ECONOMIC ANALYSIS

A. Introduction

1. **Economic rationale.** Uzbekistan's economy grew by 6.6% annually during 2009–2019 and relies heavily on its railway network, which extends over 4,735 kilometers (km), transports 30%–40% of total freight and 3%–4% of intercity passengers, and is operated and managed by the state-owned company O'zbekiston Temir Yo'llari (UTY).[1] Freight represents most of UTY's operations, and freight traffic increased by 2.7% annually from 42.4 million tons in 2000 to 70.1 million tons in 2019, about one-third of which were international movements. Passenger ridership increased by 2.4% annually from 14.6 million in 2000 to 22.9 million in 2019. However, the sustained economic growth has increased pressure on the railway network; investments in the railway network's capacity and efficiency are consequently required to continue promoting economic growth and supporting domestic and international trade, notably to the neighboring countries of the Central Asia Regional Economic Cooperation (CAREC) program.

2. **Fergana Valley.** About 29% of Uzbekistan's population of 33.0 million lives in the Fergana Valley, the country's easternmost area comprising the regions of Andijan, Fergana, and Namangan. The fertile soil and mild climate present high agricultural and textile potential, and its dense population has attracted large industries.[2] However, the regional economy remains constrained by its geography: surrounded by high mountains, Uzbekistan's Fergana Valley is connected to Tashkent either through the Kamchik Pass, 2,268 meters above sea level, or via Tajikistan's city of Khujand. The gross domestic product (GDP) per capita of the Fergana Valley was 39% below the national average in 2019, and real incomes per capita were 16.9% below the national average in 2018. To support the development of the Fergana Valley, alleviate connectivity constraints, and avoid high transboundary fees, a railway tunnel was constructed in 2016 to connect the railway network of the Fergana Valley to Tashkent through Angren and Pap.[3]

3. **Project design.** The railway network of the Fergana Valley is hampered by outdated infrastructure, which affects the network's capacity, efficiency, and safety. In 2017, the Asian Development Bank (ADB) approved a loan to finance the electrification of 145 km of tracks linking the cities of Pap, Namangan, and Andijan (the northern loop), while the southern loop connecting Pap and Andijan via Kokand was electrified by UTY.[4] However, the southern loop continues to suffer from insufficient power supply, signaling, and telecommunications systems. This additional financing project will (i) install signaling and telecommunications on the Angren–Pap–Kokand–Andijan line for 441 km of tracks, including four branch lines; (ii) construct or upgrade four traction substations to relieve the shortage of electric power, and install external power supply and supervisory control and data acquisition systems; (iii) commission maintenance equipment and upgrade the Kokand depot; and (iv) upgrade central train control center in Tashkent.

4. **Direct benefits.** Without the project, the railway network would not be able to run additional electric trains, and long delays would be incurred—particularly for freight. The demand for passenger and freight trains would thus remain suppressed, while part of the demand would divert to road-based modes. The project will address key operational bottlenecks, and in turn

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[1] The freight market share of railways averages 17% in the European Union and 25%–30% in North America.
[2] Including General Motors Uzbekistan, the Fergana and Altiarik refineries, and Quartz joint stock company.
[3] The $1.9 billion project resulted in a 19.2 km, single-track, electrified tunnel that began operating in September 2016. Before its opening, freight traffic from the rest of Uzbekistan was brought to Angren by rail and transshipped onto road vehicles to continue to the final destinations in the Fergana Valley. World Bank. Pap–Angren Railway.
[4] ADB. Uzbekistan: Central Asia Regional Economic Cooperation Corridor 2 (Pap–Namangan–Andijan) Railway Electrification Project.

improve (i) the movement of goods and people within the Fergana Valley, (ii) economic corridor performance between the Fergana Valley and Tashkent, and (iii) operational and environmental efficiency. While Uzbekistan's trade increased by 22.0% with the Kyrgyz Republic and 14.1% with Tajikistan annually from 2009 to 2019, it represents only 3.2% of Uzbekistan's total trade.[5] By upgrading infrastructure along a key section of the CAREC Corridor 2, including branch lines to the Kyrgyz Republic and Tajikistan, the project will also contribute to promoting regional connectivity and international trade, and supporting the development of regional value chains.

B. Demand Analysis

5. **Methodology.** Passenger and freight forecasts were based on an analysis of historical and projected socioeconomic growth trends, historical railway traffic trends, travel costs, and maximum railway capacity. A feasibility study prepared by UTY provided key technical parameters.[6] Future traffic consists of (i) normal traffic, predicted to grow in line with socioeconomic development; (ii) traffic diverted from roads; and (iii) generated traffic, in line with the release of latent travel demand and an increase in traffic because of railway improvements.

