

## ECONOMIC ANALYSIS

### A. Introduction

1. The proposed additional co-financing of \$38 million—through a grant from the Australian Department of Foreign Affairs and Trade (DFAT)—will support an expansion of the scope of the *Health Services Sector Development Program* (HSSDP) by upgrading one more health center and an additional eight existing community health posts, plus staff training. Papua New Guinea's (PNG) decentralized service delivery framework suffers from funding constraints, weak supervision, and limited accessibility of health facilities. The project investment component of the HSSDP supports: (a) civil works to build additional health facilities at the district level; and (b) systems improvements, i.e., financial management, medical supply logistics, and health information, along with capacity building—through a workforce management tool and integrated suite of organizational development and experiential people development programs—to increase the efficiency of health services delivery.

### B. Health Facilities

2. Planned new health facility investments under this additional financing aim to build upon progress in strengthening community health posts under the ongoing *Rural Primary Health Services Delivery Project*, and ongoing work on at least 8 new facilities—including 2 district hospitals and 6 health centers—under the original scope of the HSSDP.<sup>1</sup> Economic analysis of new facilities was undertaken in accordance with Asian Development Bank's (ADB) *Guidelines for the Economic Analysis of Projects* and *Handbook for the Economic Analysis of Health Sector Projects*.<sup>2</sup> The analysis covers a period of 20 years, including project setup, and is based on a world price numeraire. Nontraded components are adjusted using a standard conversion factor (SCF) of 0.95. A shadow wage rate factor (SWRF) of 0.67 is used to convert financial wages into economic wage rates for unskilled labor.<sup>3</sup> Project costs are inclusive of capital and operations and maintenance (O&M) costs, plus physical contingency, but taxes and subsidies are excluded. Economic values are expressed in constant 2017 US dollars.

3. Estimated economic costs and benefits under a with-project scenario are compared with those derived in a without-project scenario to gauge the magnitude of potential net economic gains from investment in additional health facilities. Selection of specific locations for corresponding types of health facilities will be subject to criteria considering various factors including community needs, equity in access, and capacity to operate and maintain given levels of service delivery, among others. Under the without-project scenario, it is assumed that the health needs of the population living in the target districts would be served by existing health care infrastructure. Average population served is estimated at around 25,000 for a health center and 8,000 for community health posts. The population is assumed to stay constant over the period of analysis because of rural–urban migration and an expected fall in fertility rates. Demographic data is drawn from the PNG Census 2011.

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<sup>1</sup> ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant and Loan Papua New Guinea: Rural Primary Health Services Delivery Project*. Manila; and ADB. 2018. *Report and Recommendation of the President to the Board of Directors: Proposed Programmatic Approach, Policy-Based Loan for Subprogram 1, and Project Loans Papua New Guinea: Health Services Sector Development Program*. Manila.

<sup>2</sup> ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila; ADB. 2000. *Handbook for the Economic Analysis of Health Sector Projects*. Manila

<sup>3</sup> Conversion factors are consistent with those derived from the economic analysis of the ongoing *Rural Primary Health Services Delivery Project* (footnote 1).

## 1. Valuation of Economic Benefits

4. Project benefits quantified in the analysis include: (i) improved productivity with reduced incidence and severity of illnesses resulting in fewer lost days of work; (ii) productivity gains from reduced mortality, particularly among mothers and newborn infants; (iii) improved productivity with fewer work days lost to caring for sick relatives and attending funerals; (iv) household savings arising from lower travel costs; and (v) shorter waits for health care services. Intangible benefits such as consumption and utility gains derived by individuals from feeling healthier, psychological benefits of not having a sick family member to care for; herd immunity through increased immunization rates among communities; and government resource savings with more efficient delivery of health care services are unquantifiable and are therefore not included in the analysis.

5. **Productivity improvements.** The benefits of reduced morbidity and mortality are valued using the human capital approach. This considers health improvements as investments in human capital, which in turn increase potential future earnings. The value of human capital is measured using expected lifetime earnings of individuals that benefit from project interventions, adjusted for labor force participation rates and working life expectancies. The national minimum wage of 3.50 kina per hour (effective since July 2016) is adjusted by the unskilled SWRF as well as the SCF, and then converted to US dollars to derive the \$0.70 per hour estimate used to value earnings forgone in episodes of illness and premature death. Foregone earnings are therefore valued at \$4.22 per day based on a 6-hour workday, or \$1,012 per year assuming a 30-hour workweek and 48-week working year.

