

ECONOMIC AND FINANCIAL ANALYSIS

1. Economic analysis of four sample road projects for rehabilitating and upgrading under the proposed Madhya Pradesh District Connectivity Sector Project was carried out using the Highway Development Model 4 (HDM-4). The model requires input data on traffic, road geometry, condition, pavement structure and material characteristics of the existing road, maintenance and road improvement costs, and vehicle operating cost (VOC) parameters. The detailed project reports prepared by Madhya Pradesh Road Development Corporation (MPDRC) provided the required input data, and the four road projects have been evaluated based on the current traffic and cost assessment. The costs to the road agency and road users in the with- and without-project cases were estimated and used for deriving the net costs and benefits of the project and to calculate the economic viability of the sample roads. The project will contribute to improved road transport connectivity in the state of Madhya Pradesh by reconstructing and rehabilitating about 1,600 kilometers (km) of major district roads (MDRs) to all weather standards. All-weather roads will provide all-year access to social services and markets and significantly reduce VOCs. Least-cost options have been adopted for technical designs for the MDRs, considering that the project involves improvements to existing roads on site. Existing bituminous surfaces are proposed to be improved by bituminous overlays, while existing rigid pavements are proposed to be improved by concrete overlays. Longitudinal and cross drains are also proposed to be in line with existing systems.

2. **Project Road Details.** Madhya Pradesh is surrounded by five states: Chhattisgarh, Gujarat, Maharashtra, Rajasthan, and Uttar Pradesh. Because of its central location, traffic from these surrounding states passes through its state largely from the road and railway network. Other modes of transport, such as civil aviation and coastal shipping, have a very limited role in the state's transport services and would require a substantial initial investment cost. Modal shares in Madhya Pradesh are shown in Table 1. The project scope was considered based on the least-cost approach to invest in road transport. The four sample roads selected have mostly single or intermediate lane and two-lane configurations. They pass through rural areas with fertile agricultural land all along the corridor. The project road corridors will need capacity augmentation to cater to the anticipated increase in traffic. The project road sections have poor riding surface for the majority of their length, and require rehabilitation and capacity expansion. Traffic volume was obtained from the classified traffic counts carried out on project road sections. The traffic composition on the project road sections indicates that passenger traffic accounts for 53%–96% of the traffic, of which 17%–69% is two-wheeler traffic. Significant goods vehicle traffic exists on the project road sections—100 to 550 vehicles per day. Traffic details for the project roads are in Table 2.

Table 1: Modal Shares in Madhya Pradesh, 2007–208

Mode of transport	Percentage (%)
Road	63.9
Railway	36.1
Coastal shipping	0.0
Airways	0.0
Total	100.0

Source: Government of India. Planning Commission. 2011. *Total Transport System Study*. Delhi.

Table 2: Base Year Traffic on Project Road Sections

No.	Project Road	Road Length (km)	AADT (units)	Share (%)	
				Passenger Vehicles	Goods Vehicles
1	Chitrangi–Kasar Road	40.39	90	95.80	4.20
2	Mahua–Chuwahi Road	49.10	797	67.50	32.50
3	Dabra–Bhitarwar–Harsi Road	62.40			
	Dabra–Bhitarwar	25.90	2,981	65.10	34.90
	Bhitawar–Harsi	36.50	1,313	53.10	46.90
4	Ujjain–Makhsi Road	36.34	2576	54.23	45.77

AADT = annual average daily traffic, km = kilometer.

Source: MPRDC, 2014. Detailed project reports for various roads. Madhya Pradesh Road Development Corporation.

3. **Traffic Growth Forecast.** Traffic growth on a road facility is generally estimated on the basis of historical trends and the growth forecast of both the economy and population. In the absence of established time series data on traffic volume on the road sections, the growth forecast is made based on data available on vehicle growth and state gross domestic product (GDP) growth.

4. The state economy of Madhya Pradesh has been demonstrating strong economic growth, well above the national level. Table 3 compares the average economic growth rate in Madhya Pradesh and the Indian average during 2004–2012. The Reserve Bank of India has projected national average economic growth of 7.1% in real terms for the next 10 years (fiscal year 2014-2023) in its latest reports.

Table 3: Average Annual Economic Growth Rates, 2005–2013

Item	%
Madhya Pradesh	8.8
All of India	6.9

Source: Government of Madhya Pradesh, Department of Economics and Statistics. 2013. Madhya Pradesh Economic Survey, 2012–2013. Bhopal.