6. **Assumptions.** Although the coronavirus disease (COVID-19) is heavily impacting all economies worldwide, Uzbekistan's economy is expected to be comparatively resilient, and GDP is forecast to grow by 1.5% in 2020 and 6.5% in 2021.[7] GDP growth during 2022–2030 is estimated at 5% annually, with more conservative and tapered assumptions over time (Table 1). The elasticity of railway demand to the economic growth rate was conservatively assumed at 1.00 for passenger and 0.82 for freight, providing the basis for the growth in normal demand.[8] Table 2 summarizes the historical passenger and freight traffic volumes in Uzbekistan.

Table 1: Annual Gross Domestic Product Growth in Uzbekistan

Item	2000–2009	2010–2019	2020	2021–2030	2031–2040	2041–2050
Annual GDP growth rate (%)	6.80	6.51	1.80	4.66	3.50	2.50

GDP = gross domestic product.
Source: Asian Development Bank estimates.

Table 2: Historical Traffic Demand

Year	2000	2005	2010	2015	2019	Average Growth, 2000–2019 (%)
Passengers (million)	42.4	45.8	56.9	67.2	70.1	1.1
Passenger-km (million)	15.0	18.1	22.3	22.9	23.5	0.6
Tons (million)	14.6	15.1	14.5	20.1	22.9	3.3
Ton-km (million)	2.2	2.1	2.9	3.8	4.4	3.6

km = kilometer.
Source: Asian Development Bank estimates.

7. **Operations.** Traffic on the Angren–Pap–Kokand–Andijan line is operating at or near track capacity. The capacity will be increased to allow 17–22 daily freight trains and two additional passenger trains, resulting in a total freight capacity of 15.5–20.1 million tons per year and an additional capacity of 466,000 passengers a year. Despite improvements, the network will remain constrained by its single track, and capacity on the Angren–Pap section (footnote 3) is estimated

[5] Uzbekistan's total trade increased by 8.5% annually from 2009 to 2019. Government of Uzbekistan, State Committee of the Republic of Uzbekistan on Statistics. External Trade (Imports) (accessed 31 July 2020).
[6] UTY. 2016. *Electrification of the Angren–Pap–Kokand–Andijan Railroad.* Tashkent.
[7] ADB. 2020. *Asian Development Outlook Supplement, June 2020: Lockdown, Loosening, and Asia's Growth Prospects*. Manila.
[8] The GDP elasticity of freight demand is normally about 1.0, and the GDP elasticity of passenger demand is typically 1.5–2.0 in developing economies. R. Fouquet. 2012. Trends in Income and Price Elasticities of Transport Demand (1850–2010). *Energy Policy*. 50. pp. 62−71.

to be reached by 2032 for freight and 2026 for passengers. Diverted demand from road to rail was estimated at a maximum of 10% of existing demand for freight and passengers. Generated demand was estimated at a maximum of 10% of base demand for freight traffic, decreasing to 0% by 2045 as capacity is utilized. Considering the limited capacity increase for passenger trains, the analysis did not consider generated demand for passenger traffic. Table 3 outlines the estimated traffic volume on the Angren–Pap–Kokand–Andijan line, which (i) represents 65% of the demand for the Angren–Pap section; (ii) is used for estimating costs and benefits, and (iii) is distinct from that of the original project; which only assessed the demand for the northern loop.

Table 3: Forecast Traffic Volumes

Item	Average, 2017–2019	2020	2025	2030	2035	2040	2045	2050
Freight (million tons)								
Base case	7.71	7.82	9.58	10.42	10.78	10.78	10.78	10.78
With project		7.82	11.58	13.34	15.08	16.96	17.65	17.65
Passengers (million trips)								
Base case	0.90	0.91	1.13	1.22	1.32	1.42	1.50	1.50
With project		0.91	1.33	1.51	1.62	1.74	1.89	1.97

Source: Asian Development Bank estimates.

C. Economic Analysis

8. **Key economic assumptions.** The economic analysis of the project has been carried out following ADB guidelines by comparing the incremental costs of the project with the incremental benefits in the with- and without-project scenarios.[9] The economic analysis valued all costs and benefits in monetary terms, in economic prices, in United States dollars, using the world price numeraire, and discounted to 1 July 2020 at a rate of 9%. The analysis assumed a 30-year period (2020–2049), with a residual value of capital assets based on their economic lives. The analysis assessed only the costs and benefits related to the scope of the additional financing project, which mainly focuses on improving systems for the southern loop of the railway network.

