ECONOMIC ANALYSIS

A. Introduction

1. Project

1. The Padma bridge will provide a vital link in the national road network of Bangladesh, particularly for the southwest zone of the country. The bridge will support development in an area that has been poorly served by the road network.

2. The bridge will save significant travel time between Dhaka Division and the southwest of Bangladesh and possibly on to India. Travel time savings are expected to be about 2 hours for cars and buses and over 10 hours for trucks. The Padma bridge will sharply lower transport costs and bring significant economic structural change to the southwest zone. Changes in the relative prices of factors in production, goods, and services will encourage the relocation of economic activities, generation of new activities, and changes in how current economic activities are pursued.

3. As with the Jamuna bridge, positive impacts are expected on poverty alleviation in the southwest zone, particularly in Khulna and Barisal divisions, with increased economic activity and consumption expenditure after the opening of the Padma bridge.

2. Approach

4. Building on earlier project preparation studies conducted by aid agencies,[1] the current economic evaluation updates (i) project cost estimates and the expenditure profile; (ii) traffic forecast; (iii) the values of the road user parameters (unit vehicle operating costs and unit time costs for passengers and freight); (iv) the values of parameters determining non-road user benefits (capitalized value of service area land, river crossing construction cost savings for utilities, and bridge structure usage fee revenue); and (v) the method of measuring savings in ferry waiting time and freight deterioration costs due to the different traffic modeling approach adopted in this study.

B. Cost

5. Project cost estimates for capital expenditure used in the economic evaluation are based on the estimates of financial prices including physical contingencies but excluding price contingencies (the economic evaluation used constant 2009 prices) and duties and taxes, as these are transfer payments from contractors to the government and not resource costs. A standard conversion factor of 0.9 is used for converting the financial costs into the economic costs. The project cost estimate used for the economic evaluation is $1,884 million.

6. Annual operation and maintenance expenditures were included in the economic evaluation at 1.25% of the cost estimates for the main bridge and river training works, including physical contingencies, in the first 5 years of operation and at 0.75% thereafter.

[1] Japan International Cooperation Agency. 2005. *The Feasibility Study of the Padma Bridge*. Tokyo; ADB. 2005. *Technical Assistance to the People's Republic of Bangladesh for Preparing the Padma Multipurpose Bridge Project.* Manila.

C. Traffic Forecast

7. Using detailed information on socioeconomic conditions and travel patterns, a transport model was developed to forecast traffic volumes for the Padma bridge. The basic steps involved in the transport modeling are to (i) build the base and future year networks; (ii) determine base year river crossing demand using an origin–destination survey undertaken in May 2009 and calibrate it to current conditions of road traffic; (iii) determine growth in future demand by forecasting growth in car ownership and changes in socio-demographics, including population and employment; (iv) calculate, based on the relative costs of each mode, how mode choice may change for future year demand; (v) assess freight movements; and (vi) assign motorized traffic to a representation of the road network.

8. Reduced travel cost and improved accessibility will induce additional traffic demand in future years. For passenger traffic, an elasticity of 1.0 was assumed.[2] For freight traffic, an elasticity of 0.55 was derived by estimating the impact of improved accessibility on regional economic output, and then the impact of a change in regional economic output on truck travel. [3]

9. Traffic forecasts from model runs with different traffic demand scenarios and assumptions are in Table 1. The "with bridge" scenarios resulted in high traffic volumes in the opening year, taking account of significant traffic diversion from the existing ferry crossings, and additional traffic from induced demand that had been suppressed due to lack of travel opportunities across the Padma River.[4] While the transport model produces a forecast assuming travelers have "perfect knowledge" of the traffic conditions and induced demand instantly results in additional trips, adjustments in travelers' behavior to new travel conditions normally take place gradually over a period of time. For economic evaluation purposes, a scenario that assumes gradual rise in induced demand in the first 10 years of bridge opening has been adopted as the base case.

Table 1: Traffic Forecast for Economic Evaluation
(annual average daily traffic)

Year	Without Bridge	With Bridge		Base Case[b]
		Without Induced Demand[a]	With Induced Demand	
2014	2,394	7,835	11,683	7,835
2020	3,413	11,273	22,240	20,491
2024	4,093	13,566	29,278	28,928
2034	6,748	22,590	48,691	48,691
2044	9,510	31,980	68,307	68,307

[a] Forecast traffic for the Padma bridge that assumes no additional trips generated from induced demand and the origin-destination patterns remain unchanged.

[b] Traffic used as base case in the economic evaluation, which assumes a gradual rise in induced demand. The traffic volume at bridge opening year takes the value of traffic without induced demand, and will later gradually rise to the level of traffic with induced demand.

Source: Design Consultant.

[2] This means a 10% decrease in the cost of travel will result in a 10% increase in traffic.

