ECONOMIC AND FINANCIAL ANALYSES (Updated)[1]

1. The economic analysis follows the standard methodology for road improvements: the situation expected with road improvements, referred to as the "with-project case", was compared with the situation expected if the roads remain at their present standard, the "base case". The analysis takes into account factors that can be quantified, such as the road construction and maintenance costs, forecast volumes of traffic, and the potential level of benefit per vehicle. It provides measures of the overall returns obtainable from the project, which can be compared to returns from expenditure on other types of road works and other types of investment, so that capital resources can be distributed throughout the economy.

2. **Traffic studies.** Following the usual conventions, traffic levels are expressed in terms of daily traffic flows. When expressed as total traffic over 24 hours, the term "average daily traffic" is used. When seasonal variations are taken into account, the term "annual average daily traffic" (AADT) is used. Estimates of AADT are required as the basis of the analysis.

3. Moving car observer counts and manual classified traffic counts identifying different vehicle types were carried out on all the study roads[2]. The counts were carried out for a minimum of 2 days, at each of 11 sites. Additional counts, due to proposed additional financing, were carried out at the Prey Var–Mocva, Mocva, and Bavet border-crossing points for the analysis of the Prey Var–Mocva cross-border facility (CBF). From the traffic study, the base-year traffic volume for the roads was estimated (Table 1).

Table 1: Base Year (2011) Traffic Estimates (Annual Average Daily Traffic)

Road Section	Count Site and Traffic Section Length (km)		Non-motorized	Motor-cycle	Light Vehicle	Bus	Truck
NR13	Traping Smach (north)	22.0	300	1,590	131		51
	Chong Ou (central)	26.0	473	1,786	162		67
	Preah Tonle (south)	14.4	185	3,066	307		83
314D	Brosoth (north)	17.1	306	1,178	147	3	97
	Kampong Rou (south)	8.5	541	1,422	111	3	75
150B	Ta Ches (east of NR5)	5.8	279	992	84	5	77
	Trapeang Khtum (west of NR5)	14.0	326	432	53		52
	Tuek Phos (west)	13.0	210	816	84		33
NR53	Tuol Khpos (east)	16.0	333	688	36		15
	Kbal Tuek (west)	15.8	17	158	46		3
151B	Thpong	3.6	165	844	124		30

AADT = annual average daily traffic, km = kilometer, NR = national road.
Source: Asian Development Bank.

4. **Traffic growth.** To assess the benefits of road improvements, it is necessary to establish future traffic levels on the project roads. In this study, traffic levels need to be projected for 2011–2034 to provide the data for a 20-year benefit period. Using estimates of gross domestic product (GDP) growth based on the most recent (2015) Asian Development Bank (ADB) and World Bank country reports, and assumed elasticities (motorcycle traffic: 2.0,

[1] Update is based on the proposed additional financing.
[2] This moving car survey is conducted in a running vehicle while counting the vehicles that are coming from the opposite direction and those that are passing and have passed by the vehicle in the same direction. Classified counts are done at a stationary point where the vehicles passing the points are counted according to the vehicle classification.

other passenger traffic: 1.5, and freight traffic: 1.2) based on recent traffic studies (2015) in Cambodia, the estimated traffic growth rates are shown in Table 2.

Table 2: Traffic Growth Rates

(%)

Vehicle Category	2011–2014	2015–2019	2020 onward
Motorcycles	8.0	12.0	10.0
Passenger vehicles	6.0	9.0	7.5
Freight vehicles	4.8	7.2	6.0

Source: Asian Development Bank.

5. **Economic evaluation methodology.** Annual cost and benefit streams were considered over a 25-year period from 2011, and discounted to 2011 values using a discount rate of 12%. It was assumed that works would be implemented from 2013 to 2018, giving a benefit period of 20 years. The economic viability is expressed by incorporating the concept of discounting and was calculated from the annual cost and benefit streams, the net present value (NPV), and the economic internal rate of return (EIRR).

6. **Prices.** The unit prices used for costing purposes and for assessing benefits were based on international border prices in Cambodia in mid-2011, using the United States dollar as the unit of currency. Most items included in the evaluation of roads are tradable and economic prices are based on international border prices. A standard conversion factor for nontraded goods was estimated at 0.92.

