ECONOMIC AND FINANCIAL ANALYSIS

A. General

1. Roads are the main mode of transport in Pakistan, accounting for 96% of all inland freight and 92% 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 remainder is classified as either provincial highways or local roads. The motorway and highway network comprises less than 5% of the total road length but caters to about 80% of total traffic. Despite the high levels of reliance on road transport, the quality of the infrastructure is still cause for concern. Although national highways have attracted considerable investments since 2005, they need further improvement—only 7% are in good condition and 26% are in poor or very poor condition.[2]

2. Pakistan is strategically located between the Arabian Sea and landlocked Afghanistan, Central Asia, and the province of Xinjiang in the People's Republic of China (PRC). Pakistan provides the shortest route to seaports for these locations, so it should be strategically positioned to benefit from this. However, various factors such as security and the state of the existing transport infrastructure have prevented Pakistan from maximizing the benefits of its geographical location. Nonetheless, trade should increase if the physical transport infrastructure improves.

3. The main domestic transport corridor is along a north–south axis, between the port city of Karachi in the south and the northern cities of Lahore, Faisalabad, Islamabad, and Peshawar, via Multan and Pindi Bhattian. The traffic between Multan and Pindi Bhattian can either (i) travel about 430 km via Lahore on the national highway N-5 and the motorway M-2; or (ii) travel about 280 km on the two-lane provincial road network, e.g., via Kabirwala, Shorkot, Jhang, and Chiniot.

4. A 52 km motorway link, the M-3, exists between Pindi Bhattian and Faisalabad. The M-4 motorway which connects Faisalabad with Multan will, when completed, provide a more direct route for traffic traveling from southern Pakistan to Islamabad, Peshawar, Afghanistan, or the PRC, and will form part of the Central Asia Regional Economic Cooperation (CAREC) corridor. The rationale for the project includes reducing the cost of national and international trade, improving connectivity for local traffic, reducing accident rates, relieving congestion, and improving economic competitiveness.

5. The completed M-4 motorway will have four sections: (i) section 1 Faisalabad–Gojra (58 km), (ii) section 2 Gojra–Shorkot (62 km), (iii) section 3 Shorkot–Khanewal (64 km), and (iv) section 4 Khanewal–Multan (57 km).

6. Section 1 was opened to traffic in March 2015 and section 4 in December 2015. Works on section 2 have started, financed by the National Motorway M-4 Gojra–Shorkot Section Project approved by the Asian Development Bank (ADB) in September 2015.[3] The Government

[1] Government of Pakistan, Ministry of Finance. 2014. *Pakistan Economic Survey 2013–14*. Islamabad.
[2] Data provided by the National Highway Authority (NHA) based on its road asset management system.
[3] Asian Development Bank (ADB). 2015. Report and Recommendation of the President to the Board of Directors: *Proposed Loan and Administration of Grant to the Islamic Republic of Pakistan for the National Motorway M-4 Gojra–Shorkot Section Project*. Manila.

of Pakistan has requested ADB to finance section 3 in 2016 as additional finance to this project, and advance procurement of civil works started in the fourth quarter of 2015. Since the traffic flow on sections 2 and 3 is contingent on the completion of both sections, which will complete a motorway link between Islamabad and Multan, this economic analysis is for sections 2 and 3 combined to assess the overall economic rationale for the completion of the M-4 corridor. The analysis is based on that conducted as part of preparing the original National Motorway M-4 Gojra–Shorkot Section Project, with updates to economic costs reflecting actual contract values for section 2 and applying similar unit costs to section 3. All other aspects of the economic analysis remain the same.

7. The without-project scenario consists of sections 1 and 4 being completed, with traffic from Multan to Pindi Bhattian split between (i) the N-5 and the M-2 (via Lahore), (ii) the provincial road network between Multan and Pindi Bhattian, and (iii) the M-3 and sections 1 and 4 of the M-4 (with traffic diverting to the local road network between Gojra and Khanewal).

8. The existing N-5 between Lahore and Multan is a four-lane road which has become highly urbanized over time. Annual average daily traffic varies by section but averages more than 14,000 vehicles per day. The traffic mix is varied, comprising cars, assorted types of trucks, three-wheel cabs, buffalo-drawn carts, motorcycles, and pedestrians. The extent of urbanization, combined with the lack of development control and unregulated traffic composition, creates obvious road safety problems and low transport efficiency. Many vehicles traveling between Multan and Pindi Bhattian currently use the provincial road network, e.g., Multan–Kabirwala–Shorkot–Jhang–Chiniot–Pindi Bhattian. These roads are generally paved two-lane roads, with lane widths of 3.65 meters (m) and hard shoulders of 1.00–2.00 m. They are relatively urbanized and have at-grade access from local dwellings and businesses throughout. Upon opening of the M-4 sections Faisalabad–Gojra and Multan–Khanewal, a proportion of this traffic will divert to the M-4 and use the provincial road network only from Khanewal to Gojra.

