ECONOMIC AND FINANCIAL ANALYSIS

A. General

1. **Context**. Roads are the main mode of transport in Pakistan, accounting for 96% of all inland freight and 91% of all passenger traffic. According to the Pakistan Economic Survey, 2013–2014,[1] Pakistan has 263,755 kilometers (km) of public roads, of which 12,131 km are classified as motorways or national highways; the rest are either provincial highways or local roads. The motorway and highway network constitutes less than 5% of the total road length, but handles about 80% of total traffic. Since 2005, Pakistan has made considerable investments in national highways, but 26% of them are in poor or very poor condition with only 7% rated in good condition.[2] Comparable figures for provincial roads are not available, but the condition of provincial roads on average is likely to be worse than national highways. Sindh is a province in southern Pakistan bordering India, Baluchistan, and the Arabian Sea. Its capital and the largest city, Karachi, is the economic and industrial center of Sindh. In addition to being an important producer of natural gas, oil, and coal, Sindh is also produces a number of major agricultural crops: wheat, sugar cane, cotton, bananas, and rice.

2. Sindh's road network totals 25,737 km, of which 1,365 km are classified as national highways, 2,830 km as provincial highways, 11,630 km as secondary roads, and 9,912 km as access roads. The provincial highways play an important role in Sindh, connecting the district centers to the national highways and to each other. They also serve many small and medium-sized towns, and provide access to jobs, services, and markets for the local population.

3. The rationale for the Sindh Provincial Road Improvement Project includes (i) reducing the cost of moving people and goods, (ii) improving connectivity for local traffic, and (iii) improving economic competitiveness.

4. The proposed project will upgrade more than 328 km of provincial highways in Sindh, divided into 6 sections: Kandhkot–Jacobabad (43 km), Jacobabad–Ratodero (36 km), Khyber–Sanghar (64 km), Sanghar–Mirpurkhas (64 km), TM Khan–Badin (67 km), and Mirwah–Naukot (54 km). These sections, plus another 62 km of road sections that do not justify immediate upgrading, will be placed under long-term maintenance contracts. Candidate sections were given a score based on each road's importance and condition. Final selection was made by ranking sections and treatment options on their economic return.

5. **Without-project**. The "without project" scenario involves the six provincial road sections being maintained in line with current practice with maintenance largely confined to crack sealing and patching of potholes. The provincial roads are in mixed condition. Several sections have been recently overlaid with asphalt but are already showing signs of deterioration. A few sections were largely washed away by recent floods and are in an extremely poor state. Annual average daily traffic (AADT) varies by section but averages more than 6,000 vehicles per day on the six sections. The traffic mix includes motorcycles, cars, assorted types of trucks, rickshaws, buffalo-drawn carts, and pedestrians. The extent of urbanization, combined with the lack of development control and the traffic composition, creates road safety challenges.

6. Lanes are generally 3.5–3.7 meters wide, but in some sections are less than 3 meters. Hard shoulder widths (where present) vary but are generally unpaved. The roads pass through

[1] Ministry of Finance. 2014. *Pakistan Economic Survey 2013–2014*. Islamabad.
[2] Data provided by National Highway Authority (NHA) based on their road asset management system.

numerous urban areas with at-grade accesses to the road from local dwellings and businesses throughout.

7. **With-project**. The "with-project" scenario involves bringing each road to a good single-carriageway (2-lane) road standard, with 3.65-meter wide lanes and where possible 2.5 meter hard shoulders. The design speed is generally 90 km/hour for rural areas and 60 km/hour for urban sections.

8. The completion of the "with-project" scenario will yield the following benefits: (i) reduced travel time, and lower vehicle and trip costs for passenger movements in rural areas of Sindh; (ii) lower cost for movement of goods to benefit business and local products located in the areas along the roads; ; and (iii) lower costs of congestion.

9. During the feasibility study, different technical options were studied for each section. These included (i) simple patching and sealing for sections where the existing pavement is not badly damaged; (ii) repairing and strengthening the overlay; and (iii) fully reconstructing. The option to delay works until funds are available under the Sindh Annual Development Program was also considered. The appropriate design standard was chosen based on an incremental analysis whereby the additional benefits of the more expensive intervention were compared with the additional cost.

B. Traffic Studies

10. Estimates of traffic demand used in the economic analysis are based on traffic counts and forecasts by ECIL consultants. In June 2014, 13 traffic counts were undertaken on the 6 project roads. Table 1 shows the average traffic flows and composition on the project roads.