6. New health facilities are expected to contribute to lower mortality rates in target districts, particularly among mothers and newborn infants. It is assumed that new facilities will help reduce mortality rates by at least one-fourth (Table 1).<sup>4</sup> Benefits from investments are modeled to take at least 2–3 years to begin to be realized. Further, all project benefits are expected to gradually build-up as participation rates rise over the first few years of operation. For conservative valuation of benefits, it is assumed that participation rates only reach 100% after 4 years, to account for information asymmetry and sheer remoteness of some target communities and populations.

**Table 1: Assumed Reductions in Mortality Rates**

Indicator	Without Project	With Project
Neonatal mortality (per 1,000 live births)	25	18
Infant mortality (per 1,000 live births)	45	33
Under-five mortality (per 100,000 live births)	57	43
Maternal mortality (per 100,000 live births)	215	161

Source: ADB estimates and World Bank World Development Indicators online database.

7. The annual economic wage rate is used to estimate the productive value of 1 year of life. Avoided mortality is estimated as the total number of productive years not lost due to premature death. The average productive life of a person is conservatively estimated to be between ages 20–40. For maternal mortality, it is estimated that the average birthing age is 25, resulting in 15 years of foregone income for each maternal death.<sup>5</sup> Further, the project will reduce the number of workdays lost to illness by an average of 2 days per episode per person per year, with each person ill, on average, three times a year. Although the duration of illness is expected to shorten under the project, the annual number of episodes is not seen to change. Time spent caring for sick relatives will likewise be reduced, but it is assumed that about half of all caregivers are likely

<sup>4</sup> Assumed reductions are more conservative relative to targets of the PNG *National Health Plan 2011–2020*, which anticipates declines in mortality rates between 30% and 45%.

<sup>5</sup> Demographic profiles used in valuation of project benefits are consistent with the latest available information published in PNG *Census 2011*.

to be elderly people who, though able to provide caregiving services, are not otherwise productively engaged.

8. **Resource cost savings.** Households in remote areas of PNG currently incur significant costs in accessing health care because many rural facilities have either closed or offer poor services due lack of power, water, and medical supplies. This has prompted people to bypass these facilities and travel to urban centers to seek health care services. Costs include time incurred travelling to health care centers and waiting time for consultations.<sup>6</sup> With the construction of new health care facilities and the resulting improved access to health care facilities, these costs can be expected to decline by at least half. The average number of visits to health care centers is once per year in general, and twice per year for mothers, expectant mothers, and infants.<sup>7</sup>

## 2. Valuation of economic costs

9. Estimated costs include: (i) investment costs, which include the costs of constructing health-care facilities and installing medical and other equipment; (ii) O&M, replacement, and repair costs, which include the costs of maintaining health care facilities, replacing and repairing equipment, restocking supplies, wages, transport, and security.<sup>8</sup> Cost estimates place financial investment costs at \$29.6 million, inclusive of 10% physical contingencies. Upon application of the SCF to non-traded inputs, plus the SWRF on the unskilled labor component, economic investment costs are estimated at \$27.0 million. Annual O&M costs in financial terms are estimated at \$750,000 for the health center and \$100,000 for each community health post.<sup>9</sup> These are likewise converted to economic values of \$684,225 for a health center and \$91,230 for community health posts using the relevant conversion factors.

## 3. Economic internal rate of return

10. The economic internal rate of return (EIRR) of the additional upgrades health facilities was derived by calculating the discount rate at which the total present value of benefits and the total present value of costs are equalized. The results show that the proposed project yields an EIRR of 14.9%, exceeding the economic opportunity cost of capital (EOCC) for social sector and poverty-targeting projects of 6.0%. The project is therefore considered economically viable.