9. The with-project scenario involves completion of the M-4 to provide a continuous motorway-standard link between Multan and Pindi Bhattian. This means building a four-lane motorway with lane widths of 3.65 m and a design speed of 120 km/hour. The traffic will be segregated with a median barrier dividing opposing flows. Development will be limited with entry and exit points restricted to designated junctions. This will markedly reduce the potential for conflict, which is the cause of a high proportion of road collisions. The average speed should exceed 90 km/hour in the opening year. The road will lower the cost of transport within the area in question. The with-project scenario will yield the following benefits: (i) shortened journey time and lower vehicle trip costs for passenger movements between southern and northern Pakistan; (ii) lower cost for movement of goods, benefiting both local businesses and also international trade along the CAREC corridor, and associated improvements in competitiveness for businesses in the area; (iii) improved safety through provision of a higher-quality segregated road, resulting in fewer collisions and associated fatalities and injuries; (iv) higher quality of life in bypassed urban areas, with residents experiencing fewer negative externalities (e.g., less noise, better health outcomes from lower exposure to nitrogen oxides and other harmful emissions associated with road traffic); and (v) lower costs of congestion.

B. Traffic Studies

10. A strategic traffic assignment model was created to assess the likely demand on the completed full-length M-4. The traffic model was built using the traffic assignment package SATURN. It consists of 214 internal zones covering all of Pakistan and four external zones, and

includes 14 vehicle categories. The model is based on an average hour between 7 a.m. and 7 p.m. during a typical weekday. Four years were modeled (i.e., 2015, 2020, 2025, and 2030). The highway network was developed using MapInfo geographic software. The modeling considers the impact that imposition of tolls has on the demand for each tolled road.

11. Available origin and destination surveys, traffic counts, and travel time surveys—mainly from 2014 or 2015—were used in calibrating and validating the model in accordance with standard international practice. The modeling includes consideration of traffic generation, and the likely future increases in traffic from the PRC to major cities in Pakistan and onward to the ports of Gwadar and Karachi. Table 1 shows the forecast demand on the M-4 once the last section opens.

Table 1: Estimated Annual Daily Traffic on M-4, 2020
(passenger car units)

Section	Annual Daily Traffic
M-4 Gojra–Shorkot (section 2)	7,915
M-4 Shorkot–Khanewal (section 3)	10,322

Source: J M Duggan Consulting's traffic study report, Asian Development Bank estimates.

12. Gross domestic product (GDP) growth in Pakistan averaged 4.3% during 2005–2015.[4] Forecasts of GDP growth for 2016–2020 have been sourced from the International Monetary Fund, and range from 4.5% in 2016 to 5.2% in 2020. A GDP growth rate of 4% has been assumed after 2020 based on recent growth trends.

13. Traffic forecasts were made for the 20-year period from 2020 to 2039. Table 2 shows the demand forecast along the two ADB sections of the M-4. The forecasts are based on general traffic growth calculated using historic relationships between vehicle registrations and GDP, generated traffic based on elasticity of demand with respect to the generalized cost of about –1.3 on average (meaning that a 1.0% reduction in costs is associated with a 1.3% increase in the number of trips), and, for traffic demand to and from the PRC, an increased growth rate ranging from 15% in 2015 to 5% in 2039 because of the anticipated increase in trade along the PRC–Pakistan economic corridor. The forecasts predict traffic to increase steadily over the appraisal period, driven by an increasing transfer of traffic from congested parallel corridors.

Table 2: Forecast Annual Daily Traffic on M-4, 2020–2035
(passenger car units)

Section	2020	2025	2035
M-4 Gojra–Shorkot (section 2)	7,915	11,225	23,333
M-4 Shorkot–Khanewal (section 3)	10,322	14,426	28,392

Source: J M Duggan Consulting's traffic study report, Asian Development Bank estimates.