7. **Evaluation models.** The Highway Development and Management Tool (HDM-4) was used to analyze the upgrading works. The latest version available for general use is version 2.06, which was used in this study.

8. **Costs.** The major capital costs are the costs of the civil construction works proposed for each road section, with a single design option considered for each. The capital costs for the project roads and the CBF are summarized in Table 3.

Table 3: Estimated Capital Costs ($)

Road	Length (km)	Civil Works		Design and Supervision	Land and Property	Total	Per km
		Financial	Economic				
NR13	62.4	20,264,639	16,617,004	2,077,125	386,804	19,080,933	305,549
314D	25.6	8,489,001	6,960,981	870,123	225,996	8,057,100	315,297
150B east	5.8	1,567,259	1,285,152	160,644	57,912	1,503,709	257,838
150B west	25.5	5,641,870	4,626,333	578,292	123,335	5,327,960	208,735
NR53	31.8	3,559,077	2,918,443	364,805	62,863	3,346,111	105,098
151B	3.6	458,813	376,227	47,028	11,582	434,837	122,042
CBF (ha)	5.3	5,060,000	4,149,200	410,000	45,280	4,604,480	

CBF = cross-border facility, ha = hectare, km = kilometer, NR = national road.
Source: Asian Development Bank.

9. **Road maintenance costs.** The cost of road maintenance is not a major factor in the evaluation of roads; however, upgrading from unsealed to sealed standard normally results in lower maintenance costs in the with-project case. This cost reduction is considered as a benefit in the evaluation. In the with-project case, it was assumed that the roads will be maintained in a conventional way, with the maintenance operations determined within HDM-4. Provision was also made for an asphalt concrete overlay if the predicted surface roughness reached a level of international roughness index (IRI) 7, but this did not occur. The unit costs of the maintenance

operations are shown in Table 4.

Table 4: Road Maintenance Cost Rates ($)

Type of Road	Work Item	Unit	Cost ($)
Unsealed road	Grading	km	120.0
	Regravelling	m^3	10.0
Sealed road	Crack sealing	m^2	2.0
	Pothole repair	m^2	9.5
	Edge repair	m^2	7.5
	SBST reseal	m^2	3.0
	Asphalt concrete overlay (4 cm)	m^2	10.5
All surfaces	Annual routine	km	350.0

cm = centimeter, km = kilometer, m^2 = square meter, m^3 = cubic meter, SBST = single bituminous surface treatment.
Source: Asian Development Bank.

10. **Benefits: savings in vehicle operating costs.** Vehicle operating cost (VOC) savings were estimated using the HDM-4 model. The main characteristics of the vehicle types used in the analysis include estimated average utilization.

11. Economic fuel prices are based on border prices of imported fuel. Fuel prices have been volatile in recent years (2104 and 2015), reflecting major changes in the price of crude oil, and the current price may not be appropriate to use as the price in real terms over the evaluation period. The future pressure of demand and the limit on supply are expected to increase the oil price above general price changes. A long-term average crude oil price of $120.00 per barrel, in current price terms, was assumed. This is consistent with border prices of about $0.86 per liter for diesel fuel and $0.84 per liter for petrol. Given the uncertainty about future oil prices, these fuel prices are only indicative. The wages of vehicle drivers vary in the range $1.10–$1.60 per hour, with the higher rates applying to larger vehicles. Not all vehicles have a paid driver and average crew costs were derived from the estimated number of crew for each vehicle type. Wages paid for vehicle-maintenance labor range from $0.60 per hour for unskilled workers to $2.00 per hour for senior mechanics. A workshop labor rate of $3.00 per hour was used to allow for overheads.

12. The level of VOCs is determined by many factors but the two main determinants are IRI and speed. In Table 5, VOCs are shown for the vehicle types used in the study for a range of roughness levels. They are estimated for a typical road section in flat terrain. An IRI of 3 represents the typical roughness level of improved roads over a number of years; the other IRI levels shown are examples of typical roughness levels of the existing surfaces.

