ECONOMIC ANALYSIS

1. The 2010 economic analysis conducted for the current project was revised for the economic analysis for the proposed additional financing of the Ha Noi Metro Rail System Project (Line 3: Nhon–Ha Noi Station Section). The revised analysis took into account (i) updated capital costs, (ii) a new construction schedule, and (iii) changes in income per capita in Viet Nam and the dong–US dollar exchange rates. The revised economic internal rate of return (EIRR) of the project is 12.9%, slightly higher than the 12.7% estimate in 2010.

A. Original Analysis

2. **Demand**. The 2008 project feasibility study[1] forecast transport demand in the Ha Noi city area for 3 years (2010, 2020, and 2030) using a four-stage transport model. Three scenarios were analyzed: one without line 3, one with line 3, and one with line 3 and an extension. After 2030, demand was assumed to increase at a 3.5% annual rate. The study predicted under the scenario with line 3 only that daily ridership would reach 157,000 passengers by the 2010 project line opening date then being assumed, 276,000 passengers in 2020, and 458,000 by 2030. With the extension to line 3, ridership would reach 630,000 in 2030. These figures were used for the 2010 analysis, which anticipated an opening date in 2015.

3. **Costs**. The original analysis derived the economic capital costs from financial costs using standard Asian Development Bank methodology and estimated them to be $1.0 billion in 2009 terms. This was based on a euro–US dollar exchange rate of €1.40 = $1.00 and a dong–US dollar rate of D16,220 = $1.00. Operation and maintenance costs were forecast for 30 years taking into account real inflation and rehabilitation requirements.

4. **Benefits**. Benefits were computed over a 50-year operational period. The main benefit was a reduction in travel time for current bus users and people travelling by car and motorcycle. Total time savings were estimated using the demand model for current users, projections of the number of passengers who would shift from other transport modes to using the metro, and calculations of these time savings for those who would still travel by car and motorcycles but would benefit from the reduced road congestion and faster road travel times the metro would bring about. These figures were multiplied by an average value of time of D19,207 per hour ($1.18 in 2009 US dollars), which was assumed to grow over time at the same rate each year as growth domestic product (GDP) per capita—i.e., by 4.5% annually until 2040 before slowing to a yearly 3.0%. Vehicle operating cost savings were the second largest benefit. They were calculated using estimated cost savings from (i) less use of motorcycles and private cars due to passengers shifting to travel by metro, (ii) a reduction in the private vehicle ownership rates, and (iii) lower bus operating costs due to a restructuring of bus lines to take into account the introduction of the metro services.

5. Three additional benefits had been calculated and valued using the model forecasts:

(i) **Accident cost savings.** The analysis assumes that the number of road accidents will decrease with road traffic. The cost per accident was assumed to increase in real terms at the same rates of growth of GDP per capita used to increase the value of time.

[1] SYSTRA. 2008. Hanoi Pilot Light Metro Line - Section Nhon - Hanoi Railway Station, Feasibility Study Report. Ha Noi (final report, project reference: PIC-TRE-DOO-L00-00010-E-3A, December).

(ii) **Pollution savings.** Three forms of pollution were considered. The analysis predicted that noise pollution, local air pollution, and global air pollution would decrease, in a manner directly related to the reduction in vehicle kilometers. Local pollution costs were meant to represent the costs of illness and damage to buildings caused by pollution. The estimate of the cost of global air pollution was derived from French standards, adjusted to Ha Noi income levels.[2]

(iii) **Avoided road maintenance cost.** The forecast reduction in road traffic implies slower road degradation, which decreases road maintenance needs. The analysis calculated a road maintenance unit cost per vehicle, which was inflated at a 3% annual growth rate in real terms.

6. **Results**. The original 2010 analysis found the project to be economically viable, with an EIRR of 12.7%.

B. Updated Analysis

7. **Demand**. The opening date for the project line 3 has been postponed to 2020, about 10 years later than assumed in the original feasibility study. The model originally used for analysis could not be run again for the project with the additional financing, because this would require a major recalibration and a large program of traffic surveys. As a result, the update analysis assumed that the traffic levels originally forecast for 2010 in the feasibility study to be the base estimate for 2020. This is a conservative assumption, since demand for rapid, efficient transport services may be greater now due to worsening road traffic congestion. The analysis results were tested for a 4-year ramp-up period in ridership that was not considered in 2010 but is likely to occur.

8. **Costs**. The reevaluated project economic capital costs are $1.17 billion in 2015 US dollars. This is based on exchange rates of €1.11 = $1.00 and D21,129 = $1.00. All operating costs were reevaluated accordingly. Operating costs were based on updated schedules of investment and renewal of rolling stock and track.

9. **Benefits**. The following adjustments were made:

(i) **Time savings**. The assumption regarding the total quantity of time saved was left unchanged from the original study, but the base value of time was updated to D32,618 per hour ($1.54 in 2015 US dollars). This is based on the real increase in income per capita in the Ha Noi region between 2008–2015. Economic growth was faster than the original analysis anticipated, and the dong appreciated in real terms against the US dollar during the period. Because the project opening date was postponed by 5 years, the estimate of the value of passengers' time rose from $1.92 per hour in the first year of operation, now 2020, from the $1.18 per hour projected for the original operating start year of 2015 (a 60% increase).