C. Economic Costs

14. The economic costs of the project (i.e., the completion of sections 2 and 3) comprise (i) capital investment, which includes civil works, land acquisition and resettlement, as well as consulting services for construction supervision and social safeguard management; and (ii) road maintenance. Costs related to taxes, duties, and financing charges during implementation have

[4] International Monetary Fund. World Economic Outlook database. http://www.imf.org/external/data.htm (accessed on 4 April 2016).

been excluded. Table 3 gives a breakdown of the investment costs for sections 2 and 3, based on actual contractual values achieved for the Gojra–Shorkot section currently under construction. The overall unit cost amounts to about PRs0.31 billion/km for civil works, equivalent to $3.0 million/km.

Table 3: Financial Cost Estimate for M-4 Sections 2 and 3
(PRs billion, 2015 prices)

Item	M-4 Gojra–Shorkot*	M-4 Shorkot–Khanewal
Land acquisition and resettlement	1.1	2.2
Civil works	17.2	22.1
Consulting services	0.5	0.0
Taxes	2.5	3.1
Physical contingencies	1.0	1.2
Price contingencies	8.5	3.7

*Financial cost has been updated accordingly after all civil works contracts for the Gojra–Shorkot section were awarded.
Sources: National Highway Authority and Asian Development Bank estimates.

15. Financial costs were converted to economic costs in line with ADB guidelines.[5] The economic analysis was undertaken in domestic prices. A distinction was made between traded and nontraded goods, and a shadow exchange rate factor of 1.039 was applied to traded goods. A shadow wage rate factor of 0.85 was estimated and applied to vehicle operators and unskilled labor. Resettlement costs included some transfer payments and these have been excluded in line with ADB guidelines. Land prices were based on Bureau of Revenue unit rates, calculated from (i) net revenue derived from agricultural income (for particular crops), (ii) market values from recent transactions, and (iii) minimum prices set for various land types. Unit rates based solely on net revenue from agricultural income were requested but not made available. Therefore, an assumption was made relating to the ratio of Bureau of Revenue unit rates to net revenue derived from agricultural income. As the economic analysis was undertaken in 2015 prices, it excluded price contingencies—in effect applying a conversion factor of zero to this expenditure category—but included physical contingencies. A residual value equivalent to 20% of the investment cost—estimated by applying the straight-line depreciation method to individual project items based on assumed life-spans—has been included in the economic analysis.

16. Unit rates for maintenance of sections 2 and 3 of the M-4 of PRs14.19 million per km for functional overlay and PRs23.80 million for structural overlay, as well as unit rates for regular maintenance (i.e., patching, crack sealing, vegetation cut, and side-drain cleaning) were sourced from the operation and maintenance (O&M) division of the National Highway Authority (NHA) based on expenditures on similar types of roads.

D. Economic Benefits

17. **Vehicle operating costs**. Savings in vehicle operating costs (VOCs) accrue from better traffic conditions and a higher level of service on the new M-4 compared with the congested traffic conditions on the existing N-5 and the provincial road network. Unit rates for VOC per km by international roughness index (IRI) value have been provided by the NHA based on calibrated HDM-4 model outputs.[6] The IRI values for the new motorway network and local road

[5] ADB. 1997. *Guidelines for the Economic Analysis of Projects.* Manila.
[6] HDM-4 is a software package and associated documentation which serves as a tool for the analysis, planning, management, and appraisal of road maintenance interventions and investment decisions.

network between Pindi Bhattian and Multan are forecast to average 3 (new motorway) and 7 (local road network) over the appraisal period. The VOC unit rates used in the economic analysis are in Table 4.

18. Savings in travel time costs will result from higher permissible vehicle speeds, better alignment, increased level of service, and easier overtaking conditions. Average speeds are calculated by the traffic model by applying speed flow formulae that link average speeds to road type and volumes on roads. Travel times are also affected by changes in trip length as trips that are currently made on parallel corridors divert to the new M-4.

Table 4: Vehicle Operating Cost Rate Applied
(PRs per kilometer, 2015 economic prices)

Vehicle Type	Very Good (IRI=2)	Good (IRI=3)	Fair (IRI=4)	Poor (IRI=8)	Very Poor (IRI=12)
Car, medium size	14.2	14.3	14.6	15.6	17.5
Goods vehicle	16.9	17.0	17.4	18.4	20.1
Bus, light	19.7	19.9	20.4	22.1	24.3
Bus, medium	37.1	37.4	39.3	47.6	56.2
Bus, heavy	55.0	55.6	58.3	69.6	82.4
Truck, light	56.6	57.1	59.4	71.3	83.8
Truck, medium	82.9	83.5	86.9	104.4	122.7
Truck, heavy	98.1	99.1	103.5	123.0	144.6
Truck, articulated	129.8	131.3	136.7	156.9	179.4

IRI = international roughness index.
Source: National Highway Authority, Asian Development Bank estimates.

