4	102.1	443.2	320.0	396.5	36.2	76.1	32.5
2019	0.0	103.7	495.9	396.3	433.8	39.9	81.1	1,343.2
2020	0.0	108.1	548.6	488.8	473.0	43.6	86.1	1,531.9
2021	0.0	109.8	601.3	600.4	514.1	47.3	91.0	1,744.3
2022	574.4	129.0	626.9	601.8	557.3	50.3	96.9	1,230.0
2023	0.0	131.0	652.5	597.4	607.5	53.3	102.9	1,882.6
2024	0.0	133.0	678.1	586.1	660.1	56.3	108.8	1,956.4
2025	0.0	135.1	703.7	566.1	715.3	59.3	114.7	2,024.1
2026	0.0	137.2	729.3	536.6	773.3	62.3	120.7	2,085.0
2027	0.0	139.3	754.9	515.1	834.1	65.3	126.6	2,156.7
2028	0.0	141.5	780.5	486.8	897.8	68.3	132.5	2,224.5
2029	0.0	143.7	806.1	451.2	964.6	71.3	138.5	2,288.1
2030	0.0	146.0	831.8	406.5	1,034.6	74.3	144.4	2,345.6
2031	0.0	148.3	857.4	352.0	1,108.0	77.4	150.3	2,396.7
2032	804.1	176.2	841.5	283.4	1,173.3	78.9	153.3	1,550.1
2033	0.0	178.9	825.6	247.1	1,220.7	80.5	156.4	2,351.4
2034	0.0	181.7	809.7	206.8	1,270.0	82.1	159.5	2,346.5
2035	370.6	184.5	793.9	162.5	1,321.3	83.7	162.7	1,969.1
2036	300.0	187.3	778.0	113.6	1,374.7	85.4	166.0	2,030.4
2037	0.0	190.3	762.1	0.0	1,430.3	87.1	169.3	2,258.5
2038	0.0	193.2	746.2	0.0	1,488.0	88.9	172.7	2,302.6
2039	0.0	196.2	730.3	0.0	1,548.2	90.6	176.1	2,349.0
2040	0.0	199.3	714.5	0.0	1,610.7	92.4	179.7	2,398.0
2041	0.0	202.4	698.6	0.0	1,675.8	94.3	183.2	2,449.5
2042	0.0	205.6	683.4	0.0	1,743.5	96.2	186.9	2,504.4
2043	0.0	208.8	668.2	0.0	1,813.9	98.1	190.7	2,562.1
2044	0.0	212.1	653.7	0.0	1,887.2	100.1	194.5	2,623.3
2045	(3,412.2)	215.4	639.2	0.0	1,963.4	102.1	198.4	5,758.6
							EIRR	**13.8%**
							ENPV	**1,348.3**

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.
Source: Asian Development Bank estimates.

5. Sensitivity Analysis

15. Sensitivity analysis was carried out over the base case with respect to adverse changes in the costs, travel forecasts, and benefits (Table 3). The analysis shows that the proposed project has an EIRR more than 12% in almost all sensitivity tests, except when both cost increase and benefit reduction are considered. Even in this scenario, the EIRR is only marginally below 12%. Considering the overall contribution of the project to sustain the city's economic growth, and recognizing the potential of the east–west corridor, the integrated benefits and impacts of the project are expected to outweigh the costs.

Table 3: Results of Sensitivity Analysis

Sensitivity Scenario	EIRR (%)	Switching Value (%)
Case-I Base case	13.8	…
Case-II Cost increased by 10%	12.7	17.0
Case-III Line 2 not constructed	13.6	…
Case-IV Operation and maintenance costs increased by 10%	13.7	340.0
Case-V Benefits reduced by 10%	12.5	13.5
Case-VI Cost increased by 10%, and benefits reduced by 10%	11.4	7.5

… = not available, EIRR = economic internal rate of return.
Source: Asian Development Bank estimates.

B. Financial Analysis

16. Financial analysis has been carried out to assess the viability of the proposed project investment based on the incremental earnings and operational cost savings that would accrue to JMRC as a result of the implementation of Line 1-Phase B. The analysis was carried out on an incremental basis using the discounted cash flow method, and calculating the financial internal rate of return (FIRR) of the project. It is based on the following considerations:

(i) Capital costs are based on the estimated project costs for 2013. The capital cost includes construction of Line 1-Phase B and associated facilities, and the rolling stock cost. It also includes physical contingencies and project management costs.

(ii) The O&M cost includes staff costs, expenditure toward the upkeep and maintenance of the system, and energy costs. The estimates from the detailed project report have been adopted in the analysis.[5]

(iii) Revenue is generated from fare box collection, advertisements, and rentals at stations and Depot. Line 1-Phase B, which provides connectivity to the CBD, generates and attracts about 55% of the trips. In terms of physical length, Line 1-Phase B is about 19 % of the total Line 1. In terms of cost, Line 1-Phase B is about 41% of the total Line 1 cost. Considering the travel demand generation, project cost, and length, 35% of the fare box collection estimated for total Line 1 is allocated to Line 1-Phase B. Revenue other than fare box collection is

[5] Jaipur Metro Rail Corporation. 2012. *Detailed Project Report: Jaipur Metro (Phase-I) Mansarovar to Badi Chaupar*. Delhi.

considered at 10% of fare box collection, in line with the observed trend in a similar metro project in Delhi.