5. The growth of registered vehicles on the road gives an indication of the traffic growth (Table 4). Vehicle growth for 2004–2012 was 10.0% for Madhya Pradesh. The elasticity of the vehicle growth against GDP growth is also shown in Table 4. To have a better understanding of these annual traffic growth rates across different vehicle types, the growth of different vehicles during 2007–2009 is shown in Table 5 for Madhya Pradesh.

Table 4: Growth of Registered Vehicles, 2004–2012

Item	Compound Annual Growth Rate of Registered Vehicles	Elasticity, calculated against GDP growth rate
Madhya Pradesh	10.0%	0.71
All of India	10.3%	0.65

GDP = gross domestic product.

Source: Government of India. Ministry of Road Transport and Highways. 2011–12. *Road Transport Year Book*. Delhi

Table 5: Growth of Registered Vehicles in Madhya Pradesh, 2007–2009

Year	Car	Two-Wheeler	Standard Bus	Minibus	Truck	Tractor	Trailer
2007	208,052	3,895,557	7,134	73,797	135,509	394,356	200,719
2008	237,022	4,292,649	7,119	80,311	149,718	411,424	206,640
2009	272,009	4,691,218	6,960	86,611	162,226	432,618	210,903
Growth (%)	14.3%	9.7%	(1.2%)	8.3%	9.4%	4.7%	2.5%

() = negative.

Source: Government of India. Ministry of Road Transport and Highways. 2011–12. *Road Transport Year Book*. Delhi

6. The growth of registered vehicles by type shows that vehicle composition is rapidly changing—in favor of personalized modes. The long-term vehicle growth rate for Madhya Pradesh is envisaged to grow at least in line with the national growth rate.

7. In the Madhya Pradesh State Road Development Plan (2013–2033), traffic growth rates from 2012 to beyond 2026 have been considered within the range of 6.8%–5.6%. Since the project roads are MDRs passing through mostly rural and semi-urban areas, the traffic growth rate is likely to be mainly affected by rural economic activities. Considering the rapid growth of economic activities in rural areas of Madhya Pradesh, the traffic growth rate throughout the project period has been considered as 6.5%. Since most of the roads are single lane or intermediate lanes, a considerable increase in traffic movement is envisaged as a result of improvement in road conditions and resulting development activities. Generated traffic has been considered, especially in the case of single and intermediate lane roads, in the analysis. Rural development, along with agriculture, is the main thrust area of the government of Madhya Pradesh, so a rural–urban continuum through wider commodity circulation is needed. The improvement of rural roads having connectivity with urban centers is necessary so that income generation and wider commodity and service circulation take place in rural areas, and considerable traffic is generated. The magnitude of generated traffic will depend on the level of benefits accrued to the project influence area by the improvement of road conditions, such as time savings, VOC savings, and development brought by road investment. A weighted average of adopted generated traffic of 20% is applied.

8. **Costs and Benefits.** Costs considered for the analysis include the construction cost, the cost of environmental and social impact mitigation, utility shifting costs, operation and maintenance costs, and road user costs. Construction costs were derived from the detailed design bill of quantities and unit cost estimates based on the current schedule of rates. The financial cost per kilometer for construction of the project roads is in Table 6. Low annual average daily traffic on the project roads means that disruption during the construction period will be minimal. Customs duty and value-added tax are included in the project cost estimate, but excluded from the economic analysis. Physical contingencies are included as they are part of the value of resources to be used in the construction, but price contingencies are excluded as they are due to the value of currency, and do not reflect real changes in the volume of resources consumed. Economic analysis has been carried out using the world price numeraire presented in domestic currency. Financial construction and maintenance costs were converted to economic costs using a standard conversion factor of 0.85, which is calculated as a ratio of (total import and export values) to (total import and export values plus trade related duties).

Table 6: Construction Cost

No	Name of Project Road	Cost per kilometer (Rs million)
1	Chitrangi–Kasar Road	17.64
2	Mahua–Chuwahi Road	20.96
3	Dabra–Bhitarwar–Harsi Road	25.72
4	Ujjain–Makhsi Road	23.11

Source: Detailed Project Reports prepared by MPRDC.

