# ECONOMIC ANALYSIS

## A. Scope of the Investment Project

1. The Functional Plan for Transport 2032 by the National Capital Region Planning Board envisaged a regional rapid transit system (RRTS) corridor to be constructed between Delhi and Meerut to build better connectivity and to relieve traffic congestion in the National Capital Region. The investment project is envisaged to be beneficial for the development of the region and to help connect townships and centers of economic activity that are planned along the corridor. The proposed alignment passes through the dense developments of Delhi, Ghaziabad, and Meerut. It will comprise a double-line, standard gauge, rapid railway system built on elevated viaducts and go underground in heavily populated areas. It will connect Modipuram in Meerut to Sarai Kale Khan in Delhi. The viaduct will be built along the central median strip of the highway connecting Delhi to Meerut. The entire route length of the corridor is about 82 kilometers (km).

2. The present analysis assesses the economic viability of the Delhi–Meerut Regional Rapid Transit System Investment Project. The economic analysis of the investment project has been carried out in line with the Guidelines for the Economic Analysis of Projects of the Asian Development Bank.[1] The economic internal rate of return (EIRR) has been calculated by assessing the economic and/or societal benefits and the costs of the investment project over a period of 36 years, comprising 6 years of construction and 30 years of operation, in domestic price numeraire presented in national currency.

## B. Demand Analysis

3. The travel demand forecast study is included in the detailed project report (DPR). The Delhi–Ghaziabad–Meerut corridor is in the states of Delhi and Uttar Pradesh. Currently, the cities of Delhi and Meerut are connected by National Highway 24, which is the main and most-used road link between the two cities and carries most of the road traffic between Delhi and Meerut, Hardwar, and Dehradun. Development plans of Delhi, Ghaziabad, Meerut, Modinagar, and Muradnagar have been studied. The plans project the populations and economic activities for each of the cities in accordance with the proposed development. The average daily traffic and modal composition of vehicles on a typical weekday in both directions along the corridor have been recorded in passenger car units between Meerut and Delhi at various locations.[2] The traffic composition indicates a very high proportion of private vehicles consisting of cars and two-wheelers.

4. After estimating the potential catchment area trips, data collected by stated preference surveys were analyzed to arrive at the logit mode choice model. The model is used to estimate the shift from a given origin–destination pair to the RRTS based on the travel time, travel cost, and waiting time for that origin–destination pair. This exercise of identifying the shift of travel from existing modes to the RRTS is performed for each mode and the shift is calculated using the fares, travel time, and waiting times of the existing mode to that of the RRTS. The analysis includes mode shift in the case of road after implementation of the Delhi–Meerut expressway. The resulting composition of modal shift is 15% from two-wheelers, 20% from cars, 40% from buses, and the rest are from electric multiple units. The travel demand forecast study also includes various influencing factors of travel time, travel cost, and waiting time in realistic and conservative development scenarios. Lastly, the ridership used for estimating revenue and operational

---

[1] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

[2] The estimated number of passenger car units ranges from 58,000 to 102,000 between Meerut and Delhi at various locations.

parameters was based on fare levels (travel cost) derived from revenue optimization and willingness to pay of users.[3] On a conservative basis, the ridership estimates used for the calculations of various benefits gradually increase from 200,000 passengers per day and are capped at a maximum ridership of 750,000 passengers per day.

## C. Economic Cost Analysis

5. The economic costs of the investment project have been calculated from the financial costs (capital and operation and maintenance expenditures) by adjusting them with conversion factors. The market prices of the capital expenditure have been considered from the inputs obtained from the National Capital Region Transport Corporation (NCRTC). The total project cost is approximately ₹299.7 billion, including soft costs (e.g. costs for design, inspection, accounting, legal fees) and post-construction costs (including replacing assets and procuring additional rolling stock for the incremental traffic). The operation and maintenance expenditure includes maintenance, energy, human resources, and the rehabilitation grant taken from the DPR. The energy operation and maintenance includes expenditure toward traction and auxiliary power for the stations. The economic costs are calculated as the product of market prices of capital expenditure and operation and maintenance, and their respective conversion factors as per the Appraisal Guidelines for Metro Rail Project Proposals by the Ministry of Housing and Urban Affairs (MOHUA). The economic costs are listed in Table 1.[4]

**Table 1: Economic Costs**
(₹ million)

| Expenses | Cumulative Costs in Market Prices | Conversion Factors | Economic Costs |
|---|---|---|---|
| Capital expenditure | 299,773 | 0.83 | 248,812 |
| Operations and maintenance | 282,569 | 0.87 | 245,835 |
| **Total Expenditure** | **582,342** | | **494,646** |

Source: Asian Development Bank.