(iv) Rolling stock requirements for incremental traffic are incorporated in the cost stream. Replacement costs for equipment caused by wear and tear during the analysis period were considered.

(v) All financial projections are shown in 2013 nominal Indian rupees, with no adjustment for inflation. Operating costs are assumed to increase in real terms as specified in the economic analysis (2% in case of staff costs and 1% in case of maintenance and energy costs). The fare is assumed to rise by 3% every 2 years in real terms.

(vi) The revenue and cost streams are compared for a 30-year period, excluding the construction period. In the last year, the residual values of various assets were considered according to their economic life by applying the straight-line depreciation method.

17. The estimated financial rate of return for the project in real terms is 3.7%, which is above the estimated weighted average cost of capital (WACC) of 1.65% for JMRC for Line 1-Phase B.[6] The results of the financial analysis in real terms are in Table 5. The analysis did not consider exchange rate fluctuation over the analysis period. The cash flow projections indicate that the project would generate sufficient liquid cash resources to allow the project to meet its O&M costs and debt service obligations. The project is also expected to generate a debt service coverage ratio exceeding 1 only after the first 10 years. Owing to the customized repayment period, with 8 years grace period and 15 years thereafter for repayment, the project will have sufficient accumulated cash resources to fully meet its obligations.[7]

18. A sensitivity analysis was carried out over the base case with respect to adverse changes in the costs and benefits. The results are in Table 4. The analysis shows that all proposed project sections have a financial internal rate of return higher than the WACC in all sensitivity tests.

Table 4: Results of Sensitivity Analysis

Sensitivity Scenario	FIRR (%)
Case-I Base case	3.7
Case-II Project cost increased by 10%	3.2
Case-III Fare box revenue decreased by 10%	2.9
Case-IV Operation and maintenance costs increased by 50%	3.0
Case-V Project cost increased by 10%, and revenue reduced by 10%	2.3

FIRR = financial internal rate of return.
Source: Asian Development Bank estimates.

[6] For WACC calculation for Line 1-Phase B, the cost of Asian Development Bank (ADB) funding (68% of the cost) is taken at a spread of 0.4% over the London interbank offered rate (a total of 2.03% including the maturity premium), and the government of Rajasthan funding of the balance of 32% is considered as equity and assumed at an equity cost of 12% per annum (risk free rate of 8% + 4% premium for equity).

[7] The analysis assumes an Indian rupee depreciation of 2% per annum (based on the last 10 years exchange rate fluctuation) and effective interest rate of 3% over the period.

Table 5: Results of Financial Analysis for Line 1-Phase B
(Rs million)

	Costs		Revenue		
Year	Capital	Operation and Maintenance	Fare Box	Advertisement and Others	Net Cash Flow
2014	1,340.8				(1,340.8)
2015	1,609.0				(1,609.0)
2016	3,083.9				(3,083.9)
2017	6,033.8				(6,033.8)
2018	1,340.8	132.1	519.4	51.9	(901.7)
2019	0.0	134.1	556.7	55.7	478.2
2020	0.0	136.1	577.8	57.8	499.5
2021	563.9	151.6	633.0	63.3	(19.2)
2022	0.0	153.8	657.1	65.7	568.9
2023	0.0	156.1	702.9	70.3	617.1
2024	0.0	158.4	729.6	73.0	644.2
2025	0.0	160.7	779.9	78.0	697.2
2026	0.0	163.1	809.6	81.0	727.4
2027	0.0	165.5	864.6	86.5	785.6
2028	0.0	168.0	897.5	89.8	819.3
2029	0.0	170.5	957.9	95.8	883.2
2030	0.0	173.0	994.3	99.4	920.7
2031	789.5	196.4	1,060.4	106.0	180.5
2032	0.0	199.2	1,071.0	107.1	978.9
2033	0.0	202.1	1,110.7	111.1	1,019.7
2034	1,092.0	205.0	1,121.8	112.2	(63.0)
2035	884.0	207.9	1,162.6	116.3	186.9
2036	0.0	210.9	1,174.2	117.4	1,080.7
2037	0.0	214.0	1,216.2	121.6	1,123.8
2038	0.0	217.1	1,228.4	122.8	1,134.1
2039	0.0	220.3	1,271.6	127.2	1,178.5
2040	0.0	223.5	1,284.3	128.4	1,189.3
2041	0.0	226.7	1,328.8	132.9	1,235.0
2042	0.0	230.1	1,342.1	134.2	1,246.3
2043	0.0	233.4	1,387.9	138.8	1,293.3
2044	0.0	236.9	1,401.8	140.2	1,305.1
2045	(3341.3)	240.3	1,448.9	144.9	4,694.7
				FIRR	**3.7%**
				FNPV @ WACC	**5,299.2**

( ) = negative, FIRR = financial internal rate of return, FNPV = financial net present value, WACC = weighted average cost of capital.
Source: Asian Development Bank estimates.