9. Maintenance treatments are triggered within the HDM-4 model based on the set maintenance standard for with- and without-project scenarios and costs calculated based on the unit prices for treatments given as input to the model. Examination of maintenance of project road sections indicates that the road sections are not allowed to deteriorate to very bad conditions. Based on this, the analysis assumes that periodic maintenance needs are met in the without-project case as well as the with-project case, but no pavement strengthening is considered in the without-project case. Road user costs were estimated within the HDM model using input provided on VOC parameters.¹ The economic price of fuel was taken from the detailed project report of the National Highways Authority of India road project in Madhya Pradesh at the end of 2012 (Obaidullaganj–Hoshangabad–Itarsi–Betul section of National Highway 69). The economic price of fuel per liter is taken as Rs37.00 for petrol and Rs28.00 for diesel.

10. For passenger-carrying vehicles, the values of passenger working and nonworking time were considered from the detailed project report for the Obaidullaganj–Hoshangabad–Itarsi–Betul section of National Highway 69. As most of the National Highway 69 passes through a rural area of Madhya Pradesh, work value time and nonwork value time appear to represent the rural condition of Madhya Pradesh, since most of the project road sections are located in rural areas. The value of nonworking time is taken as one-sixth of the value of work time. Values for state GDP per capita were obtained from the Government of India's Economic Survey^{2 3} A summary of the calculated values of time for each passenger-carrying vehicle is in Table 7.

¹ Information required for updating the main VOC parameters—such as vehicle prices, crew and maintenance labor cost, and tire costs—were obtained from the detailed project reports.

² Government of India. State of Madhya Pradesh. 2012. *Directorate of Economics and Statistics*. Bhopal.

³ The net state domestic product data of Madhya Pradesh was used to calculate per capita income, and then the total number of employed persons was determined. Taking into consideration the income of persons employed, estimated by using the household consumption expenditure rate and assuming 2,000 working hours per year, an average work time value of Rs42.57 was determined. It was assumed that two-wheeler operators had 13% higher time value than the average value, car passengers had 94% higher time value, and bus passengers had 32% higher time value than the average time value. The working passenger time weights are based on the Indian Roads Congress. 2009. *Manual of Economic Evaluation of Highway Project in India*. New Delhi. Indian Roads Congress.

Table 7: Adopted Values of Passenger Working and Nonworking Time
(Rs per hour)

State	State GDP per capita at current prices (Rs)	Bus		Car		Two- and Three-Wheelers	
		Working	Non-Working	Working	Non-Working	Working	Non-Working
Madhya Pradesh	38,669	47.67	8.41	70.00	10.40	40.00	6.82

GDP = gross domestic product.

Sources: Asian Development Bank estimates; Government of India, Ministry of Finance.

11. The benefits of upgrading the project roads will include higher vehicle speeds, better riding quality, and safer roads—resulting in reduced travel time and VOCs during the analysis period. Without the project, the road capacity will be reached in the next five years and speeds will drastically reduce. Road deterioration will also be faster with higher traffic. The benefits considered in the analysis are VOC savings and time savings.

12. **Economic Assessment.** Economic analysis has been carried out using the HDM-4 model comparing the with- and without-project scenarios for each of the project road sections. Based on the pavement condition and capacity analysis, improvement options including pavement rehabilitation and/or reconstruction and capacity augmentation (widening to standard two-lane configuration) were defined; this forms the with-project scenario. The without-project scenario involves basic maintenance and periodic surface renewals to the existing roads. An analysis period of 20 years of operation, including 2 years of construction period, was used. The project improvement includes capacity augmentation, and the salvage value for each road section was calculated for road components considering the straight-line depreciation approach and the values included at the end of the analysis period. A discount rate of 12% was used as a desirable rate of return for calculating the net present value (NPV).

13. The results of the economic analysis, in terms of the economic internal rate of return (EIRR) and NPV (in Rs million) for the proposed project improvement option, are in Table 8. The results indicate that the proposed improvements of the sample project roads are all economically viable, yielding an EIRR above 12% and in most cases significantly higher—indicating the high EIRR. The cost–benefit stream for the four roads together is in Table 9.

Table 8: Economic Analysis Results

Road No.	Road Name	EIRR (%)	NPV (Rs million)
1	Chitrangi–Kasar Road	15.64	142.84
2	Mahua–Chuwahi Road	17.56	427.58
3	Dabra–Bhitarwar–Harsi Road	22.96	953.38
4	Ujjain–Makhsi Road	21.91	779.71
Four roads together		20.02	2,303.51

EIRR = economic internal rate of return, NPV = net present value.

