ECONOMIC AND FINANCIAL ANALYSIS

1. The economic internal rate of return (EIRR) for the project is calculated as the difference between the capital and road user costs with and without the project. Calculations are made for 24 years starting in 2013. Road and jetty improvements are assumed to be completed in 2018, giving a benefit period of 20 years. No benefits are included for sections of roads completed before the end of the overall construction period.

2. The approach to the financial analysis follows the Guidelines for the Financial Analysis of Projects of the Asian Development Bank (ADB).[1] Given that the project is not revenue generating, the analysis focuses on the executing agency's financial capacity to meet the recurrent costs of operating and maintaining the developed facilities in a sustainable manner. The overall financial position of the executing agency is appraised to ensure the financial capacity to cover recurrent project costs.

A. Prices

3. Costs and benefits are calculated using economic costs based on border prices for traded goods and services, and domestic market prices net of taxes and subsidies for nontraded items. The prices are for mid-2013 using dollars. The net of tax economic cost of regular gasoline is calculated at $0.88/liter and diesel at $0.96/liter based on border prices. Lubricant costs are estimated at about $3.00/liter for motorcycles and $5.00/liter for 4-wheel drives. Passenger time values are likely to increase in real terms, in step with increasing per capita income; an allowance is made to reflect this. Underemployment of unskilled laborers is considerable, and reflected in adopting a shadow price of the market rate for unskilled labor of 0.8. Altogether, a conversion factor of 0.85 was applied to financial costs of capital.

B. Traffic Demand Analysis

4. Traffic is estimated for each road section evaluated. Base year traffic is estimated using 2-day manual classified counts carried out on all study roads, with more than one count site used in some cases. These were verified by moving observer counts, which were used to check on changes in traffic flow along the roads, and then adjusted to an annual average daily traffic basis. The growth rate can be related linearly to anticipated gross domestic product (GDP). This is normally preferable as it incorporates changes in overall economic activity. On that basis, traffic growth is forecast by applying elasticities of demand for transport with respect to GDP growth, with growth rates forecast for three separate time periods over the evaluation period. In this study, 2013 is the base year of traffic count surveys. Hence, the growth rate of real GDP is also considered from 2013. An average annual growth rate of 6.6% is used for 2014–2017 based on the International Futures of the University of Denver,[2] and the medium- and long-term predicted growth rates referred to by the Economic Research Service of the United States Department of Agriculture with 7.7% for 2017–2022, 7.2% for 2022–2027, and dropping to 6.8% after 2017.[3] Using these growth rates of GDP and assumed elasticities of demand for vehicles, the normal traffic growth rates are calculated (Table 1).

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[1] ADB. 2005. *Financial Management and Analysis of Projects.* Manila.

[2] University of Denver. Cambodia Country Profile, International Futures, Version 7.00. Denver.

[3] Economic Research Services, United States Department of Agriculture. 2013. *Historical and Projected Gross Domestic Product per Capita for Baseline Countries/Regions (in 2005 dollars) 2000–2030.* Washington, DC.

Table 1: Normal Traffic Growth Rates

Mode of Traffic	2014–2017	2017–2022	2022–2027	2027 onward
Motorcycle	11.22	13.09	12.24	11.56
Passenger	7.92	9.24	8.64	8.84
Freight	7.26	8.47	7.92	7.48

Source: Asian Development Bank (ADB).

5. In addition to normal growth, traffic is assumed to increase by up to 15% for motorcycle traffic, 20% for passenger cars, and 10% for freight traffic, following the sealing of roads, to allow for the impact of road user cost reductions and all-weather accessibility.

C. Evaluation Model

6. The economic analysis of upgrading the roads is based on the Highway Development and Management Tool (HDM-4), using the latest version available (version 2.08). The model simulates the road condition for each road section, year-by-year, considering (i) road deterioration, which is the prediction of pavement deterioration and surface roughness; (ii) works effect, whereby the effects of road works on pavement condition are simulated and the corresponding costs determined; and (iii) road user effects, with the costs of vehicle operation and travel time determined to estimate the costs and benefits of alternative road improvement and maintenance strategies.

D. Benefits

7. Two types of benefits are considered: (i) savings in travel time, and (ii) savings of vehicle operating cost (VOC). The residual value of the works is considered as a benefit from road improvement, representing the remaining asset value of the works, and is included at the end of the evaluation period, although the impact of the result is small when an evaluation period of more than 20 years is used. The residual value in this study is assumed to be zero.