Table 5: Vehicle Operating Costs ($/km)

Vehicle Type	IRI 3	IRI 10	IRI 16	Vehicle Type	IRI 3	IRI 10	IRI 16
Bicycle	0.01	0.00	0.00	Bus	0.48	0.70	0.88
Animal cart	0.11	0.15	0.18	Small koyun[a]	0.09	0.10	0.12
Motorcycle	0.04	0.04	0.05	Large koyun	0.20	0.30	0.35
Motorcycle + trailer	0.05	0.06	0.07	Light truck	0.25	0.33	0.40
Car	0.24	0.29	0.35	Medium truck	0.32	0.40	0.48
Jeep/4-wheel drive	0.39	0.57	0.72	Heavy truck (3 axle)	0.81	1.04	1.28
Pick-up	0.29	0.40	0.51	Heavy truck (4/5 axle)	0.97	1.26	1.53
Minibus	0.23	0.29	0.37	Heavy truck (semi-truck)	0.87	1.19	1.51

IRI = international roughness index, km = kilometer.
[a] A koyun is a walking or two-wheel tractor.
Source: Asian Development Bank.

13. **Travel time savings.** Road improvements lead to an increase in vehicle speeds, thus

reducing journey times. A value of time per hour for each vehicle type is applied as a unit cost to journey times to produce a passenger time cost per vehicle-hour. A value of time based on gross domestic product (GDP) per head was adopted here. The level of GDP is used as a basic indicator of the value of working time. The estimated annual per capita GDP in 2011 at current prices is $900.80.[3] Assuming that 50% of the population is economically active and on average works 2,000 hours per year, the average hourly income in 2011 was $0.90. This is higher than a typical rural wage. A value of $0.50 per hour was used for the working time of motorcyclists and other passengers, except those in cars and 4-wheel drives. Typically, passengers in these two vehicle types have incomes well above the average, usually being in the highest 20% income group. Without information on household income levels for road users, an assumption was made that these passengers have an average working time value of $2.00 per hour, which is more than twice the national average. A general assumption was made that 30% of travel time should be valued as working time, but for car and 4-wheel drive passengers 50% was used. Nonworking time was valued at $0.30 per hour for car and 4-wheel-drive passengers and $0.15 for all others.

14. **Evaluation of Prey Var–Mocva border crossing.** A 12-hour traffic count and an origin and destination survey were carried out simultaneously in July 2011 to determine the number of vehicles crossing the border and the nature of the journeys. The same surveys were carried out at Bavet for comparison, and to determine the potential for diversion following the upgrading of Road 314D. The results of the traffic count adjusted to an AADT basis are in Table 6.

Table 6: Daily Traffic at Prey Var–Mocva Border Crossing

Bicycle and Pedestrian	Motorcycle	Motorcycle + Trailer	Car	Jeep/4 wheel-drive	Koyun[a]		Truck	
					Small	Large	Medium	Heavy
315	2,088	9	20	3	14	1	1	1

[a] A koyun is a walking or two-wheel tractor.
Source: Asian Development Bank

15. **Trade.** Commercial trade flows at the border are monitored by the General Department of Customs and Excise. The reports state that the Prey Var–Mocva border checkpoint has only imports, and no exports. The data for the period 2008–2010 is shown in Table 7.

Table 7: Recorded Imports at Prey Var–Mocva (tons)

Harmonized Commodity Classification Section	2008	2009	2010
Vegetables, fruits, and grains		4	9
Fertilizer and chemical products	30	2	1,010
Plastic and rubber products	121	152	142
Wood products		31	
Metal and metal products		750	749
Electrical and mechanical equipment	2	30	
Total	**153**	**969**	**1,910**

Source: General Department of Customs and Excise

16. Although no Cambodian exports cross the road border at Prey Var–Mocva, a substantial quantity of rice is exported to Viet Nam via inland water transport. The trade is not recorded officially and the exact volumes are not known. Information was obtained from the traders involved and from the Kampong Rou District Office. This suggests annual volumes of at least 100,000 tons, far greater than the volume of import trade by road. Information from one of the largest traders suggests that the annual volume of rice exports through Prey Var–Mocva could

[3] International Monetary Fund. 2011. *World Economic Outlook Database*. April.

be close to 200,000 tons, but this could not be verified. This unregulated export takes place at several places in southeastern Cambodia.

