

ECONOMIC ANALYSIS

A. Scope of Economic Analysis

1. The Multimodal Passenger Hub and Railway Maintenance Project is part of the E'mei–Miyi railway (EMR), which is an investment in a new railway line running roughly alongside the existing Chengdu–Kunming railway alignment. The EMR is currently under construction under PRC government financing. A prior Asian Development Bank (ADB) project (the Mountain Railway Safety Enhancement Project) was approved in 2017 to finance safety equipment along the EMR, and its economic assessment demonstrated that the EMR as a whole was economically viable, with an economic internal rate of return (EIRR) of 14.8%.¹ The Multimodal Passenger Hub and Railway Maintenance Project will assist Chengdu Railway Bureau (CRB) to upgrade its maintenance equipment and build a new multimodal passenger hub in conjunction with the EMR project. This economic analysis evaluates the costs and benefits of these two outputs separately from the EMR.

2. For maintenance equipment, the without-project case is the continued use of China Railways' existing maintenance equipment across the 10,800 track-kilometers (km) operated by the CRB. In the with-project case, high-efficiency mechanized maintenance machines would be acquired for use across CRB's network. For the multimodal hub output, in the without-project case the EMR would be built but the planned Xichang west station (the multimodal hub) would not be constructed and passengers traveling to and from Xichang would be required to travel by road to the next closest railway station at Mianning, about 56 km from downtown Xichang. In the with-project case, Xichang west station would be constructed about 10 km from downtown Xichang.

B. Project Costs

3. Financial costs were converted into economic costs and adjusted to the domestic price numeraire by excluding taxes, price contingencies, and financial charges and applying a standard exchange rate factor of 1.02 to tradable goods.² A shadow wage rate factor was not applied. All costs are expressed in constant 2018 prices in yuan. The multimodal hub component includes costs for subgrade, track, bridges, and culverts for eight tracks in the station area. Since the railway construction would require two tracks in the without-project case, 25% of these costs have been deducted for the economic evaluation of the multimodal hub. Table 1 shows the cost estimates converted to economic costs of the overall project. The analysis assumes that no additional costs would be incurred if Xichang west station were not constructed. However, it is reasonable to expect that Mianning station would need to be expanded to accommodate the additional passengers if the project station were not constructed. Since no expansion was assumed in the without-project case, the economic analysis of the multimodal hub should be considered highly conservative.

4. Annual operation and maintenance costs for the maintenance machines are estimated at CNY22 million. The cost of replacing maintenance machines when they reach the end of their useful lives is included. The operation and maintenance costs of the multimodal hub are estimated at CNY12.4 million in 2023. These are based on the salary and benefit expenses for the planned 51 station staff, and overhead of 40% of labor. Real wages are assumed to increase at 4% per annum until 2023, 3% until 2027, and 2% thereafter.

¹ ADB. 2017. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the People's Republic of China for the Mountain Railway Safety Enhancement Project*. Manila.

² The calculation was based on published 2017 International Monetary Fund data using the methodology described in A. Lagman-Martin. 2003. *Shadow Exchange Rates for Project Economic Analysis: Toward Improving Practice at the Asian Development Bank. Economics and Research Department Technical Note Series*. No. 11. Manila: ADB.

Table 1: Total Investment Cost
(CNY million)

Item	2020	2021	2022	2023	2024	2025	2026	Total
A. Multimodal Hub	42.96	117.92	154.32	147.14	70.63	48.10	2.67	583.74
Construction works	11.89	76.77	105.85	114.22	52.86	34.85	0.00	396.44
Equipment installation	0.67	4.35	6.00	6.47	2.99	1.97	0.00	22.46
Equipment	1.25	8.04	11.08	11.96	5.53	3.65	0.00	41.50
Others: LAR, design, and management	28.12	22.11	22.21	4.58	4.65	4.61	2.67	88.96
Physical contingencies	1.03	6.66	9.18	9.91	4.58	3.02	0.00	34.38
B. Maintenance Equipment	39.66	222.53	256.86	353.98	268.40	156.50	24.28	1,322.22
Equipment	39.48	221.50	255.68	352.35	267.16	155.78	24.17	1,316.12
Others: capacity building	0.18	1.03	1.18	1.63	1.24	0.72	0.11	6.10
C. Total Project Cost	82.63	340.45	411.19	501.12	339.03	204.60	26.95	1,905.96

LAR = land acquisition and resettlement.

Notes:

1. In economic prices. Numbers may not sum precisely due to rounding.

2. Economic prices exclude price contingencies, taxes and duties, and finance charges.

3. Tradable goods are multiplied by the standard exchange rate factor.

Source: Asian Development Bank estimates.

C. Economic Benefits

5. Economic benefits of the multimodal passenger hub are based on a comparison of the travel time and costs borne by passengers in the with- and without-project cases. The feasibility study prepared for the EMR estimated that about 2.8 million passengers would board at Xichang west station in 2025. If Xichang west station is not constructed, these passengers would be required to travel an additional 46.4 km to Mianning station, requiring an additional 49 minutes of travel time on average. In the without-project case, passengers boarding at Mianning would have a (50 km) longer railway trip if their destination is toward Kunming and a (50 km) shorter railway trip if their destination is toward Chengdu.