8. The design of road pavement can be considered in terms of traffic, surfacing, basic structure, climate conditions, and lifecycle cost. For Mekong River island, the lifecycle cost of concrete roads is viable and is the only solution for flooding. Moreover, after the completion of bridge construction from the mainland to Koh Mitt, heavy vehicle traffic is expected to be very high; the concrete pavement will require less maintenance.

9. Travel time savings are obtained when road improvements lead to an increase in vehicle speeds, thus reducing the journey time of passengers. A value of time per hour for each vehicle type is applied as a unit cost to journey time to produce passenger time costs. VOC savings will be estimated using HDM-4. VOC is a basic item in road project evaluations and the main source of benefits. The HDM-4 model predicts the consumption of resources for each component of VOC per kilometer. The model takes into account a wide range of factors, including the surface condition and geometry of each road section, and the characteristics of representative vehicles.

10. The VOC savings stem primarily from reduced surface roughness and increased travel speed on the improved roads. In this study, VOC savings are estimated for 14 vehicle types commonly used in rural Cambodia, including conventional motorized vehicles, nonmotorized vehicles, and unconventional motorized vehicles (Table 2).

Table 2: Vehicle Operating Costs Data

Vehicle Type	ESA	Average Life (years)	Vehicle Characteristics: Vehicle Hours	Utilization (km)	Crew	Economic Price ($)	VOC ($/km): IRI 3	IRI 10	IRI 15
Bicycle	0.000	10	150	2,500		40	0.00	0.00	0.01
Animal cart	0.000	6	1,300	4,000	1.0	300	0.11	0.15	0.17
Motorcycle	0.000	8	600	8,000	0.4	700	0.03	0.04	0.05
Motorcycle + Trailer	0.000	10	600	8,000	1.0	850	0.04	0.05	0.06
Car	0.004	12	750	15,000	0.4	22,000	0.25	0.31	0.37
Jeep/4WD	0.010	10	750	25,000	0.8	48,500	0.36	0.54	0.68
Pick-up	0.050	10	1,250	25,000	1.0	12,000	0.18	0.24	0.28
Minibus	0.040	10	1,600	35,000	1.0	14,500	0.20	0.26	0.32
Bus	0.700	10	1,750	35,000	2.0	22,000	0.38	0.51	0.64
Small koyun	0.050	10	400	6,000	1.0	1,500	0.08	0.09	0.10
Large koyun	0.200	10	400	6,000	1.0	3,000	0.19	0.32	0.36
Light truck	0.200	8	1,600	30,000	1.0	15,000	0.26	0.37	0.44
Medium truck	0.800	12	2,000	40,000	1.5	22,000	0.36	0.51	0.61
Heavy truck	3.500	12	2,400	45,000	1.0	45,000	0.66	0.93	1.13

4WD = 4-wheel drive; ESA = equivalent standard axle; km = kilometer; IRI = international roughness index; VOC = vehicle operating cost.
Source: ADB.

E. Project Costs

11. The major capital costs are the cost of civil construction works proposed for each road section to upgrade it to double bituminous surface treatment (DBST) in rural areas and a concrete standard in the Mekong islands. Based on an engineering point of view, specific cost estimates are based on the inventories. The cost estimate includes earthwork and allied activities, sub-base and base courses, bituminous works, structures, drainage and protection work, ancillary work, unexploded ordnance, miscellaneous, day-works schedule, contingency, as well as design and project management costs.

12. The current bridges are adequate in most cases, with many newly constructed. The cost of replacement of inadequate bridges is included in the project cost. No land acquisition or resettlement costs are expected. Only minor environmental mitigation measures are expected to be required, and an allowance for any costs is included in the contingency.

13. The variation of cost of improvement per kilometer depends on the road width, location of material available, and labor works. The financial and economic costs used for each road are shown in Table 3, and the cost of improvement for Mekong islands is shown in Table 4.