## D. Economic Benefits Analysis

6. It is expected that society will gain multiple benefits from the RRTS investment project such as savings in vehicle operating costs (VOCs), fuel, and travel time, as well as decreased pollution. All the benefits are calculated in market price terms and then converted to economic prices using conversion factors as per the MOHUA guidelines. The starting point for computation of most of the economic benefits is the shift in passenger traffic from existing modes to the RRTS as obtained from the NCRTC. The ridership estimates used for the calculations of various benefits are obtained from the DPR and capped at a maximum ridership of 750,000 passengers per day on a conservative basis. It may be noted that the capacity of the RRTS is higher than the maximum ridership considered for the assessment.

7. **Time savings**. Time savings are calculated for the passengers that are expected to shift from existing modes to the RRTS and the passengers that still use existing modes with reduced congestion.

---

[3] The willingness to pay (WTP) survey provides an insight into user behavior and their WTP as a trade-off for the time and cost savings on the proposed corridor as compared to alternative modes. Accordingly, a stated preference survey was conducted along the corridor to determine WTP. The acceptable fare as indicated by users was ₹2 per kilometer.

[4] Government of India, Ministry of Housing and Urban Affairs. 2017. *Appraisal Guidelines for Metro Rail Project Proposals*. Delhi.

8. It is expected that there will be savings in travel time for passengers who shift from road to the RRTS. This will be because of a higher average speed on the RRTS (90 kilometers per hour [km/h]) than by road (26 km/h). Time saved per person is computed using the average lead of 30 km and different average speeds over the RRTS and road. Total time saved is deduced as the product of the number of passengers who shift to the RRTS and the time saved per person. The value of time (VOT) is ₹77.37 per hour by taking the weighted average per capita incomes of Delhi, Ghaziabad, and Meerut. On average, one-third of the passengers are assumed to be nonworking and their VOT is 30% of that of the working population. The monetary VOT savings are obtained as a product of total time saved and VOT.

9. It is expected that there will be time savings for passengers who continue to use roads after the RRTS is commissioned. This is attributable to an increase in their average speed because of reduced congestion. Such increase in average speed has been assumed to be 25%.[5] The time saved per person is computed using an average lead of 30 km and different average speeds in without- and with-RRTS scenarios. The total time saved is deduced as the product of the number of passengers who continue to use roads and the time saved per person. It may be noted that the number of passengers on roads after 2031 has been obtained by escalating the passengers on roads in 2031 with the weighted average compound annual growth rate of the decadal population growth of Delhi, Ghaziabad, and Meerut. The monetary VOT savings are obtained as the product of VOT and the total time saved, and are converted into economic terms using a conversion factor of 1.0. The congestion caused by construction has been mitigated to a minimum because the road has been widened by one additional lane in each direction prior to construction. In fact, after construction is finished, the road will be wider than before.

**Table 2: Value of Time Savings in Economic Terms**
(₹ million)

| Item | 2025 | 2030 | 2035 | 2040 | 2045 | 2050 | 2054 |
|---|---|---|---|---|---|---|---|
| Modal shift to RRTS | 9,500 | 22,098 | 31,847 | 40,721 | 52,068 | 66,576 | 81,043 |
| Reduced congestion on road | 1,921 | 4,263 | 6,409 | 8,742 | 11,923 | 16,262 | 20,846 |
| **Total** | 11,421 | 26,361 | 38,257 | 49,463 | 63,991 | 82,839 | 101,889 |

RRTS = regional rapid transit system.
Source: Asian Development Bank.

10. **Fuel savings.** There will be fuel savings because of a reduction in the number of vehicles on the road after a shift of passengers from road to the RRTS. The distance that would have been travelled by vehicles had they been not taken off the roads is computed using a lead of 30 km and modal shift composition obtained from the NCRTC. The fuel cost per distance travelled by different categories of vehicles (buses, cars, and two-wheelers) is taken as per the MOHUA guidelines. The total fuel savings are calculated as a product of fuel cost per distance travelled and the distance saved for buses, cars, and two-wheelers as a result of a shift of passengers to the RRTS. The energy cost of the RRTS has been accounted for in the operation and maintenance cost. Monetary values of such fuel savings are converted into economic prices using a conversion factor of 0.90.

11. **Savings in vehicle operating costs.** It is expected that there will be savings in VOCs (excluding fuel costs) because of a reduction in the number of vehicles on the road after the passengers shift to the RRTS. The distance that would have been travelled by the vehicles that are taken off the roads is computed using a lead of 30 km and modal shift composition obtained from the NCRTC. The vehicle operating cost per distance travelled by a vehicle is taken according

[5] The speed increment has been assumed at various values in calculating the EIRR. The final EIRR is not too sensitive to this parameter.

to the MOHUA guidelines. The final VOC savings are calculated as a product of the number of vehicles reduced per day, an average trip length of 30 km per vehicle, and VOC per distance travelled. Vehicles considered for assessment of this benefit include cars, two-wheelers, and buses.

