ECONOMIC ANALYSIS

A. Introduction

1. Papua New Guinea (PNG) has a decentralized service delivery framework that suffers from funding constraints, weak supervision, and limited accessibility of health facilities. The project investment component of the proposed PNG Health Services Sector Development Program (SDP) allocates $95.0 million in Asian Development Bank (ADB) financing, comprising a loan from ordinary capital resources (OCR) of $45.1 million and a concessional OCR loan (COL) of $49.9 million. This will support (i) civil works to build additional health facilities in districts; and (ii) system 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 service delivery.

B. Health Facilities

2. Planned new health facility investments under the SDP aim to build upon progress made in strengthening community health posts under the ongoing Rural Primary Health Services Delivery Project (Rural Health Project).[1] An economic analysis of new facilities was undertaken in accordance with ADB's Guidelines for the Economic Analysis of Projects and its *Handbook for the Economic Analysis of Health Sector Projects*.[2] 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.[3] Project costs are inclusive of capital and operation and maintenance (O&M) costs, plus physical contingency, but taxes and subsidies are excluded. Economic values are expressed in constant 2017 United States 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 an investment in additional health facilities. Under the with-project scenario, at least eight new facilities—including two district hospitals (service level 4) and six health centers (service level 3)—will be established across PNG's provinces and districts. The selection of specific locations for corresponding types of health facilities will be subject to criteria considering various factors, such as community needs, equity in access, and capacity to operate and maintain given levels of service delivery. 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. The average population served is estimated at around 25,000 for health centers and 50,000 for district hospitals. 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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[1] ADB. 2011. *Report and Recommendation of the President to the Board of Directors: Proposed Loan and Administration of Grant and Loan to Papua New Guinea for the Rural Primary Health Services Delivery Project*—Economic Analysis (linked document). Manila.

[2] ADB. 2017. *Guidelines for the Economic Analysis of Projects*. Manila; ADB. 2000. *Handbook for the Economic Analysis of Health Sector Projects*. Manila

[3] 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. Unquantified benefits include consumption and utility gains derived by individuals from feeling healthier, psychological benefits of not having a sick family member to care for, herd immunity resulting from increased immunization rates among communities, and government resource savings from the more efficient delivery of health care services.

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 United States dollars to derive the $0.70-per-hour estimate used to value earnings forgone in episodes of illness and premature death. Forgone 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 a 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 25% (Table 1).[4] 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 a 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 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-5 mortality (per 100,000 live births)	57	43
Maternal mortality (per 100,000 live births)	215	161

Source: Asian Development Bank 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 to premature death. The average productive life of a person is conservatively estimated to be between ages 20 and 40. For maternal mortality, it is estimated that the average birthing age is 25, resulting in 15 years of forgone income for each maternal death.[5] 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

[4] 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%.

[5] Demographic profiles used in valuation of project benefits are consistent with the latest available information published in PNG's 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 because of lack of electricity, 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 and waiting for consultations.[6] 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 50%. 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.[7]

2. Valuation of Economic Costs

9. The estimated costs are (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. Cost estimates place financial investment costs at $63.5 million, inclusive of 10% physical contingencies. Upon application of the SCF to nontraded inputs, plus the SWRF on the unskilled labor component, economic investment costs are estimated at $57.9 million. Annual O&M costs in financial terms are estimated at $1.0 million for each district hospital[8] and $750,000 for each health center. These are likewise converted to economic values of $912,300 for district hospitals and $684,225 health centers using the relevant conversion factors.

3. Economic Internal Rate of Return

10. The economic internal rate of return (EIRR) of new 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 10.1%, exceeding the economic opportunity cost of capital for social sector and poverty-targeting projects of 6.0%. The project is therefore considered economically viable.

