ECONOMIC AND FINANCIAL ANALYSES

A. Methodological Approach

1. The assessment approach follows the analytical framework of the Highway Development and Management (HDM) Model.[1] The project analysis module of HDM-4 was used to estimate the economic and engineering feasibility of the project. The model is based on the concept of pavement life-cycle analysis. The key observation is that road pavement once constructed, deteriorates as a result of several factors including traffic loading, climatic conditions, and maintenance regimes. The model simulates the impacts of the road condition and design standards on road users and the effects of road work, such as the effect of reconstruction in the case of the project.

(i) **Road deterioration** is assumed to be directly affected by the standards of maintenance applied to repair defects on the pavement surface, thereby permitting the road to carry traffic in accordance with its original design specifications. Pavement performance is represented by the riding quality that is measured in terms of the international roughness index (IRI).[2]

(ii) **Impacts of the road condition and design standards on road users** are measured to predict economic resource consumption. Such road user costs include vehicle operating cost (VOC) (fuel, tires, oil, spare parts consumption, depreciation, and capacity utilization); cost of travel time for both passengers and cargo; and cost to the economy of road accidents.

2. Due to the uncertainty inherent in making assumptions about the behaviour of the various variables, sensitivity analysis is carried out to study the impact of variations in key parameters on the feasibility of the road investment project. This analysis indicates which of the parameters examined are likely to have the most significant effect on the feasibility of the project. The important variables that should be considered in a sensitivity analysis are

(i) cost of the proposed investment; the base cost of the project was converted using a standard conversion factor of 0.84 to reflect the situation of real prices in the project province;
(ii) traffic volume, both baseline flow and forecasted growth rate;
(iii) vehicle use, loading, and utilization; and
(iv) net benefit streams, reflecting variations in transport costs.

3. The comparison of with- and without project scenarios generates standard indicators for project feasibility, used as decision criteria for the investment, notably the net present value (NPV) and the economic internal rate of return (EIRR). The with-project scenario assumes improved road quality and a more systematic and rational maintenance regime. Under the without-project scenario, the status quo in terms of the maintenance regime is assumed resulting in roughness of the road surface increasing in step with expected rising traffic volume.

[1] World Road Association. 2002. *HDM-4 Version 2*. Paris.
[2] The IRI is used to define a characteristic of the longitudinal profile of a traveled wheel track and constitutes a standardized roughness measurement. The measurement units are meters per kilometer or millimeters per meter. The IRI is based on the ratio of a standard vehicle's accumulated suspension motion caused by roughness (in millimeters, centimeters, or inches) divided by the distance traveled by the vehicle during the measurement (meters, kilometers). The IRI scale is open-ended.

Because the project road has not received any capital (periodic) maintenance in the past, such is not included in the evaluation. The development of pavement conditions over time reflecting different maintenance regimes and traffic loads is expressed in terms of the IRI.

4. HDM-4 computes benefits accruing to normal, generated, and diverted traffic, as a function of a reduction in vehicle operating and time costs.[3] The quantities of resources consumed and vehicle speeds were calculated first and then multiplied by unit costs of the resources to obtain total operating and travel time costs. The resources consumed and the vehicle operating conditions are a function of traffic volume and the composition of traffic by vehicle type, pavement type, geometric characteristics of the road, and roughness of the road surface. The inputs to the economic evaluation were adapted to conditions representative of the project road.

5. The project road provides access to the network of CAREC road corridors and is thus a road of regional significance. Due to this, the analysis was undertaken from national and regional perspectives. As a consequence, the evaluation comprises benefits accruing to international and domestic traffic. No distinction has been made, however, between international and domestic traffic and their respective benefits and costs. Additionally, the analysis can be assumed to be conservative. That is, while the analysis considers the specific microeconomic benefits and costs to road users, it does not consider the much broader macroeconomic benefits to the region from increased trade, resulting from greater access to markets and economic opportunity and more efficient transport.

B. Results of the Analysis

1. Assessment of Pavement

6. The pavement design for the project road is based on the assumption that all road sections carrying more than 7,000 vehicles/day will be upgraded to category I. The project road meets this condition. Category I corresponds to a dual carriageway with a 27.5-meter wide road platform. In the without-project scenario, the pavement—because of structural weaknesses—is at an imminent state of failure or has already failed in many sections. Based on this, the IRI**,** which the consultants estimated based on visual surveys, is currently in the range of 8 to 10.