9. **Project capital costs**. Project economic costs were derived from financial costs and include capital costs, consulting services, and physical contingencies, but exclude financing charges and price contingencies. The project costs were revalued in economic terms by separating the cost items into tradable materials and equipment, non-tradable materials, skilled labor, and unskilled labor. A standard conversion factor of 0.96 was used to convert domestic market price values to border price equivalent values, and a standard wage rate factor of 0.70 was used for unskilled labor, resulting in a project economic cost of $132.6 million.

10. **Recurring costs.** Operation and maintenance (O&M) costs were derived from existing costs incurred by UTY, and include traction costs, maintenance costs for systems, and locomotive maintenance costs. Traction costs were based on energy consumption unit rates of 471.6 kilowatt-hours per 10,000 ton-km and 98.3 kilograms of diesel per 10,000 ton-km, with an average economic diesel cost of $0.57/liter and average power cost of $0.013 per kilowatt-hour. Locomotive maintenance costs are estimated at $0.16/engine-km for diesel and $0.10/engine-km for electric locomotives. Annual O&M costs for systems were estimated at 0.5% of capital costs for electric systems, and 3.0% of capital costs for signaling and telecommunication systems.

11. **Economic benefits.** The project will increase the capacity, efficiency, and sustainability of the Fergana Valley's railway network. The capacity added by the project will divert passenger and freight traffic using road-based modes, and release suppressed freight demand that would

[9] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila.

not be met without the project. Overall, the project will increase demand and reduce travel costs and times along CAREC Corridor 2—contributing to increased regional trade to neighboring countries, mainly the Kyrgyz Republic and Tajikistan. Project benefits include (i) time savings for freight traffic and passenger journeys, (ii) vehicle operating cost savings for diverted traffic, and (iii) carbon dioxide (CO_2) emission savings.[10] The project will also reduce traction and locomotive maintenance costs for additional traffic,. It will also improve the safety of railway operations, by improving the traffic control capacity of railway operations in the Fergana Valley, and by reducing road traffic in the with-project scenario, both of which are expect to reduce rail and road accidents. However, such economic benefits were not quantified. The benefits of generated demand were quantified as half of the benefits of normal demand.

12. **Time savings for freight.** The signaling, telecommunications, and electrification systems will lead to significant time savings for freight trains using the Angren–Pap–Kokand–Andijan route, by shortening the idling times associated with the single-track operations, and in turn increasing capacity. Average journey time savings were estimated at 1.5 hours for freight. The value of time for freight was based on comparable values in the European Union, estimated at $1.24 per ton-hour in 2002 prices, which was weighted by the respective GDP per capita on a power purchasing parity basis of Uzbekistan, to arrive at a conservative freight value of time of $0.24 per ton-hour.[11]

13. **Time savings for passengers.** Passenger trains between Pap and Andijan currently take an average of 90 minutes. The project will result in a reduction of journey time savings estimated at 30 minutes per journey. The passenger value of time was based on the GDP per capita, the employment ratio, and the wage rates in Uzbekistan, resulting in a value of time of $1.5/hour for work trips, which were assumed to account for 70% of total trips, and $0.3/hour for nonwork trips.

14. **Vehicle operating cost savings.** Part of the capacity added by the project will attract freight and passengers from road modes. Cost savings were based on unit vehicle operating costs of $0.71/km for heavy trucks and $0.16/km for cars, based on the Highway Development Highway Development and Management Model (HDM-4) for comparable roads in Uzbekistan.

15. **Emissions reduction.** The project will result in a net reduction in CO_2 emissions, as electric locomotives emit less CO_2 than the diesel locomotives that would be used without the project, and less CO_2 than the heavy trucks and cars used for diverted freight and passenger traffic. The CO_2 emissions savings were based on emissions rates estimated at 31 grams (g) per ton-km for diesel locomotives, 13 g for electric locomotives, 669 g per ton-km for heavy goods vehicles, and 164 g per ton-km for passenger cars. CO_2 emissions were converted at a value of $38.60/ton in 2020 prices, increasing at 2% per annum in real terms.

16. **Economic internal rate of return.** Based on the estimated economic costs and benefits, the economic internal rate of return (EIRR) of the additional financing project is estimated at 14.5% and the net present value is estimated at $74.8 million, indicating the project's economic viability (Table 11). Economic cost and benefit streams are summarized in Table 12.