**Table 2: Results of Economic Analysis**  
(in constant 2017 \$, unless otherwise stated)

Year	Project costs		Project benefits				Net benefits	
	Capital	Recurrent	Productivity improvements		Resource cost savings			
			Reduced morbidity	Reduced mortality	Reduced caregiving	Reduced travel time	Reduced waiting time	
2018	-	-	-	-	-	-	-	-
2019	(11,614,871)	0	0	0	0	0	0	(11,614,871)
2020	(11,614,871)	0	0	0	0	0	0	(11,614,871)
2021	(1,255,072)	(1,414,065)	740,718	0	320,796	236,703	118,351	(1,252,568)

<sup>6</sup> Transportation cost savings from shorter and more infrequent trips to seek health care are left unquantified in the analysis as these are difficult to accurately measure and are also likely to be much smaller than travel time and waiting time savings, which are considered in the model.

<sup>7</sup> Inder, B. et. al., 2011. *Modeling costs and efficiency of primary health care services in Papua New Guinea*. Center for Health Economics Research Paper 2011(70). Monash University.

<sup>8</sup> As in the original (ongoing) project, no land acquisition costs will be involved in expanding the scope of the project since state, or church-leased, land for which titles are not contested will be selected for all project sites.

<sup>9</sup> Australian Department of Foreign Affairs and Trade and World Bank. 2017. *Service Delivery by Health Facilities in Papua New Guinea*. May (unpublished).

Year	Project costs		Project benefits				Net benefits	
	Capital	Recurrent	Productivity improvements		Resource cost savings			
			Reduced morbidity	Reduced mortality	Reduced caregiving	Reduced travel time		Reduced waiting time
2022	(1,255,072)	(1,414,065)	1,481,437	118,007	641,592	473,405	236,703	282,007
2023	(1,255,072)	(1,414,065)	2,366,827	236,014	1,025,043	756,339	378,169	2,093,255
2024	0	(1,414,065)	3,252,217	377,069	1,408,495	1,039,272	519,636	5,182,624
2025	0	(1,414,065)	3,396,888	518,124	1,471,150	1,085,503	542,752	5,600,352
2026	0	(1,414,065)	3,686,231	541,172	1,596,461	1,177,965	588,983	6,176,748
2027	0	(1,414,065)	3,830,903	587,268	1,659,117	1,224,196	612,098	6,499,518
2028	0	(1,414,065)	3,975,574	610,316	1,721,772	1,270,427	635,214	6,799,239
2029	0	(1,414,065)	4,120,246	633,365	1,784,428	1,316,658	658,329	7,098,961
2030	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2031	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2032	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2033	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2034	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2035	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2036	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
2037	0	(1,414,065)	4,120,246	656,413	1,784,428	1,316,658	658,329	7,122,009
							<b>ENPV (\$)</b>	<b>23,939,546</b>
							<b>EIRR (%)</b>	<b>14.86%</b>

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.

#### 4. Sensitivity Analyses

11. The estimated base case EIRR is subjected to adverse parameter changes to test the robustness of economic viability under unfavorable conditions. Sensitivity analyses results confirm that economic viability is not particularly sensitive to unexpected cost escalations. Also, even under pessimistic scenarios regarding realization of quantified benefit streams, economic viability is generally maintained. The main risk involves a scenario where no productivity gains are realized from reducing illnesses following project implementation, which causes the EIRR to fall below the economic opportunity cost of capital of 6% (Table 3).

**Table 3: Sensitivity Analyses Results**

Scenario	ENPV (\$)	EIRR (%)	Switching value (%)
Base case	23,939,546	14.9%	
20% capital cost overrun	19,358,338	12.4%	104.5%
20% recurrent costs increase	21,451,665	14.0%	192.4%
20% increase in both capital and recurrent costs	16,870,458	11.6%	67.7%
No change in illness-induced productivity loss	(4,895,215)	3.6%	(83.0%)
No reduction in productivity lost from mortality	19,798,877	13.6%	
No change in productivity loss to caregiving	11,451,566	10.7%	
No change in travel time	14,725,162	11.9%	
No change in waiting time	19,332,354	13.4%	
Projected benefits are not realized until year 5	8,466,819	8.7%	

( ) = negative, EIRR = economic internal rate of return, ENPV = economic net present value.

#### C. Overall Project assessment

12. Recall that the original (ongoing) project has an estimated EIRR of 10.1% (footnote 1). Given the economic analysis results of this additional financing to upgrade one more health center and eight community health posts, the overall Project can be expected to yield an overall EIRR of 11.5%. The overall Project's economic viability therefore remains robust.