6. The economic value of time (VOT) for work trips and nonwork trips is estimated separately. Work travel is valued at the average hourly wage for Xichang, while nonwork travel time is valued at 50% of work travel, consistent with standard practice.³ The VOT is based on a gross domestic product per capita of CNY82,217 in 2018⁴ and 2,080 working hours per year, resulting in a VOT of CNY39.5 per hour for work travel and a VOT of CNY19.8 per hour for nonwork travel. Both VOTs are escalated in line with growth in the real gross domestic product per capita, which is assumed to increase at 4% per annum until 2023, 3% until 2027, and 2% thereafter. It is assumed that 50% of high-speed rail trips are work related.

7. Savings in vehicle operating costs are estimated based on the difference in the economic costs of passenger travel for road and rail transport. The economic costs per passenger-km for each mode were taken from the economic analysis prepared for the EMR under the Mountain Railway Safety Enhancement Project approved in 2017 (footnote 1). The economic costs of travel were based on published fares per passenger-km for the railway (CNY0.2568 per passenger-km) and road transport services (CNY0.786 per passenger-km). To convert these nominal costs to economic costs, the value added for road transport services is assumed at 39.89% of total revenue less 1.43% for net taxes and 12.39% for operating surplus.⁶ The corresponding figures

³ L. Zamparini and A. Reggiani. 2007. Meta-Analysis and the Value of Travel Time Savings: A Transatlantic Perspective in Passenger Transport. *Networks and Spatial Economics*. 7 (4). pp. 377–396.

⁴ Based on 2016 data for Xichang, which was projected to 2018 based on prefectural growth data. Liangshan Prefecture Statistical Bureau. 2016. *Liangshan Statistical Yearbook*. Xichang.

⁶ These coefficients are taken from Government of the People's Republic of China, National Bureau of Statistics. 2015. *China Statistical Yearbook 2015*. Beijing (Table 3-21).

for China Railway Corporation are 50.40% value added less 3.45% net taxes and 7.9% operating surplus. Applying these factors, the economic cost of travel was estimated at CNY0.2049 per passenger-km on roadways and CNY0.0672 per passenger-km on high-speed railways in 2023.

8. Greenhouse gas emissions reduction and road safety benefits were also estimated for the multimodal hub output. The number of tons of carbon dioxide (CO₂) per traffic unit for road and rail were computed. The savings for rail compared with road were found to be 25.4 tons of CO₂ per million passenger-km, valued at CNY234 per ton. This amount was included in the benefit stream (CNY0.7 million in 2023). Road safety benefits from reduced roadway travel were also included. Accident costs per passenger-km were estimated at CNY0.00339 for roads and CNY0.00010 for railways in Sichuan province. Unit costs for emissions and accidents were borrowed from the economic analysis conducted for the Mountain Railway Safety Enhancement Project (footnote 1).

9. Economic benefits of the maintenance equipment include labor cost savings and reduced consumption of railway materials because of the higher productivity and work quality of mechanized maintenance machines compared to the existing equipment. In the without-project case, CRB would continue to maintain its network utilizing its existing maintenance equipment. In the with-project case, high-efficiency mechanized railway maintenance machines would be procured, which are much more labor and time efficient. Mechanized track maintenance, in conjunction with rail grinding, increases the quality of the running surface and reduces the forces transmitted to the infrastructure by passing trains. In addition to increased labor efficiency, the track geometry becomes more durable and extends the intervals between major maintenance events, extending the life cycle of the track from 12 to 14 years on average. Based on the productivity figures provided by CRB, the maintenance machines are expected to save about 1.35 million hours of staff labor (about 2.95% of total maintenance labor hours) and about CNY353 million in materials (rail, ballast, and sleepers) every year. Labor savings are valued at the reported salary and welfare benefit costs reported by CRB and escalated by 4% per annum until 2023, 3% until 2027, and 2% thereafter.

D. Results of the Economic Cost-Benefit Analysis

10. The project will result in large positive net economic benefits. The economic internal rate of return (EIRR) for the project is 22.23% (Table 2) and the net present value (NPV) at a 9% discount rate is CNY1.75 billion. For the multimodal hub, the primary benefits of the project are time savings, which represent about 79.5% of the benefits. Passenger travel costs represent about 19.5% of the benefits, and CO₂ reduction benefits and accident cost reductions together represent about 1% of the benefits. The EIRR for the multimodal hub is 16.7% with an NPV of CNY366.66 million. For the maintenance equipment, the largest share (78%) of the benefits comes from the reduction in materials costs because of the extended useful life of the infrastructure. The remaining 22% of the benefits are from reduced labor inputs required. The EIRR for the maintenance machinery is 25.3% with an NPV of CNY1.39 billion. All components are economically viable.