Table 1: Baseline Demand, 2014

Section	Motor-cycles	Rickshaws	Cars	Vans	Buses or Minibuses	Trucks	Tractor and Trailer	AADT
Kandhkot–Jacobabad	4,108	532	1,263	692	57	269	250	7,169
Jacobabad–Ratodero	1,924	428	236	211	28	66	109	3,000
Khyber–Sanghar	2,785	855	1,588	525	114	334	20	6,219
Sanghar–Mirpurkhas	3,797	867	1,145	666	97	229	48	6,848
TM Khan–Badin	3,925	702	2,320	809	265	632	108	8,760
Mirwah–Naukot	2,622	435	923	178	209	197	184	4,749

AADT = annual average daily traffic.
Source: ECIL traffic study report.

11. Gross domestic product (GDP) growth in Pakistan averaged 4.4% during 2005–2013, and the forecasts of GDP growth for 2014–2019 vary from 3.1% in 2014 to 5.0% in 2018.[3] A GDP growth rate of 4.0% for 2020 onwards has been assumed based on recent trends. GDP per capita growth rates have been calculated based on these GDP projections and United Nations population projections.

12. Traffic was forecast for 2018–2037. Table 2 shows the demand forecasts for both the with project and without project scenarios. The with project scenario includes the effect of the imposition of tolls on cars, vans, trucks, tractors, and trailers on two sections (Khyber–Sanghar and TM Khan–Badin).

[3] International Monetary Fund. *World Economic Outlook Database*. http://www.imf.org/external/data.htm (accessed 19 March 2015).

Table 2a: Forecast AADT, 2018–2037 With Project Scenario

	2018	2020	2025	2030	2035	2037
Khandhkot–Jacobabad	8,803	9,521	11,585	14,094	17,148	18,547
Jacobabad–Ratodero	3,680	3,981	4,844	5,893	7,169	7,754
Khyber–Sanghar	7,398	8,002	9,735	11,845	14,411	15,587
Sanghar–Mirpurkhas	8,411	9,097	11,068	13,466	16,383	17,720
TM Khan–Badin	10,334	11,177	13,599	16,546	20,131	21,773
Mirwah–Naukot	5,831	6,306	7,672	9,335	11,357	12,284

AADT = Annual average daily traffic.
Source: Asian Development Bank estimates.

Table 2b: Forecast AADT, 2018–2037 Without Project Scenario

	2018	2020	2025	2030	2035	2037
Khandhkot–Jacobabad	8,384	9,068	11,033	13,423	16,331	17,664
Jakobabad–Ratodero	3,505	3,791	4,613	5,612	6,828	7,385
Khyber–Sanghar	7,274	7,868	9,572	11,646	14,169	15,326
Sanghar–Mirpurkhas	8,010	8,664	10,541	12,825	15,603	16,876
TM Khan–Badin	10,246	11,082	13,483	16,405	19,959	21,587
Mirwah–Naukot	5,553	6,006	7,307	8,890	10,816	11,699

AADT = Annual average daily traffic.
Source: Asian Development Bank estimates.

C. Economic Costs

13. The economic costs of the project comprise (i) capital investment, including civil works, resettlement, physical contingencies, and consulting services for construction supervision and institutional strengthening; and (ii) road maintenance. Costs related to taxes, duties, and financing charges during implementation have been excluded. Table 3 provides a breakdown of the investment costs for the project.

14. The unit cost for civil works is about $550,000/km (excluding taxes).

Table 3: Financial and Economic Cost Estimates ($ million)

Unit	Financial Cost	Economic Cost
Resettlement	0.10	0.40
Civil Works	176.17	176.08
Equipment	0.50	0.51
Taxes and Duties	11.28	0.00
Project Management Consultants	4.50	4.58
Institutional Strengthening	7.50	7.62
Project Administration	1.00	1.00
Physical Contingencies	9.37	9.33
Price Contingencies	11.21	0.00
Interest During Construction	5.18	0.00
Commitment Charge	0.70	0.00
Total	**227.51**	**199.51**

Source: ADB estimates.

15. The economic analysis excluded price contingencies. Resettlement costs were reviewed and categorized as either transfers or resource costs and relevant conversion factors applied in line with Appendix 14 of the 1997 ADB guidelines.[4] Financial costs were otherwise converted to economic costs by application of conversion factors[5] in line with the ADB Guidelines for Economic Analysis of Projects (footnote 4).

[4] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila.
[5] The conversion factors include: discount Year: 2014. Construction Start-End Year: 2016-2019. First Year of Benefits: 2019. Appraisal Period: 20 years. Numeraire Used: Domestic Price Numeraire. Value of time (in work, 2013): PRs90/hour (increasing in line with real GDP growth). Value of time (non-work, 2013): PRs27/hour

16. Unit rates for maintenance for the scenarios with and without the project were sourced from the Highway Development and Management model produced by ECIL and are based on expenditures on similar types of roads.