[3] The JICA feasibility study developed an econometric model, from which an elasticity of 0.55 was derived for district economic output with respect to district travel time to/from Dhaka. This means a 10% decrease in travel time to/from Dhaka will lead to a 5.5% increase in district economic output. An elasticity value of around 1.0 was estimated for truck travel across the Padma River with respect to nominal gross domestic product (GDP), from historic data on GDP growth and truck traffic growth. The elasticity of induced truck traffic with respect to travel cost is 0.55 (= 0.55 x 1.0), using travel time to/from Dhaka as an indicator of the generalized costs of truck traffic.

[4] Due to significant reduction in travel time and cost, approximately 80% of the traffic across the Padma River at the Paturia ferry crossing (located 60 km upstream of the Padma bridge site at Mawa) is estimated to divert to the Padma bridge, in addition to the traffic diversion from the Mawa ferry crossing.

10. Historically, river crossing traffic across the Padma River has been growing between 10 - 15% per year. Should this continue, traffic at Mawa ferry crossing would be approximately 3,000 annual average daily traffic (AADT) by 2014 and traffic at Paturia would be 7,000 AADT. Assuming a 70% diversion rate from Paturia, estimated Padma bridge traffic would be around 8,000 AADT in 2014. This compares favorably with the opening year traffic of 7,800 AADT derived from the model run.

11. Table 2 presents the travel time savings likely to be experienced by users of the Padma Bridge for a selection of typical trips from Dhaka at bridge opening in 2014. These travel time savings include savings in wait time at ferry landing points. Travel time for ferry routes in Table 2 includes ferry wait time weighted by vehicle classes, which currently ranges from 2 hours for cars to 5-10 hours for trucks. Due to long ferry wait, it is expected that a large number of traffic will be diverted from the existing ferry services to the Padma bridge.

Table 2: Travel Time and Distance Savings

Destination	Paturia Ferry Route	Mawa Ferry Route	Padma Bridge Route	Savings from Paturia Ferry	Savings from Mawa Ferry
Khulna					
Time	7 hr 50 min	12 hr 45 min	3 hr 30 min	4 hr 20 min	9 hr 15 min
Distance	240 km	170 km	170 km	70 km	-
Jessore					
Time	7 hr 00 min	12 hr 55 min	3 hr 20 min	3 hr 40 min	9 hr 35 min
Distance	210 km	160 km	160 km	50 km	

Source: Design Consultant.

D. Benefits

12. The quantified benefits of the bridge investment are measured incrementally to the without-bridge case, i.e., they are measured as the difference between the without-project and the with-project cases. The economic analysis considers (i) benefits arising from annual savings in vehicle operating cost (VOC) and travel time to existing passengers and freight crossing the Padma River, and (ii) benefits accruing to new trips generated by induced demand. Other types of benefits include the (i) savings in costs associated with operation of the ferry services, (ii) capitalized value of service area land, (iii) capitalized value of agricultural land to be reclaimed or protected by river training works, and (iv) revenue from bridge structure usage fees levied on utilities.

13. VOC is used to place an economic value on cost savings, incorporating various factors: fuel, tires, and maintenance, etc. For the economic evaluation, unit VOC was derived from the Road User Cost Annual Report, 2004–2005.[5] Total VOC was disaggregated into fuel and nonfuel components, which were then escalated to 2009 values by the increase in average petroleum spot price[6] and the consumer price index[7]. The VOC for the different vehicle classes was then weighted using the vehicle proportions observed during a traffic survey in May 2009 to determine VOC for trucks, buses, and light vehicles.

[5] Government of Bangladesh. 2005. *Road User Cost Annual Report, 2004–2005.* Roads and Highways Department, Ministry of Communications. Dhaka.

[6] International Monetary Fund. 2009. *Indices of Primary Commodity Prices,* 1999-2009. Washington D. C.

[7] Government of Bangladesh, 2009. *Consumer Price Index and Inflation September 2009.* Bangladesh Bureau of Statistics. Dhaka.

14. A measure of value of time is used to convert travel time savings into a monetary value. Travel time costs for passengers and crew were sourced from the Roads and Highways Department (footnote 2) and for freight in transit from an ADB technical assistance report.[8] These were then adjusted to 2009 prices by estimating the increase in general wage rate index using data sourced from the Bangladesh Bureau of Statistics (footnote 3) and ADB.[9]

Table 3: Benefits Used in Updated Economic Evaluation

Benefit	Measure
Savings in vehicle operating costs (VOC)	(Vehicle-kilometers traveled [VKT] without bridge – VKT with bridge) × Unit VOC
Savings in travel time costs (TTC)	(Vehicle-hours traveled [VHT] without bridge – VHT with bridge) × Unit TTC
Savings in ferry operating costs	2009 tariff revenue × annual traffic growth rate without bridge
Capitalized value of agricultural land to be reclaimed or protected by the river training works	Affected land area × 2009 value of land for paddy and highland uses × annual rental return at 18%, capitalized over 30 years at the economic opportunity cost of capital (EOCC) less allowance for 3% per annum real increase in land values
Capitalized value of service area land	Service area × 2009 land value × annual rental return at 18%, capitalized over 30 years at EOCC less allowance for 3% per annum real increase in land values
Savings in utilities' river crossing cost	Power and telecoms cost saving compared with construction of independent crossing; gas based on route distance saving of 30 kilometers

EOCC = opportunity cost of capital, TTC = travel time costs, VHT = Vehicle-hours traveled, VKT = Vehicle-kilometers traveled, VOC = vehicle operating costs.
Source: Design Consultant.