Table 3: Road Improvement Costs

Code	Road Section: Start	End	Road: Length (km)	Width (m)	Cost of Improvement ($/km): Financial	Economic	Implementation Period
KC1	Veal Toch	Kabas	43.0	6.0	94,993	80,744	2015–2017
KC3	Khlong Tboung	Beung Chroung	13.0	5.5	99,353	84,450	2015–2017
KC4	Phlak Samraong	Teuk Tum	24.8	5.5	90,988	77,340	2015–2017
KC5	Memot	Don Roath	9.8	5.5	125,917	107,029	2015–2017
KC6	Mream Teak	Trapeang Rusey	25.2	5.5	90,020	76,517	2015–2017
KC7	Phsa Torsu	Chroy Sosit	17.2	5.5	87,919	74,732	2015–2017
TK1	Tram Kok	Mungkol Meanlech	16.5	5.5	106,404	90,443	2015–2017
TK2	Pich Sa	Sobin	18.3	5.5	101,634	86,389	2015–2017

	Road Section		Road		Cost of Improvement ($/km)		Implementation Period
			Length	Width			
Code	Start	End	(km)	(m)	Financial	Economic	
KSP1	Kraing Kcheay	Kandal	18.6	5.5	89,376	75,969	2015–2017
KSP2	Talat	Kandal	23.1	5.5	91,982	78,184	2015–2017
KSP5	Phsa Slab Leng	Sala	33.5	5.5	98,174	83,448	2015–2017
KCH1	Chheu Neak	Preal	4.1	5.5	112,355	95,502	2015–2017
KCH2	Thmar Reab	Veal Sbov	22.9	5.5	112,167	95,432	2015–2017
KCH12	Thnal	Alaing Ke	11.5	6.0	140,895	124,861	2015–2017
PS2	O Tapoang	Rum Lech	8.6	5.5	153,300	130,305	2015–2017
PS3	Trapeang Chorng	Beung Botkandal	16.1	5.5	129,237	109,852	2015–2017
PS4	Trapeang Chorng	Khna Toteung	5.1	5.5	162,447	138,080	2015–2017
PS5	Talo	Prahal	13.1	6.0	153,199	131,069	2015–2017
PS6	Trapeang Chorng	Snam Preah	14.3	5.5	167,825	142,651	2015–2017
PS7	Beung Khnar	Phteas Rong	21.9	5.5	130,336	110,786	2015–2017
PS9	Phteas Prei	Sre Sdok	18.0	5.5	119,660	101,711	2015–2017
PS10	Kandieng	Sre Sdok	12.0	5.5	184,610	156,919	2015–2017
PS11	Bak Chinchean	Phteas Rong	8.2	5.5	127,911	108,724	2015–2017
PS13	O Sandan	Kampong Po	8.2	5.5	180,953	153,810	2015–2017
BB1	Ou Ta Ki	Ta Kream	19.6	5.5	132,075	112,264	2015–2017
BB2	Chroy Sdao	Nikom	6.0	6.0	108,931	92,591	2015–2017
BB3	Ta Meun	Taa Poung	8.7	5.5	111,870	95,090	2015–2017
BB4	Sdao	O Khum	29.2	5.5	117,067	99,507	2015–2017
BB5	Sdok Pravoeuk	Svay Yor	14.2	5.5	122,593	104,246	2015–2017
BB7	Kampong Preang	Svay Cheat	11.6	5.5	111,191	94,512	2015–2017
BB10	Preaek Chik	Prey Tralach	5.5	5.5	121,113	102,946	2015–2017
BC1	Thmaor pourp	Pheas Thbaung	27.2	5.5	107,833	92,477	2015–2017
BC2	Sala Krav	Pheas Thbaung	17.4	5.5	113,040	96,084	2015–2017
BC3	Chupvary	Ponley	27.0	6.0	123,686	105,133	2015–2017
BC4	Prek Chik	Thnal Bot	9.1	5.5	107,555	91,422	2015–2017
BC6	Or Nhor	Tasol	10.0	6.0	119,243	101,357	2015–2017
SR4	Khchas	Chan Sar	17.0	5.5	81,929	69,940	2015–2017
SR7	Angkor Chum	Puok	29.5	6.0	137,661	117,011	2015–2017
KT1	Thnort	Ou Angkor	40.0	5.5	100,871	85,740	2015–2017
		Total	**679.0**		**114,299**	**97,301**	

BB = Battambang, BC = Banteay Meanchey, KC = Kampong Cham, KCH = Kampong Chhnang, km = kilometer, KSP = Kampong Speu, KT = Kampong Thom, m = meter, PS = Pursat, SR = Siem Reap, TK = Takeo.
Source: ADB.