D. Economic Benefits

17. Improved road surface conditions and widened carriageways, relative to the conditions of the existing provincial road network, will generate vehicle operating cost (VOC) savings. ECIL has provided unit rates for VOC per km by IRI based on calibrated HDM-4 model outputs. Table 4 shows the VOC unit rates used in the analysis (in 2014 prices).

Table 4: Vehicle Operating Costs by Vehicle Type, 2014($/km)

IRI	Rick Shaw	Motorcycle	Car	Minibus	Bus	Van	Truck (2 axle)	Articulated Truck (4 axle)	Tractor
2	0.053	0.053	0.258	0.299	0.708	0.142	0.648	1.117	2.001
3	0.055	0.055	0.260	0.303	0.72	0.146	0.659	1.135	2.008
4	0.055	0.055	0.262	0.311	0.737	0.147	0.681	1.168	2.018
5	0.054	0.053	0.264	0.316	0.737	0.145	0.695	1.180	2.022
6	0.053	0.051	0.270	0.331	0.763	0.144	0.735	1.234	2.063
7	0.052	0.049	0.271	0.334	0.768	0.143	0.745	1.245	2.074
8	0.050	0.045	0.278	0.347	0.793	0.144	0.781	1.296	2.115
9	0.049	0.042	0.284	0.358	0.814	0.145	0.810	1.341	2.147
10	0.048	0.039	0.291	0.371	0.838	0.149	0.839	1.402	2.186
11	0.047	0.037	0.298	0.382	0.864	0.152	0.863	1.455	2.217
12	0.047	0.036	0.306	0.396	0.899	0.157	0.898	1.525	2.259
13	0.048	0.036	0.316	0.413	0.940	0.164	0.938	1.607	2.310
14	0.049	0.036	0.324	0.427	0.971	0.169	0.969	1.668	2.350

IRI = international roughness index, km = kilometer.
Source: ECIL and Asian Development Bank estimates.

18. Savings in travel time costs will result from increases in vehicle speed because of the improved riding surface and wider road width, which will make passing easier. Average speeds are calculated in the calibrated HDM model produced by ECIL. Average speeds in the opening year (2018) for a typical road section (Thul bypass) were 58 km/hour with the minimum improvements and 78 km/hour with reconstruction. The rule of a half[6] has been applied to benefits from generated trips (i.e., VOC and time savings). Changes to accident costs resulting from the upgrading of the carriageway, which currently varies between 5.5 m and 7.3 m, to a consistent 7.3 m have not been included in the economic analysis because data is lacking. The value of business travel time adopted was based on recently released average wage data for Pakistan.[7] The value of nonworking time was taken as 30% of the value of working time. The economic analysis used an average value of time of Rs90 per hour for work travel and Rs27 per hour for non-work travel in 2013 prices. Average vehicle occupancy was derived from ECIL estimates of 2 persons per motorcycle, 2.5 occupants for cars, and 10 for buses and minibuses. As the VOC unit rates used include a crew cost component, the time savings calculation did not include any savings in terms of vehicle crew, as this would represent double-counting. Of all occupants including crew of cars, light vehicles, and buses, 25% were assumed to be in

(increasing in line with real GDP growth). Shadow Wage Rate Factor: 0.85 (unskilled labor). Shadow Exchange Rate Factor: 1.04. Conversion Factor applied to Supervision: 1.0. Conversion Factor applied to taxes, duties, profits, transfers: 0.0.

[6] A standard assumption in cost benefit analysis of transport projects that the demand function is linear in the relevant region of generalized costs. Net benefits to travelers are estimated as the generalized consumer surplus from the change in generalized costs on all travel movements.

[7] Pakistan Bureau of Statistics. 2014. *Labor Force Survey 2012–2013 (Annual Report)*. Islamabad.

business time. No passengers were assumed for commercial vehicles. While trucks and tractors frequently carry farm workers during the harvest season, the opportunity cost of any time saved is expected to be small.

E. Results of Economic Analysis

19. An economic assessment of the project was carried out by comparing the incremental benefits derived from reductions in VOC and travel times resulting from the project's construction against the initial investment costs and changes in operation and maintenance costs over the 23-year appraisal period (3 years of construction and 20 years of operation).