19. Time savings were calculated based on traffic model forecasts of time and distance between each origin–destination pair in the without- and with-project scenarios, applying the "rule-of-half" to generated trips. The value of business travel time adopted was based on recently released average wage data for Pakistan, and adjusted to consider differences in income levels between car users and bus passengers.[7] The value of nonworking time was taken as 40% of the value of working time. The economic analysis used an in-work value of time for 2015 of PRs248 per hour for car travel and of PRs83 per hour for bus travel (after applying the shadow wage rate). The value of time increases in line with changes in forecast real GDP per capita. Average vehicle occupancy was derived from NHA estimates of 2.5 persons per car or light vehicle, 20.0 persons per small bus, and 45.0 persons per large bus. As the VOC unit rates shown above include a crew cost component, the time savings calculation did not include any savings in terms of goods vehicle crew, as this would represent double counting. Twenty-five percent of all occupants (including crew) of cars, light vehicles, and buses were assumed to be on business time.

20. Savings in accident costs after upgrading the carriageway from a two-lane road to a four-lane dual carriageway were not included in the economic analysis because of insufficient data. The calculated economic return on sections 2 and 3 of the M-4 therefore is considered to be a conservative estimate.

E. Results of Economic Analysis

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

21. An economic assessment of the project has been carried out using the standard appraisal methodology that compares the incremental benefits derived from reductions in VOCs and travel times resulting from the construction of sections 2 and 3 of the M-4, against the initial investment costs and required O&M costs over the 20-year appraisal period. The results of the economic analysis are shown in Table 5, expressed as the key economic indicators of benefit–cost ratio, economic internal rate of return (EIRR), and net present value (NPV) at a 12% discount rate. The results are presented in the domestic price numeraire. The results indicate that the project is economically viable. The EIRR for the completed M-4 corridor is 13.6% and the NPV is PRs 4,871 million. The economic indicators are considered to be conservative estimates as the impact on road safety has not been monetized because of lack of data. Table 6 shows the stream of costs and benefits over time.

22. Sensitivity tests and calculations of switching values were carried out to determine the effect of variations in key input parameters on the key economic indicators, as well as the effect of deferred maintenance. Table 7 shows a switching value of 15.0% with respect to construction costs, meaning that if construction costs were to increase in real terms, the project would still be economically efficient if such escalation is limited to 15.0%. A scenario with no periodic maintenance, resulting in (i) reduction of the residual value to 10% of investment costs, (ii) shortening of the operational life of the road to 15 years, and (iii) 5% reduction in benefits year on year after 2030, reduces the EIRR to 10.8%, highlighting the importance of maintenance. In summary, the economic analysis was undertaken in line with ADB guidelines (footnote 4). The project yields an EIRR above 12% and is therefore economically viable.

Table 5: Result of the Economic Analysis
(2015 domestic prices)

	Benefit–Cost Ratio	**NPV** (PRs million)	**EIRR** (%)
M-4 (sections 2 and 3)	1.15:1	4,871	13.6

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

Table 6: Benefit and Cost Streams
(2015 domestic prices, PRs million)

Year	**Capital Costs**	**Maintenance Costs**	**VOT Savings**	**VOC Savings**
2015	891	0	0	0
2016	5,757	0	0	0
2017	12,209	0	0	0
2018	18,237	0	0	0
2019	6,573	0	734	2,544
2020	0	9	829	2,338
2021	0	9	1,056	2,970
2022	0	9	1,292	3,610
2023	0	9	1,538	4,259
2024	0	9	1,794	4,917
2025	0	9	2,061	5,583
2026	0	9	2,332	5,848
2027	0	9	2,613	6,116
2028	0	9	2,906	6,388
2029	0	9	3,210	6,663
2030	0	1,514	3,536	6,949
2031	0	9	3,877	7,239
2032	0	9	4,232	7,534
2033	0	9	4,602	7,834

2034	0	9	4,988	8,139
2035	0	9	5,390	8,450
2036	0	2,157	5,523	8,520
2037	0	9	5,659	8,593
2038	(8,734)	9	5,798	8,667
			EIRR	13.6%
			NPV	4,871

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

Table 7: Result of the Sensitivity Analysis
(2015 domestic prices)