(ii) **Vehicle operating costs**. The vehicle operating cost assumptions used in the original study were reviewed, found to remain sound, and kept unchanged.

(iii) **Accident savings and environmental benefits**. International reviews suggest that the costs related to injuries and deaths are a function of GDP per capita. It was assumed that the ratio of GDP per capita and the society's willingness to pay to save a marginal life (the value of life) would remain constant. The original

[2] Ministère de l'Equipement, des Transports, du Logement, du Tourisme et de la Mer. 2004. *Instruction cadre relative aux méthodes d'évaluation économique des grands projets d'infrastructures de transport*. Paris.

estimates were adjusted in line with growth in GDP per capita in Ha Noi in a manner similar to that applied to time savings. Since environmental benefits from reduced pollution are also determined by reference to improvements in health, the same adjustment factors were used.

(iv) **Road maintenance benefits**. The assumptions used for road maintenance benefits in the original study were reviewed and found to remain consistent with actual maintenance costs in the country.

10. **Results**. The updated analysis established a project EIRR of 12.9% and a net present value at a 12% discount rate of $80 million. It found the project to still be economically viable. The EIRR was impacted negatively by the 17% increase in the US dollar cost and the project delays, but this is more than compensated by the rise in the values of time and other benefits. Table 2 shows the reevaluated costs and benefits.

11. **Sensitivity**. The project's viability was shown by testing to be largely insensitive to negative changes in both capital cost and benefits. Table 1 shows the results of sensitivity testing conducted for the update. The tests showed that the project would remain viable under scenarios in which costs increased by 20%.

Table 1: Results of Sensitivity Tests

Scenario	**EIRR** (%)	**NPV** *****($ million)	**Switching Value** (%)
Original base case	12.7	67.0	
Updated base case	12.9	80.0	
Capital costs +10%	12.5	45.0	22.0
Operation and maintenance costs +20%	12.8	71.0	180.0
Benefits -10%	12.6	50.0	27.0
Four year ramp-up period (25% Year 1, 50% Year 2, 75% Year 3, 100% Year 4)	12.7	62.0	

EIRR = Economic Internal Rate of Return; NPV = Net Present Value.
Source: Asian Development Bank estimates.

Table 2: Annual Cost and Benefit Streams ($ million)

	MRT System Costs ($m)		Benefits ($m)									Net Benefit ($m)
			Passenger Time Savings				Vehicle Operating Costs		Road	Accident	Reduced	
Year	Capital	O&M	Public	Transfer	Induced	Congestion	Bus	Other	Maintenance	Savings	Pollution	
2009	16.2											-16.2
2010	21.3											-21.3
2011	42.1											-42.1
2012	60.2											-60.2
2013	11.5											-11.5
2014	62.5											-62.5
2015	150.1											-150.1
2016	234.8											-234.8
2017	205.9											-205.9
2018	187.7											-187.7
2019	178.5											-178.5
2020		13.1	12.8	0.6	1.6	5.5	2.5	14.5	0.9	2.9	3.4	31.8
2021		13.3	15.1	1.4	1.9	6.5	2.7	16.1	1.0	3.5	3.7	38.5
2022		13.6	17.5	2.3	2.0	7.8	2.9	17.9	1.2	4.0	4.0	46.1
2023		13.8	20.3	3.0	2.3	9.1	3.2	19.9	1.3	4.9	4.6	54.7
2024		14.1	23.7	3.9	2.7	10.7	3.4	22.2	1.5	5.6	5.0	64.6
2025		14.4	42.8	7.1	4.5	19.6	5.8	38.2	2.5	10.4	8.7	125.2
2026		14.6	50.3	9.1	5.1	21.5	5.9	40.8	2.7	11.2	8.8	140.8
2027		14.9	60.2	11.9	5.9	24.2	5.9	43.7	2.9	12.3	9.0	161.1
2028		15.2	72.0	15.5	6.9	27.2	6.0	46.7	3.1	13.5	9.3	185.0
2029		15.5	86.3	20.2	8.0	30.6	6.0	49.9	3.3	14.9	9.6	213.3
2030	75.7	15.8	103.4	26.5	9.2	34.5	6.1	53.3	3.5	16.2	9.9	171.1
2031		15.9	123.7	34.6	10.6	38.7	6.2	57.0	3.7	17.9	10.3	286.9
2032		16.1	148.2	45.3	12.3	43.6	6.2	61.0	4.0	19.6	10.7	334.8
2033		16.2	177.5	59.2	14.2	49.0	6.3	65.2	4.2	21.5	11.1	391.9
2034		16.4	212.6	77.3	16.3	55.1	6.3	69.7	4.5	23.7	11.5	460.6
2035		0.0	270.2	107.3	20.0	65.9	6.8	79.1	5.1	27.6	12.7	594.7
2036		16.5	287.0	113.9	21.3	69.9	7.0	81.9	5.4	29.3	13.5	612.7
2037		16.7	304.7	121.0	22.6	74.3	7.3	84.7	5.6	31.1	14.3	649.0
2038		16.8	323.6	128.5	24.0	78.9	7.5	87.7	5.8	33.1	15.2	687.5
2039		17.0	343.7	136.4	25.5	83.8	7.8	90.8	6.0	35.1	16.2	728.2
2040	101.7	153.3	3567.6	1460.4	272.5	896.5	73.7	857.0	56.9	364.6	167.7	7461.9

Source: Asian Development Bank estimates.