17. **Proposed costs for the cross-border facility[4].** The preliminary plan for the Prey Var-Mocva CBF is similar in concept to that provided at Bavet. It would provide separate lanes for local traffic, cars, buses, and trucks, with parking space and offices. The estimated cost is $5.06 million. The proposed CBF at Prey Var–Mocva can be implemented separately from the works to upgrade Road 314D. The benefits of the CBF would be mainly in the form of time savings for vehicles and passengers from faster processing, compared with a base case of the existing border facilities. The benefits of the CBF alone were not estimated. Therefore, wo sets of evaluation results were produced, one for Road 314D alone, and one for the CBF alone (which was the same approach used at Bavet and O'smach in previously approved projects).

18. **Evaluation results.** The appraisal was carried out for six road sections. There are no changes with respect to the cost and benefits between 2012 and up to date, July 2016. NR13 was analyzed as three sections, but the results were combined for the whole road; all three sections are individually economically viable. The results for Road 314D are shown for two cases: one with only the cost of the road upgrading and one with the capital cost of developing the CBF at Prey Var–Mocva included. No additional benefit for the CBF was calculated. Road 150B has been analyzed as two sections, east and west of NR5, and the results are shown on this basis, as the two sections are distinct in terms of the road network. The results are in Table 8. All of the road sections are shown to be viable, with positive NPVs and EIRRs above the 12% target. Overall, the project has an EIRR of 14.9%.

Table 8: Summary of Evaluation Results ($ million)

	Capital Cost Increase	Maintenance Cost Savings	VOC Savings	Passenger Time Savings	Non-motorized Savings	NPV	EIRR (%)
NR13	11.94	-0.52	13.73	3.10	0.17	5.59	15.9
314D: road only	5.04	-0.07	6.80	1.09	0.08	3.00	16.8
314D: with CBF	6.75	-0.07	6.80	1.09	0.08	1.30	13.9
150B East	0.94	-0.01	1.05	0.23	0.01	0.35	15.2
150B West	3.33	-0.05	3.26	0.46	0.08	0.52	13.4
NR53	2.09	-0.06	1.89	0.27	0.05	0.17	12.8
151B	0.27	-0.01	0.53	0.07	0.00	0.33	20.8
Total[a]	**25.33**	**-0.72**	**27.26**	**5.22**	**0.39**	**8.27**	**14.9**

CBF = cross-border facility, EIRR = economic internal rate of return, NPV = net present value, NR = national road, VOC = vehicle operating cost.

[a] The total includes the option for Road 314D including the CBF.

Source: Asian Development Bank.

19. **Sensitivity tests.** The sensitivity of the project result was analyzed with respect to changes in the benefit and cost streams, and is satisfactory. Sensitivity analysis for economic analysis shows that the CBF rehabilitation is economically viable despite one year of delay in its completion and the start of operations. Table 9 shows the results of the sensitivity tests.

[4] The proposed additional financing will cover the gap in funds that prevented the construction of the CBF and allow the CBF to be constructed. Here the overall project is considered including additional financing.

Table 9: Results of Sensitivity Tests

Test	**EIRR** (%)	**NPV** ($ million)
Base case	14.9	8.266
Capital costs increase by 20%	13.1	3.547
Benefits reduced by 20%	12.9	2.283
Decrease in base year traffic by 20%	12.5	1.363
Decrease in traffic growth rates by 20%	12.4	1.034
No time saving benefits	13.4	3.884
Capital costs + 20% and benefits – 20%	11.1	-2.697

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

20. **Financial position.** The Ministry of Public Works and Transport (MPWT) will be the project's executing agency and will be responsible for operation and maintenance after project completion. The financial analysis, therefore, focuses on the future financial position of the MPWT, aiming to assess its financial capacity to cover the recurrent expenditures of the project. The future financial position of the ministry is appraised based on its current financial position and budgetary allocation.

21. **Results of financial analysis.** The executing agency is assessed as having sufficient future financial capacity to cover the recurrent costs of sustaining the facilities developed under the overall project, including additional financing. Moreover, given the government's support for the project in assuring that it will fund the operating expenditure and periodic maintenance, an adequate budget for the recurrent costs of operating the project is reasonably expected.