2. Vehicle Fleet

7. The vehicles used in the analysis were selected from among the HDM-4 default fleets and adjusted to current prices. The vehicles are representative of the vehicle fleet in Kazakhstan and the consequent determinants of VOC. Since the VOC of every individual vehicle brand or model could not be simulated, representative vehicles were chosen for major types operating on the project road.

3. Vehicle Operating Cost

8. Road projects, including rehabilitation and reconstruction of roads, lead to a reduction in VOC for users of the improved road. For the project, the corresponding VOC savings are in the most substantial and direct benefit category. The resources consumed are reflected in the major

[3] As the analysis is limited to only one road section, diverted traffic could not be considered. However, regardless of the limitations of the model, the project road has no scope for traffic diversion.

VOC items, including fuel, tires, maintenance parts, maintenance labor, lubricants, crew, depreciation, interest, overhead, passenger time, and capital attached to freight in transit.

9. The economic evaluation is based on VOC relationships generated by the HDM-4 model under the two scenarios, i.e., with- and without the project. Without the project, the road quality is assumed to depreciate at an increasing rate with forecasted traffic volumes, increasing from an initial IRI of 8 to an IRI of 16.

10. Time savings were computed for passengers and freight. All passengers are assumed to accrue a monetary benefit from saving in travel time. The travel time between Shymkent and Zhibek Zholi under present conditions is approximately 1.5 hours for 102 km. With improved road quality under the with-project condition, this can be reduced to approximately 1 hour, generating time savings of 0.5 hours per passenger or freight trip.

11. For freight and vehicles, the savings occur from interest savings due to the shorter time that capital is tied up in vehicles and freight during transit. The freight is dominated by (i) general freight to and from Shymkent, consumer goods bound for Shymkent city, and limited agricultural produce shipped from Uzbekistan and elsewhere to Southern Kazakhstan. The weighted average of the freight mix is estimated at $550/ton carried. The interest rate applied is 8%, the average cost of capital over the past 5 years.

12. The cost per passenger-hour requires estimates of the value of time. In estimating this, working and nonworking time must be distinguished. The value of working time is directly related to the hourly wage rate. The value of working time for car passengers and drivers is estimated at $4/hour, which is the typical wage for a worker employed in southern Kazakhstan. The value of nonworking time is estimated at $2/hour, which is assumed for all unemployed bus passengers.

4. Investment and Maintenance Costs

13. Consistent with the envisaged 3 years of construction, the project funds will be released over 3 years. The costs are net of taxes and duties, and reflect the true costs of resource consumption and resource scarcity, as measured by the standard conversion factor.

14. Maintenance costs include periodic and routine maintenance costs. Periodic maintenance interventions are scheduled at intervals of 5 years based on rates made available by the Committee of Roads. No periodic maintenance is assumed for the without-project scenario consistent with the maintenance regime practiced on the project road over the past decade. This assumption reflects a rational maintenance regime. As the subbase and wearing course of the pavement are beyond repair, periodic maintenance, which is typically in the form of simple pavement overlays, would not arrest the trend of structural deterioration.

15. The without-project scenario includes $2,600/km for routine maintenance. A significantly higher rate would be required to keep the road open for traffic under the without-project scenario given the poor base state of the road. To reflect this situation, the highest average rate for Kazakhstan is assumed under the without-project alternative at $4,220/km.

5. Traffic

16. The current and projected traffic volumes are based on traffic counts that Committee of Roads (COR) has carried our regularly over the last 4 years (Table 1). Random counts using the moving-observer method of traffic counting were conducted, while travelling on the project road on 4 May 2012 and 5 June 2012.[4] Based on the expected development of Shymkent and South Kazakhstan Oblast, traffic is expected to grow at 3% per year. Traffic projections are also based on the assumption that the composition of traffic will change. The share of passenger cars currently at about 80% will decline, while the share of trucks and buses will increase over time. This assumption is based on the expectation that regional trade will grow consistent with measures to liberalize trade among the CAREC countries.