E. Economic Internal Rate of Return and Sensitivity Analysis

15. The benefit–cost analysis was undertaken over a 30-year period following the opening of the bridge. A real discount rate of 12% was used, reflecting the economic opportunity cost of capital in Bangladesh. All costs and benefits were expressed in 2009 prices, and 2009 was adopted as the discount year.

16. Table 4 shows the result of the economic cost-benefit analysis. The economic internal rate of return (EIRR) for the proposed project investment is estimated at 20.0%. A sensitivity analysis tested the effects of possible unfavorable scenarios resulting from changes in the key parameters that determine project costs and benefits. The following scenarios were tested: (i) a 20% increase in project cost; (ii) a 20% decrease in project benefits; and (iii) both a 20% increase in project cost estimate and a 20% decrease in project benefits.

17. Table 5 demonstrates the economic robustness of the project, with the EIRR remaining well above the threshold economic value in all the sensitivity tests undertaken. Even the test of a combination of a 20% increase in project cost and a 20% decrease in project benefits reduces the EIRR only to 15.0%.

[8] ADB. 2007. *Preparing the Padma Multipurpose Bridge Project.* Consultant's report. Manila (TA 4652-BAN).
[9] ADB. 2009. *Asian Development Outlook 2009.* Manila.

Table 4: Economic Cost–Benefit Analysis

($ million)

Year ending June	Project Costs			Project Benefits							Net Economic Benefits
				Road User Benefits			Non-Road User Benefits			Total Benefits	
	Capital	O&M	Total Costs	VOC	TTC	Subtotal	Ferry	Land	Utilities		
2011	60	0	60	0	0	0	0	0	0	0	(60)
2012	500	0	500	0	0	0	0	0	0	0	(500)
2013	500	0	500	0	0	0	0	0	0	0	(500)
2014	500	0	500	0	0	0	0	0	0	0	(500)
2015	324	0	324	20	33	53	33	384	211	681	357
2016	0	13	13	65	88	153	35	0	0	188	175
2017	0	25	25	89	109	198	37	0	0	235	210
2018	0	25	25	110	130	240	39	0	0	279	254
2019	0	25	25	130	150	279	41	0	0	321	296
2020	0	25	25	148	169	317	43	0	0	361	336
2021	0	25	25	170	190	360	46	0	0	406	381
2022	0	25	25	191	212	404	49	0	0	452	427
2023	0	15	15	213	234	447	51	0	0	499	484
2024	0	15	15	234	256	490	54	0	0	545	530
2025	0	15	15	255	279	534	58	0	0	592	577
2026	0	15	15	284	299	583	61	0	0	644	629
2027	0	15	15	312	320	632	64	0	0	697	682
2028	0	15	15	340	341	681	68	0	0	749	734
2029	0	15	15	368	361	729	72	0	0	801	786
2030	0	15	15	395	382	777	76	0	0	853	838
2031	0	15	15	424	402	826	81	0	0	907	892
2032	0	15	15	453	423	876	85	0	0	961	946
2033	0	15	15	482	444	925	90	0	0	1,016	1,001
2034	0	15	15	511	464	975	96	0	0	1,071	1,056
2035	0	15	15	539	485	1,024	101	0	0	1,126	1,111
2036	0	15	15	568	505	1,074	107	0	0	1,181	1,166
2037	0	15	15	597	526	1,123	113	0	0	1,237	1,222
2038	0	15	15	626	547	1,173	120	0	0	1,293	1,278
2039	0	15	15	655	567	1,222	127	0	0	1,349	1,334
2040	0	15	15	684	588	1,272	134	0	0	1,406	1,391
2041	0	15	15	713	609	1,321	142	0	0	1,463	1,448
2042	0	15	15	742	629	1,371	150	0	0	1,521	1,506
2043	0	15	15	770	650	1,420	159	0	0	1,579	1,564
2044	0	15	15	799	670	1,470	168	0	0	1,638	1,623
NPV at 12%	**1,310**	**88**	**1,398**	**1,0870**	**1,104**	**2,174**	**275**	**244**	**134**	**2,788**	**1,390**

NPV = net present value, O&M = operation and maintenance, TTC = travel time cost, VOC = vehicle operating cost.

Sources: Design Consultant, Asian Development Bank calculations.

Table 5: Sensitivity Analysis Results

Item	BCR	EIRR (%)
Base case	2.0	20.0
20% increase in project cost estimate	1.7	17.6
20% decrease in project benefits	1.6	17.0
20% increase in project cost estimate and 20% decrease in project benefits	1.3	15.0

BCR = benefit–cost ratio, EIRR = economic internal rate of return.

Source: Asian Development Bank calculations.