Source: Asian Development Bank estimates.

Table 9: Cash Flow Stream for the Sample Roads in Madhya Pradesh
(Rs million)

Year	Increase in Road Agency Costs		Decrease in Road User Costs		Net Benefits
	Capital Costs	Maintenance Costs	VOC	Time Costs	
2015	1,517.55	0.00	0.00	0.00	(1,517.55)
2016	1,995.98	0.00	3.74	18.97	(1,973.28)
2017	0.00	0.18	173.45	120.29	293.56
2018	0.00	0.17	209.39	183.66	392.88
2019	0.00	0.21	255.73	282.31	537.83
2020	0.00	0.24	323.73	406.72	730.21
2021	0.00	0.27	404.18	528.53	932.44
2022	0.00	0.31	468.59	616.67	1,084.96
2023	0.00	0.35	507.54	668.63	1,175.83
2024	0.00	0.39	540.09	708.06	1,247.76
2025	0.00	0.56	574.82	746.86	1,321.12
2026	0.00	11.34	611.91	780.60	1,381.17
2027	0.00	1.30	651.56	803.74	1,454.01
2028	0.00	1.72	690.02	805.33	1,493.62
2029	0.00	2.19	704.49	767.67	1,469.97
2030	139.60	1.96	650.80	633.68	1,142.92
2031	204.78	1.29	594.19	544.56	932.69
2032	0.00	1.55	657.92	594.39	1,250.76
2033	0.00	1.82	655.30	570.50	1,223.99
2034	(245.95)	2.12	629.81	508.74	1,382.37
				EIRR (%)	20.2%
				NPV @ 12%	2,303.51

() = negative, EIRR = economic internal rate of return, NPV = net present value, VOC = vehicle operating cost.

Source: Asian Development Bank estimates.

14. **Sensitivity Analysis.** Sensitivity analysis was carried out with respect to adverse changes in the costs and benefits: (i) construction cost increased by 10%, (ii) VOC and travel time savings reduced by 10%, (iii) construction cost increased by 10% and VOC and travel time savings reduced by 10%, and (iv) a 1-year delay in project starting. The traffic growth rate in rural Madhya Pradesh is very likely to exceed considerably the normal traffic growth scenario considered owing to huge generated traffic. The cost estimates for the project roads are based on current costs and detailed design, providing high confidence in the estimates. The results of the sensitivity analysis (Table 10) indicate that the project roads remain economically viable with adverse variations in costs and benefits.

Table 10: Sensitivity Analysis Results

Project Road	Economic Internal Rate of Return (%)				
	Base Case	Increase in Cost by 10%	Reduction in Benefits by 10%	Increase in Cost and Reduction in Benefits by 10%	1-Year Delay in Construction
Chitrangi–Kasar Road	15.64	14.22	14.08	12.74	14.09
Mahua–Chuwahi Road	17.56	16.24	16.11	14.85	16.92
Dabra–Bhitarwar–Harsi Road	22.96	21.29	21.11	19.51	21.42
Ujjain–Makhsi Road	21.91	20.45	20.30	18.88	18.79

Project Road	Net Present Value (Rs million)				
	Base Case	Increase in Cost by 10%	Reduction in Benefits by 10%	Increase in Cost and Reduction in Benefits by 10%	1-Year Delay in Construction
Chitrangi–Kasar Road	142.84	93.83	79.54	30.53	87.31
Mahua–Chuwahi Road	427.58	348.20	305.12	225.75	387.93
Dabra–Bhitarwar–Harsi Road	953.38	860.30	764.74	671.65	859.02
Ujjain–Makhsi Road	779.71	703.86	625.81	549.95	544.99

Project Road	Switching Value (%)		
	Increase in Cost	Reduction in Benefits	Increase in Cost and Reduction in Benefits
Chitrangi–Kasar Road	29.1	22.6	(12.7)
Mahua–Chuwahi Road	53.9	34.9	(21.2)
Dabra–Bhitarwar–Harsi Road	102.4	50.5	(33.8)
Ujjain–Makhsi Road	102.8	50.7	(33.9)

() = negative.

Source: Asian Development Bank estimates.

15. **Financial Sustainability.** Incremental recurrent costs associated with the project are estimated to be 0.80% of the current maintenance budget of MPRDC and 0.03% of the overall Madhya Pradesh Public Works Department budget on an annual basis. Thus, it is reasonable to expect that funds will be available to meet these costs.