12. **Savings because of reduced pollution.** Pollution is expected to be reduced primarily because of a reduction in the number of vehicles on the road as a result of the shift of passengers to the RRTS. The quantity of pollutants that would have been released into the atmosphere by the vehicles (buses, cars, and two-wheelers) that are taken off the road is computed by multiplying the emission factors of each category of vehicle and the respective distances that are saved because of the shift of passengers to the RRTS. The treatment costs of various pollutants are then multiplied with the total quantity of pollutants to deduce the savings because of reduced pollution. Similarly, the environmental cost resulting from the generation of electricity that is utilized by the RRTS is also calculated using carbon dioxide emission factors from various fuels used for electricity generation, the fuel mix for electricity generation in India, and electricity consumed by the RRTS system. Net economic benefits are calculated as the difference between the savings resulting from reduced traffic and costs of electricity generation for the RRTS. It may be noted that the emission costs, both saved and generated by the RRTS, have been computed after escalating them by 2% annually because of the increasing marginal damage of global warming over time.

## E. Economic Internal Rate of Return

13. The results indicate that the overall project investment has an EIRR of 11.33% and net present value of ₹69,744 million at a 9% discount rate, which further indicate that overall the investment project is economically feasible. The EIRR is also conservatively estimated. For example, the ridership during both the ramp-up period and normal operation period are estimated conservatively, and the residual value is assumed to be zero.

## F. Sensitivity of Economic Internal Rate of Return of the Investment Project

14. It is expected that there will be transit-oriented development along the Delhi–Meerut RRTS. This may result in a scenario in which fewer people might use the corridor because of increased proximity of residential areas to office and commercial spaces. Hence, decrease in ridership has been considered as one of the sensitivities. In addition, possible increase in capital expenditure and delay in benefits are also considered (Table 3).

**Table 3: Sensitivity Analysis**

| Scenario | EIRR (%) | NPV at 9% (₹ million) |
|---|---|---|
| Reduction in ridership (10%) | 10.36 | 39,134 |
| Reduction in ridership (20%) | 9.31 | 8,525 |
| Increase in capex (5%) | 10.96 | 60,454 |
| Increase in capex (10%) | 10.61 | 51.164 |
| Delay in benefit (1 year) | 10.29 | 39,334 |
| Delay in benefit (2 years) | 9.38 | 11,667 |

capex = capital expenditure, EIRR = economic internal rate of return, NPV = net present value.
Source: Asian Development Bank.

## G. Distribution and Poverty Analysis

15. The investment project will benefit the poor and vulnerable in various ways. First, the impacted area has a considerable number of people living below the poverty line.[6] They will benefit from the investment project directly from saved time and reduced pollution. A certain share of the drivers (e.g., owners of two-wheelers) who are poor will also enjoy reduced VOCs. The labor demand directly generated by the investment project is also likely to benefit low-income workers. Secondly, there will be indirect economic benefits generated by the investment project that will provide better access to jobs and education and promote structural transformation. These induced effects will, on a wider scale, help the poor and vulnerable.

16. The investment project costs and benefits are distributed among the investment project beneficiaries including vehicle owners, passengers, the labor force, and government. The weighted share of the head count ratio (HCR) in investment project states is 31%. Since the HCR will likely decline as the economy develops over the investment project life span, the HCR in this analysis is conservatively assumed to be 20%. It is further assumed that in the impacted area, (i) car owners and/or passengers and bus owners are not poor or vulnerable; (ii) owners of two-wheelers are 0.5 times as likely as the general population to be poor or vulnerable; (iii) passengers of two-wheelers, buses, and electric multiple units are the general population (20% HCR); and (iv) laborers involved in the construction of the investment project roads are twice as likely as the general population to be poor or vulnerable. The poverty impact ratio of the investment project is estimated at 0.27 and the investment project benefits accruing to the poor and vulnerable people are summarized in Table 4.

**Table 4: Poverty Impact Assessment**
($ million)

| Item | Passengers | Drivers | Laborers | Government | Total |
|---|---|---|---|---|---|
| NPV | 179,375 | 75,667 | 5,124 | (190,421) | 69,744 |
| Share accruing to the poor (%) | 18 | 5 | 40 | 10 | |
| Benefits accruing to the poor | 31,924 | 3,856 | 2,050 | (19,042) | 18,787 |
| | | | | **PIR** | **0.27** |

( ) = negative, NPV = net present value, PIR = poverty impact ratio.
Note: Passengers and drivers are from all modal shifts. The share accruing to the poor in each group is the weighted average according to the share of modal shifts.
Source: Asian Development Bank estimates.

[6] Government of India, Planning Commission. http://planningcommission.gov.in/index.php.