Table 4: Roads and Jetty Improvement Costs in Mekong Islands

	Road		Jetty	Cost of Improvement ($)	
Island	**Length** (km)	**Width** (m)	(number)	**Financial**	**Economic**
Mitt	14.78	4.0	0	3,748,190	3,185,962
Pir	4.75	3.5	4	1,542,140	1,310,819
Samrong	11.55	3.5	2	2,742,398	2,331,038
Soutin	15.52	3.5	3	2,714,765	2,307,550
Thmei	3.40	3.5	2	813,507	691,481

km = kilometer. m = meter.
Source: ADB.

14. Routine and periodic maintenance were considered for both cases. The maintenance operations for each are determined within HDM-4 according to road condition and assumed intervention standards or specified time interval. Maintenance of roads is assumed to take into account both the with- and without-project scenarios of upgrading pavement to DBST or concrete. Without the project, the laterite and/or earth road maintenance standard is applied to

all road sections with regravelling every 3 years and grading every 365 days.

15. Purely routine maintenance procedures, such as drain clearance, grass cutting, and traffic sign repair, would be similar in both the without- and with-project cases. As such, they do not affect the evaluation result and a nominal estimate of annual costs per km of road is applied. The criteria for with and without the project, which are based on previous studies or actual works, are shown in Table 5 and cost in Table 6.

Table 5: Road Maintenance and Improvement Criteria

Items	Standard	Work Items	Criteria
Maintenance	Laterite or earth road maintenance Maintenance before upgrading	Laterite or earth gravelling Laterite or earth grading Routine maintenance (miscellaneous)	Interval >= 3 years Interval >= 365 days Interval >= 1 year
	Maintenance after upgrading to DBST or concrete	Overlay of asphalt concrete Concrete replacement	Year >= 2025 Interval >= 8 years
		Resealing with SBST Pothole patching,100% annually Routine maintenance (miscellaneous)	Interval >= 5 years Interval >= 1 year Interval >= 1 year
Improvement	Upgrading to DBST Upgrading to concrete	30 mm surface dressing 150 mm thickness of slab without reinforcement	Year >= 2015 Year >= 2015

DBST = double bituminous surface treatment, mm = millimeter, SBST = single bituminous surface treatment.
Source: ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Kingdom of Cambodia for the Provincial Road Implementation Project.* Manila (Loan 2839-CAM).

Table 6: Unit Cost of Road Maintenance

Work Items	**Unit**	**Economic Cost** ($)
Laterite road		
Gravelling	m^3	10.0
Grading	km	120.0
Annual routine maintenance	km	350.0
DBST road		
Crack sealing	m^2	2.0
Pothole patching	m^2	9.5
Edge repair	m^2	7.5
SBST reseal	m^2	3.0
Annual routine maintenance	km	350.0

DBST = double bituminous surface treatment, km = kilometer, m^2 = square meter, m^3 = cubic meter, SBST = single bituminous surface treatment.
Source: ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan to the Kingdom of Cambodia for the Provincial Road Implementation Project.* Manila (Loan 2839-CAM).

F. Economic Analysis Results

16. The results of the economic evaluation for all project roads are summarized in Table 7. When all road sections are combined and evaluated as a single project, the EIRR is 32.4% and the net present value $173.99 million. All road sections are viable, with the EIRRs in the range of 12.2%–46.3%. The summary of economic cost and benefit flows of the project is shown in Table 8.

Table 7: Cost–Benefit Analysis for the All Road Projects

Item	Indicators
Economic internal rate of return (%)	32.4
Cost–Benefit ratio	4.18
Net present value ($ million)	173.99

Source: ADB.

Table 8: Summary of Economic Costs and Benefit Flows ($ million)