17. The economic evaluation of the project road illustrates that the project is economically feasible. The EIRR for the project is estimated at 15.9% and the NPV at $30.3 million.[5] The economic feasibility analysis of the project is based on the improved road conditions generating (i) substantial savings in VOC, which account for 71% of total benefits; (ii) time savings for road users (15%); (iii) benefits due to generated traffic (11%); and (iv) savings in road maintenance (2%). Overall, the economic feasibility of the project is robust and can tolerate adverse developments to the primary benefit and cost categories, and changes in parameters. This was assessed in the risk and sensitivity analysis supporting the EIRR calculation (Table 3).

Table 2: Sensitivity Analysis

	EIRR	Sensitivity Indicator	Switching Value
Normal case	15.9	n.a.	
Increase in cost by 20%	13.6	(0.94)	1.38
Increase in construction period by 50%	13.7	0.98	
Decrease in benefits by 20%	13.1	0.94	
Combined impact (A) and (C)	11.0	n.a.	

( ) = negative value, EIRR = economic internal rate of return.
Note: The sensitivity indicator is defined as the percentage change of the EIRR resulting from the percentage change in the independent variable. Switching value is the percentage change of an independent variable chosen to make the EIRR fall to a defined hurdle rate and the net present value to become zero. An increase in project cost by 38% would reduce the EIRR to 12% and the net present value to zero.
Source: Asian Development Bank.

6. Fiscal Impact and Sustainability Analysis

18. Unlike in other developing member countries, funding for maintenance is not considered a risk in Kazakhstan. The government has consistently increased maintenance allocations and is likely in a position to sustain a solid maintenance regime given its robust fiscal position coupled with its strategic objectives for the transport sector. Rather than continuing to cause inefficient use of government funds, the project road's fiscal impact will be reduced pressure on

[4] The method permits rough checks of traffic. It involves an observer in a moving vehicle counting the number of oncoming vehicles passed in a specified length of road. If the average speed of the moving vehicle, length of road, and trip time are known, then the traffic flow rate and thus the average daily traffic can be calculated.

[5] The NPV was computed by discounting the stream of net benefits by 12%. As the EIRR is defined as the discount rate that turns the NPV to zero and the EIRR for the project is 15.9%, the NPV must exceed zero.

the budget, as maintenance costs will be reduced. The proposed road surface is cement concrete, which was chosen because it is relatively easy and inexpensive to maintain.

19. While recurrent expenditures for routine maintenance and administration have been relatively stable over time, capital expenditures rose sharply until 2008, when the financial crisis caused a budget squeeze. The allocation for 2010 indicates a resumption of the rising trend that was interrupted in 2008 (Table 4).

Table 4: Development of Road Expenditures
($ million)

Expenditures	2006	2007	2008	2009	2010
Recurrent	46.0	58.1	61.7	52.7	51.7
Capital	373.0	718.8	711.3	482.1	1046.8

Source: Government of Kazakhstan, Committee of Roads, 2010.

20. Table 5 shows the structure of road expenditures based on average expenditures for 5-year period (2006-2010). Allocations for construction and reconstruction account for most of total resource allocations, which in part reflects the need to reduce the maintenance backlog. The composition of expenditures will become more balanced once the government has restored the whole network to maintainable conditions. The government has doubled the reconstruction rate since 2006. The maintenance allocations for the project road are largely in line with the average cost of routine maintenance spent over the last 5 years (Table 6).

Table 5: Composition of Road Expenditures
(% of total road expenditures)

Work Category	Output Km	Unit Cost $ per Km	Total $ million	% of Total
Construction and Reconstruction	3381	195461.8	660.9	82.4
Periodic Maintenance	7497	12809.2	96.0	12.0
Routine Maintenance	23495	1917.1	45.0	5.6
Total			**801.9**	**100.0**

Source: Government of Kazakhstan, Committee of Roads, 2010.

21. Government expenditures on roads are financed from the general budget, foreign loans, and investments under public–private partnership arrangements. While the government's general tax base includes taxes on road traffic-related transactions, including fuel taxes and vehicle registrations, the proceeds are not earmarked and taxes and fees are not levied with a view to recovering the consumption of resources attributable to road users. The funds assigned to roads are not automatically linked to changes in traffic volume and traffic load. The allocations are thus to some extent discretionary and not well aligned to the cost.