Table 5: Results of Economic Analysis
(2014 prices, $ million, domestic price numeraire)

	Benefit-to-Cost Ratio	NPV (2014 $ million)	EIRR (%)
Project	1.48:1	76.6	15.7
Kandhkot–Jacobabad–Ratodero	1.09:1	2.6	12.8
Khyber–Sanghar–Mirphurkhas	1.57:1	38.0	16.3
TM Khan–Badin	2.09:1	32.4	19.3
Mirwah–Naukot	1.10:1	3.5	12.9

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

20. Table 5 shows the results of the economic analysis covering the full length of the project. The results are expressed in terms of the benefit-to-cost ratio, economic internal rate of return (EIRR), and net present value (NPV) at a 12% discount rate. The results of the economic analysis are presented in the domestic price numeraire. The results indicate that the project is economically viable. The EIRR on the proposed project is 15.7% and the benefit-to-cost ratio is 1.48:1. Table 6 shows the stream of costs and benefits over time.

Table 6: Benefit and Cost Streams (2014 prices, $ million, domestic prices)

Year	Capital Costs	Maintenance Costs	VOC Savings	VOT Savings	Generated Traffic	Net Benefit
2015	0.0	0.0	0.0	0.0	0.0	0.0
2016	58.9	0.0	0.0	0.0	0.0	(58.9)
2017	76.0	0.0	0.0	0.0	0.0	(76.0)
2018	44.6	0.0	0.0	0.0	0.0	(44.6)
2019	20.0	0.5	8.0	3.1	0.2	(9.2)
2020	0.0	0.5	9.0	3.4	0.2	12.1
2021	0.0	0.5	10.3	3.9	0.2	13.9
2022	0.0	0.5	12.1	4.5	0.3	16.4
2023	0.0	0.5	14.5	5.3	0.3	19.6
2024	0.0	0.5	17.6	6.5	0.4	24.0
2025	0.0	0.5	22.0	8.0	0.5	30.0
2026	0.0	0.5	27.8	10.2	0.6	38.1
2027	0.0	2.0	35.7	13.1	0.7	47.5
2028	0.0	2.1	45.6	16.6	0.8	60.9
2029	0.0	0.8	55.0	19.9	1.0	75.1
2030	0.0	0.5	63.1	22.7	1.2	86.5
2031	0.0	0.5	71.8	25.4	1.4	98.1
2032	0.0	0.5	80.3	28.1	1.6	109.5
2033	0.0	0.5	87.8	30.6	1.8	119.7
2034	0.0	0.5	93.4	32.4	1.9	127.2
2035	0.0	0.5	97.4	33.9	2.0	132.8
2036	22.7	0.9	97.9	35.3	2.1	111.7
2037	0.0	1.1	100.6	36.7	2.1	138.3
2038	(42.5)	1.1	103.3	39.1	2.1	185.9
					EIRR	15.7%
					NPV	76.6

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

21. Sensitivity tests and calculations of switching values were carried out to determine the effect on the key economic indicators of variations in key input parameters. Table 7 shows a switching value of +48.6% with respect to construction costs, meaning that construction costs could increase by up to 48.6% in real terms and the project would still be economically efficient. Similarly vehicle operating costs savings were reduced by less than 44.1%, the project would still be considered economically effective.

Table 7: Results of Sensitivity Analysis
(2014 prices, $ million, domestic price numeraire)

Scenario	Benefit-to-Cost Ratio	NPV ($ million)	EIRR (%)	Switching Value (%)
Base	1.48:1	76.6	15.7	
Construction Cost + 20%	1.23:1	45.1	13.9	+48.6
Vehicle Operating Cost Savings – 20%	1.26:1	41.8	14.1	(44.1)
Delay by 1 year	1.43:1	69.4	15.3	

( ) = negative, EIRR = economic internal rate of return, GDP = gross domestic product, NPV = net present value.
Source: Asian Development Bank estimates.

22. In summary, the economic analysis was undertaken in line with the 1997 ADB Guidelines for Economic Analysis of Projects. As the project yields an EIRR above the 12% threshold, it is considered economically viable.

F. Results of Financial Analysis

23. Road investment is mainly funded through annual allocations from the state's Annual Development Program. The Sindh provincial budget allocation has historically been insufficient for the timely and necessary expansion of road capacity and maintenance of existing road infrastructure. It is therefore proposed that maintenance be funded through tolls on cars, vans, trucks, tractors, and trailers on two of the project roads: Khyber–Sanghar and TM Khan–Badin.

24. Over the life of the project, annual toll revenue is estimated at PRs135 million compared with the cost of operating and maintaining the road, plus associated toll equipment, of PRs192 million per year. The initial toll rates are expected to be about PRs0.85/km for cars. Therefore, toll revenue over the life of the project would be insufficient to pay back the investment costs (for the road and toll plazas). However, the net revenue generated by the project will increase the funding available to the Sindh government for maintenance activities and will help make maintenance of the project roads more sustainable.