Scenario	Benefit–Cost Ratio	NPV (PRs million)	EIRR (%)	Switching Value (%)
Base case	1.15:1	4,871	13.6	
Construction cost +10%	1.05:1	1,643.2	12.5	15.0
Vehicle operating cost savings –10%	1.07:1	2,274.0	12.7	(18.9)
Value of time benefits –10%	1.11:1	3,702.0	13.2	(41.8)
Delay of benefits by 1 year	1.09:1	2,788.0	12.9	
Severe lack of maintenance funds	0.91:1	(2,845.0)	10.8	

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

F. Results of Financial Analysis

23. Road investment is mainly funded through annual allocation from the federal Public Sector Development Program. The federal budget allocation has historically not been sufficient to allow for timely road capacity expansion and quality maintenance of existing road infrastructure. In 2003, the government established a dedicated road maintenance fund financed by toll revenue from the motorways and national highways, federal grants, and other road revenues. As a result, the NHA[8] has access to more stable funding for maintaining the national road network, which allows for more effective maintenance planning. Total maintenance expenditure increased from PRs10.1 billion in fiscal year (FY)2008 to PRs18.4 billion in FY2014. However, resources generated by the road maintenance fund are chronically short (about 40%–50%) of the unconstrained demand to maintain the roads at established quality levels.[9] Increasing toll rates (above the rate of inflation) or building more toll-based motorways and transforming existing national highways into toll-based ones with some

[8] When the NHA was established in 1991 by the NHA Act, it was positioned as a financially self-sustaining entity, while its highway development works are mainly financed by the fiscal budget through the federal Public Sector Development Program. The NHA's toll revenue accounts for only 20% of its total development expenditure and is earmarked only for road maintenance and operation. Despite this clarity that national highway development works are in a public domain and financed by the federal fiscal budget, the NHA Act requires the federal fiscal budget allocated to the NHA for national highway development to be transferred in the form of a loan. As a consequence, the balance sheet of the NHA shows huge debts to the federal government. The government and the NHA are pursuing an amendment of the NHA Act and equitization of accumulated debts in the NHA's balance sheet.

[9] The NHA is currently calculating the unconstrained road maintenance needs mainly based on the assumption of targeting average international roughness index (IRI) values (e.g., 4 m/km) for its entire national highway network. Some of the national highways with high IRI values (about 10 m/km or above) are no longer maintainable. Those roads should be prioritized for capital investment projects rather than maintenance needs. Examples of such roads are the recently approved Pakistan: Post-Flood National Highways Rehabilitation Project funded by ADB. The NHA continues to tackle those roads in disrepair separately and, with continuous growth of toll revenues, it is expected the shortfall between the actual maintenance funds and the unconstrained needs will be much smaller by 2020.

improvement would help ensure sufficient funds to adequately maintain the entire road network, but this could only be pursued from a mid- to long-term perspective.

24. The road maintenance fund—a pool of toll revenues, penalties, and other funds provided by the government and established in 2003 through the Road Maintenance Account Rules—is earmarked to finance the O&M of the entire national highway network. Additional financial analysis was carried out for the Shorkot–Khanewal part of the M-4 motorway and includes toll revenues after project completion. Over the project life-span, the forecast toll revenue will be sufficient to cover the O&M of the project road and to contribute an additional 2.5% to the NHA's annual O&M budget. In line with the annual maintenance plan generated by the road asset management system, the M-4 motorway is a top priority in the allocation of O&M funds. The NHA committed to strengthening its financial performance on the national highway network by rationalizing its toll rates (the current tariff of about PRs1.24 per passenger car per km is considered one of the lowest globally), and planning and implementing more toll-based projects.

G. List of Parameter Values and Assumptions

(i) price base year: 2015;
(ii) discount year: 2015;
(iii) currency of analysis: Pakistan rupees;
(iv) construction start year: 2015;
(v) construction end year: 2019;
(vi) first year of benefits: 2019;
(vii) appraisal period: 20 years;
(viii) numeraire used: domestic price numeraire;
(ix) value of time car travel (in work, 2015): PRs248.8/hour (increasing with real GDP growth);
(x) value of time bus travel (in work, 2015): PRs82.9/hour (increasing with real GDP growth);
(xi) nonwork time valued at 40% of in-work time (for car users and bus passengers);
(xii) GDP growth assumption: sourced from International Monetary Fund (2011–2018), 4.0% (2018 onward, ADB estimate);
(xiii) shadow wage rate factor: 0.85;
(xiv) shadow exchange rate factor: 1.039;
(xv) conversion factor applied to supervision: 1.0; and
(xvi) conversion factor applied to taxes, duties, profits, transfers: 0.0.