Appendix C. 6 – Results of Economic Evaluation

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Comparison of Cost Streams (Undiscounted)

HIGHWAY DEVELOPMENT & MANAGEMENT

Study Name:	SHYMKENT - TASHKENT ROAD	
Run Date:	10-05-2012	US$
Currency:	US Dollar	
Discount Rate:	12%	

Section		From	To	Length
	KM	705	742.5	37.5

YEAR	ROAD AGENCY COST				ROAD USER COSTS AND SAVINGS										NET
	CAPITAL WORKS	RECURRENT WORKS		TOTAL	NORMAL TRAFFIC			TIME SAVINGS			GENERATED TRAFFIC			TOTAL BENEFITS	BENEFITS
		WITH	WITHOUT		WITH	WITHOUT	NET	PASS.	FREIGHT	TOTAL	VOC	TIME	TOTAL		
2013	4.12		0.17	3.96	39.22	39.22	0.00				0.00		0.00		-3.96
2014	35.06		0.12	34.94	40.16	40.16	0.00				0.00		0.00		-34.94
2015	53.62		0.13	53.50	41.17	41.17	0.00				0.00		0.00		-53.50
2016	10.31	0.0975	0.13	10.28	43.00	42.82	-0.19	0.50	1.12	1.61	-0.02	0.24	0.22	1.64	-8.64
2017		0.1009	0.14	-0.04	36.36	45.16	8.79	0.51	1.19	1.70	1.14	0.25	1.40	11.89	11.93
2018		0.1044	0.15	-0.05	38.03	48.36	10.33	0.52	1.27	1.80	1.34	0.27	1.61	13.74	13.79
2019		0.1081	0.16	-0.05	39.80	51.80	12.00	0.54	1.36	1.90	1.56	0.28	1.84	15.74	15.79
2020		0.1119	0.17	-0.06	41.69	55.46	13.78	0.56	1.45	2.01	1.79	0.30	2.09	17.88	17.93
2021		0.1158	0.18	-0.06	43.70	59.37	15.67	0.58	1.54	2.12	2.04	0.32	2.35	20.14	20.20
2022		0.1199	0.19	-0.07	48.12	66.52	18.41	0.60	1.85	2.45	2.39	0.37	2.76	23.62	23.69
2023	3.75	0.0975	0.20	3.65	49.02	69.29	20.27	0.62	1.96	2.58	2.63	0.39	3.02	25.87	22.22
2024		0.1009	0.21	-0.11	50.13	70.66	20.53	0.64	1.97	2.60	2.67	0.39	3.06	26.19	26.31
2025		0.1044	0.23	-0.12	52.43	73.65	21.22	0.66	2.08	2.74	2.76	0.41	3.17	27.13	27.25
2026		0.1081	0.24	-0.13	53.85	75.30	21.45	0.68	2.11	2.79	2.79	0.42	3.21	27.45	27.58
2027		0.1119	0.25	-0.14	56.43	78.43	21.99	0.70	2.23	2.93	2.86	0.44	3.30	28.22	28.36
2028		0.1158	0.27	-0.15	58.11	80.19	22.08	0.73	2.25	2.98	2.87	0.45	3.32	28.37	28.53
2029	3.75	0.0975	0.29	3.56	57.93	81.77	23.84	0.75	2.26	3.01	3.10	0.45	3.55	30.40	26.83
2030		0.1009	0.30	-0.20	60.59	85.17	24.58	0.78	2.39	3.17	3.20	0.47	3.67	31.42	31.62
2031		0.1044	0.32	-0.22	61.71	86.39	24.67	0.80	2.36	3.17	3.21	0.47	3.68	31.52	31.74
2032		0.1081	0.34	-0.23	64.69	89.98	25.30	0.83	2.50	3.33	3.29	0.50	3.79	32.42	32.65
2033		0.1119	0.36	-0.25	67.89	93.72	25.83	0.86	2.65	3.51	3.36	0.53	3.88	33.21	33.46
2034		0.1158	0.38	-0.27	70.03	95.83	25.79	0.89	2.67	3.56	3.35	0.53	3.89	33.24	33.51
2035	3.75	0.0975	0.41	3.44	69.46	97.72	28.26	0.92	2.68	3.60	3.67	0.54	4.21	36.07	32.63
2036		0.1009	0.43	-0.33	69.06	96.73	27.67	0.92	2.61	3.53	3.60	0.53	4.13	35.33	35.66
														EIRR	15.9%
				77.40			81.23			17.46			12.42	NPV	28.67