17. **Sensitivity analysis.** Five scenarios assessed the robustness of the results of the economic analysis: (i) a 10% increase in project costs, (ii) a 10% reduction in project benefits, (iii) a 10% increase in capital costs and 10% in project benefits, (iv) a prolonged economic crisis

[10] The demand benefits considered in the analysis are distinct from the original project, which only considered electrification benefits for the traffic demand using the northern loop from Pap to Andijan through Namangan.

[11] G. de Jong. 2007. Value of Freight Travel-Time Savings. In D.A. Hensher and K.J. Button, eds. *Handbook of Transport Modelling.* Vol. 1. Amsterdam: Elsevier.

with dampened GDP growth in 2021–2022, and (v) a 2-year delay in realizing the project benefits. The EIRR of the project exceeds 9% in all cases, demonstrating its overall economic robustness.

18. **Overall project.** The economic analysis of the original project was also reevaluated. During 2017–2019, the average traffic on the Pap–Namangan–Andijan corridor was about 47% higher for freight and 13% higher for passengers than the demand forecast for 2020 at project appraisal. The EIRR of the original project is reestimated at 22.8%, up from 19.7% at appraisal, and the EIRR of the overall project is estimated at 20.3%.

Table 4: Economic Analysis Results of the Additional Financing Project

No.	Scenario	EIRR (%)	NPV ($ million)	Switching Value (%)
	Base Case	14.5	74.8	
i	10% increase in costs	13.4	64.2	70.7
ii	10% reduction in benefits	13.3	56.7	(41.4)
iii	10% increase in costs and 10% reduction in benefits	12.2	46.2	26.1
iv	Prolonged economic crisis	14.0	66.1	
v	2-year delay in benefits	12.2	48.4	

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

Table 5: Cost and Benefit Streams of the Additional Financing Project ($ million)

Year	Costs		Benefits				Net Benefits
	Capital Costs	O&M Costs	Time Savings (Freight)	Time Savings (Passengers)	Vehicle Operating Cost Savings	CO_2 Emissions	
2020	(0.5)	0.0	0.0	0.0	0.0	0.0	(0.5)
2021	(41.5)	0.0	0.0	0.0	0.0	0.0	(41.5)
2022	(50.7)	0.0	0.0	0.0	0.0	0.0	(50.7)
2023	(45.4)	0.0	0.0	0.0	0.0	0.0	(45.4)
2024	(0.7)	(2.3)	5.3	0.8	13.7	0.4	17.2
2025	0.0	(2.0)	5.9	0.9	15.1	0.4	20.3
2026	0.0	(1.6)	6.6	0.9	16.7	0.4	23.1
2027	0.0	(1.3)	7.3	0.9	18.2	0.5	25.5
2028	0.0	(1.1)	7.5	1.0	16.1	0.4	24.0
2029	0.0	(0.9)	7.9	1.0	14.2	0.4	22.6
2030	0.0	(0.6)	8.2	1.1	12.1	0.3	21.1
2031	0.0	(0.3)	8.4	1.1	10.1	0.3	19.6
2032	0.0	0.0	8.7	1.2	8.5	0.3	18.7
2033	0.0	0.4	9.4	1.2	9.5	0.3	20.8
2034	0.0	0.6	10.0	1.2	10.7	0.3	22.8
2035	0.0	0.8	10.5	1.3	10.6	0.4	23.5
2036	0.0	1.1	10.9	1.3	10.0	0.5	23.8
2037	0.0	1.5	11.7	1.4	11.5	0.6	26.6
2038	0.0	1.8	12.5	1.5	13.1	0.6	29.5
2039	0.0	2.2	13.4	1.5	14.8	0.7	32.6
2040	0.0	2.6	14.3	1.6	16.6	0.9	35.9
2041	0.0	3.0	14.8	1.7	18.9	0.9	39.2
2042	0.0	3.3	15.3	1.7	20.4	1.0	41.7
2043	0.0	3.7	15.9	1.7	22.0	1.0	44.3
2044	0.0	3.9	16.4	1.7	23.6	1.2	46.7
2045	0.0	3.9	16.8	1.7	25.2	1.4	49.1
2046	0.0	3.9	16.7	1.7	23.4	1.5	47.3
2047	0.0	3.9	16.5	1.7	20.8	1.5	44.5
2048	0.0	3.9	16.3	1.7	19.3	1.6	42.8
2049	13.9	3.9	16.1	1.8	17.6	1.6	54.9
					Net present value at 9% ($ million)		**74.8**
					Economic internal rate of return (%)		**14.5**

( ) = negative, CO_2 = carbon dioxide, O&M = operation and maintenance.
Source: Asian Development Bank estimates.