Table 2: Economic Evaluation
(CNY million)

Year	Multimodal Hub		Maintenance Equipment		Total Costs	Time Savings	Multimodal Hub		CO ₂ Reduction	Maintenance Equipment		Total Benefits	Net Benefits
	Capital Costs	O&M Costs	Capital Costs	O&M Costs			Travel Cost Savings	Accident Cost Savings		Labor Savings	Materials Savings		
2020	43.00	0.00	39.64	0.00	82.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(82.61)
2021	117.92	0.00	222.43	0.00	340.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(340.35)
2022	154.32	0.00	256.75	0.00	411.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(411.07)
2023	147.14	0.00	353.82	0.00	500.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(500.96)
2024	70.63	12.38	268.28	22.00	373.29	63.49	19.81	0.43	0.57	60.32	270.00	414.62	41.34
2025	48.10	12.75	156.43	22.00	239.28	77.05	23.35	0.51	0.67	71.44	310.44	483.46	244.18
2026	2.67	13.13	24.27	22.00	62.07	88.45	26.02	0.57	0.75	82.14	346.52	544.44	482.37
2027	0.00	13.53	0.00	22.00	35.53	93.55	26.72	0.58	0.77	86.18	353.01	560.81	525.28
2028	0.00	13.93	0.00	22.00	35.93	98.50	27.31	0.59	0.78	88.77	353.01	568.96	533.03
2029	0.00	14.35	0.00	22.00	36.35	102.70	27.92	0.61	0.80	90.54	353.01	575.58	539.23
2030	0.00	14.64	0.00	22.00	36.64	107.08	28.54	0.62	0.82	92.35	353.01	582.42	545.78
2031	0.00	14.93	0.00	22.00	36.93	111.65	29.17	0.63	0.84	94.20	353.01	589.50	552.57
2032	0.00	15.23	549.32	22.00	586.54	116.41	29.82	0.65	0.86	96.09	353.01	596.83	10.28
2033	0.00	15.53	0.00	22.00	37.53	121.38	30.48	0.66	0.87	98.01	353.01	604.41	566.88
2034	0.00	15.84	0.00	22.00	37.84	126.55	31.16	0.68	0.89	99.97	353.01	612.26	574.41
2035	0.00	16.16	0.00	22.00	38.16	131.95	31.85	0.69	0.91	101.97	353.01	620.38	582.22
2036	0.00	16.48	91.19	22.00	129.67	137.58	32.56	0.71	0.93	104.01	353.01	628.79	499.12
2037	0.00	16.81	0.00	22.00	38.81	141.73	32.88	0.72	0.94	106.09	353.01	635.37	596.55
2038	0.00	17.15	0.00	22.00	39.15	146.01	33.21	0.72	0.95	108.21	353.01	642.11	602.96
2039	0.00	17.49	0.00	22.00	39.49	150.42	33.54	0.73	0.96	110.37	353.01	649.04	609.54
2040	0.00	17.84	167.41	22.00	207.26	154.97	33.88	0.74	0.97	112.58	353.01	656.14	448.88
2041	0.00	18.20	549.32	22.00	589.52	159.65	34.22	0.74	0.98	114.83	353.01	663.43	73.91
2042	0.00	18.56	0.00	22.00	40.56	164.47	34.56	0.75	0.99	117.13	353.01	670.90	630.34
2043	(27.04)	18.94	(66.08)	22.00	(52.19)	169.43	34.91	0.76	1.00	119.47	353.01	678.58	730.76
EIRR												22.23%	
NPV @ discount rate of 9%												1,755.52	

() = negative, CO₂ = carbon dioxide, EIRR = economic internal rate of return, NPV = net present value, O&M = operation and maintenance.

Source: Asian Development Bank estimates.

11. Sensitivity analysis was conducted to test various adverse scenarios and assess the robustness of the results of the economic analysis. The scenarios tested are as follows: (i) case 1: 20% increase in cost; (ii) case 2: 20% decrease in benefits; (iii) case 3: combination of case 1 and case 2; and (iv) case 4: 10year delay in implementation. The results are presented in Table 3. The total cost of the proposed project would have to be 89% higher than estimated for the EIRR to fall below the threshold level of 9%. Benefits would need to decline by 47% for the EIRR to fall below 9%. A 10year delay would reduce the EIRR to 21.5%, which would not adversely affect economic viability. The combination of reduced benefits and higher costs were also tested (case 3). The results show that the project would maintain its economic viability under most plausible scenarios.

Table 3: Sensitivity Indicators and Switching Values

Scenario	Multimodal Hub			Maintenance Equipment			Overall Project		
	EIRR (%)	NPV (CNY million)	SV (%)	EIRR (%)	NPV (CNY million)	SV (%)	EIRR (%)	NPV (CNY million)	SV (%)
Base case	16.7	366.66		25.3	1,388.86		22.2	1,755.52	
Case 1	13.8	260.61	62	20.6	1,109.36	99	18.2	1,369.97	89
Case 2	13.2	187.28	38	19.6	831.59	50	17.3	1,018.87	47
Case 3	10.6	81.23	24	15.4	552.09	33	13.6	633.32	31
Case 4	16.8	331.08		23.9	1,214.06		21.5	1,545.15	

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

Note: A discount rate of 9% was used to calculate the NPV.

Source: Asian Development Bank estimates.