	Cost		Benefits					
			Normal Traffic			Generated Traffic		
Year	Capital Works	Recurrent Works	VOC Savings	Time Savings	NMT Savings	VOC Savings	Time Savings	Total
2015	25.132	0.000	0.000	0.000	0.000	0.000	0.000	(25.132)
2016	33.144	(0.082)	(13.766)	(1.958)	(0.390)	0.000	0.000	(49.176)
2017	3.214	(0.082)	(6.641)	(0.916)	(0.162)	0.000	0.000	(10.852)
2018	0.000	(4.306)	28.942	3.796	0.745	0.743	0.118	38.650
2019	0.000	(0.082)	15.992	1.941	0.404	0.398	0.057	18.874
2020	0.000	(0.082)	30.851	4.161	0.662	0.791	0.128	36.675
2021	0.000	(4.091)	41.563	5.792	0.817	1.106	0.186	53.556
2022	0.000	14.791	23.535	3.179	0.447	0.605	0.095	13.070
2023	0.000	(0.082)	42.323	6.097	0.699	1.133	0.194	50.528
2024	0.000	(4.306)	54.686	8.124	0.845	1.517	0.269	69.748
2025	0.000	30.865	33.833	5.048	0.473	0.890	0.154	9.533
2026	0.000	(0.082)	57.846	8.584	0.789	1.622	0.282	69.204
2027	0.000	(4.306)	67.672	10.256	0.914	1.965	0.352	85.464
2028	0.000	(0.082)	42.925	6.420	0.537	1.176	0.202	51.342
2029	0.000	(0.082)	66.628	10.305	0.802	1.952	0.349	80.118
2030	0.000	11.403	77.092	12.134	0.920	2.340	0.428	81.511
2031	0.000	(0.082)	49.948	8.091	0.522	1.419	0.261	60.323
2032	0.000	(0.082)	76.317	12.539	0.785	2.332	0.436	92.490
2033	0.000	(4.306)	87.777	14.651	0.896	2.755	0.525	110.911
2034	0.000	(0.082)	62.721	10.803	0.529	1.871	0.357	76.362
2035	0.000	16.191	91.673	15.949	0.785	2.912	0.565	95.694
2036	0.000	(4.306)	106.597	18.695	0.914	3.443	0.673	134.628

( ) = negative value, NMT = nonmotorized traffic, VOC = vehicle operating cost.
Note: The negative under costs indicate savings in periodic and/or routine maintenance costs that would be incurred in the base case.
Source: ADB.

17. The EIRR was analyzed for changes in the benefit and cost streams using a sensitivity analysis and calculating switching values, i.e., the percentage change in a variable that causes the EIRR to be 12% (Table 9).

Table 9: Sensitivity Analysis

Scenario	EIRR (%)	NPV ($ million)	Switching Value (%)	Sensitivity Indicator
Base case	32.4	173.99		
Costs increase by 20%	29.5	162.85	317.99	0.29
VOC decreases by 20%	29.4	134.56	(88.62)	(1.11)
Base traffic decreases by 20%	27.2	111.91	(56.18)	(1.75)
Traffic growth rate decreases by 20%	27.9	113.92	(58.06)	(1.72)
No time benefits	30.0	141.48		
No traffic generated	31.9	167.31		
Costs increase by 20%, VOC decreases by 20%	26.5	123.63		

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

18. The sensitivity analysis indicates that the EIRR is more sensitive to traffic changes, either base-year traffic or traffic growth rate, than to costs or VOC. In the severe case when costs increase by 20% and VOC reduces by 20%, the EIRR remains at 26.5%, which remains higher than the 12% threshold. Risk analysis shows that the project is highly viable economically.

G. Financial Position

19. The Ministry of Rural Development (MRD) will be the project owner and be responsible for operation and maintenance after project completion. The financial analysis, therefore, focuses on the future financial position of MRD, aiming to appraise its financial capacity for covering the project's recurrent expenditures. MRD's future financial position is appraised based on its current financial position and budgetary allocation. The General Department for Technical Affairs of MRD is responsible for project maintenance.

H. Financial Analysis Results

20. The future financial position of MRD confirms its financial capacity to cover recurrent costs to sustain facilities developed under the project. The Government of Cambodia allocated $6,750,000 in 2010, $9,184,500 in 2011, and $9,900,000 in 2012 to MRD for maintenance of rural road networks. The sealed rural roads will require less routine maintenance than current gravel roads, except for their periodic maintenance, which will only become necessary after about 7–10 years. The total increased maintenance cost of about $1,000 per year and kilometer is compatible with MRD's rural maintenance budget. Moreover, given the government's support for the project by assuring that it will fund the operating expenditure and periodic maintenance, an adequate budget for recurrent costs of operating the project is expected.

21. MRD has had several externally financed projects to improve rural roads; all were successfully completed. The entity is equipped with qualified financial staff and financial procedures based on the Financial Management Manual published by the Ministry of Economy and Finance. The project is expected to be implemented without difficulties and the completed roads sustainably maintained.