Table 2: Results of Economic Analysis

Year	Project costs		Project benefits					Net benefits
			Productivity improvements			*Resource cost savings*		
	Capital	Recurrent	Reduced morbidity	Reduced mortality	Reduced caregiving	Reduced travel time	Reduced waiting time	
2018	(5,792,639)							(5,792,639)
2019	(8,688,958)							(8,688,958)
2020	(11,585,277)							(11,585,277)
2021	(11,585,277)	(5,929,950)	0	0	0	0	0	(17,515,227)
2022	(11,585,277)	(5,929,950)	0	0	0	0	0	(17,515,227)
2023	(8,688,958)	(5,929,950)	1,446,716	0	626,555	462,310	231,155	(11,852,173)
2024	0	(5,929,950)	2,893,431	230,482	1,253,109	924,620	462,310	(165,998)

[6] Transportation cost savings from shorter and more infrequent trips to seek health care are left unquantified in the analysis because they 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.

[7] B. Inder et al. 2011. *Modeling costs and efficiency of primary health care services in Papua New Guinea*. Center for Health Economics Research Paper 2011(70). Melbourne, Australia: Monash University.

[8] 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
			Productivity improvements			*Resource cost savings*		
	Capital	Recurrent	Reduced morbidity	Reduced mortality	Reduced caregiving	Reduced travel time	Reduced waiting time	
2025	0	(5,929,950)	4,340,147	460,964	1,879,664	1,386,929	693,465	2,831,219
2026	0	(5,929,950)	7,233,578	691,446	3,132,773	2,311,549	1,155,775	8,595,171
2027	0	(5,929,950)	8,680,294	1,152,410	3,759,328	2,773,859	1,386,929	11,822,870
2028	0	(5,929,950)	10,127,009	1,382,892	4,385,883	3,236,169	1,618,084	14,820,087
2029	0	(5,929,950)	11,573,725	1,613,374	5,012,438	3,698,478	1,849,239	17,817,304
2030	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2031	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2032	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2033	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2034	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2035	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2036	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
2037	0	(5,929,950)	11,573,725	1,843,856	5,012,438	3,698,478	1,849,239	18,047,786
							ENPV ($)	**27,471,268**
							EIRR (%)	**10.07%**

( ) = 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 the economic viability is not particularly sensitive to unexpected cost escalations. The corresponding switching value shows that capital and recurrent costs would have to simultaneously be 28% above original estimates for the EIRR to fall below the economic opportunity cost of capital. Also, even under pessimistic scenarios regarding realization of quantified benefit streams, the 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%. The switching value confirms that investment in health facilities can remain economically viable even if productivity gains from reducing illnesses are 44% lower than projected in the base scenario (Table 3).

Table 3: Sensitivity Analyses Results

Scenario	ENPV ($)	EIRR (%)	Switching value (%)
Base case	27,471,268	10.1%	
20% capital cost overrun	18,094,406	8.5%	58.6%
20% increase in recurrent costs	17,038,221	8.5%	52.7%
20% increase in both capital and recurrent costs	7,661,360	7.0%	27.7%
No change in illness-induced productivity loss	(34,128,520)	(1.4%)	(44.6%)
No reduction in productivity lost from mortality	18,755,432	8.9%	
No change in productivity loss to caregiving	793,159	6.1%	
No change in travel time	7,786,552	7.3%	
No change in waiting time	17,628,910	8.7%	
Projected benefits are not realized until year 5	(2,319,873)	5.7%	

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

C. Regulatory Framework and System Improvements, and Capacity Development

12. The SDP also supports strengthening of national regulatory frameworks and public financial management as a foundation for sustainable, efficient, and effective health service delivery. These reform areas are critical for safeguarding adequate public expenditure for health, not only by streamlining national regulatory and planning frameworks for improved health

governance but also by improving allocative efficiency within the sector. Progress in these areas is crucial for long-term sustainability of health financing.

13. Further, the project's capacity building interventions comprise eight integrated organizational and workforce development strategies. These aim to strengthen skills and competencies, and facilitate behavior and attitude changes for sustainable health system change. Capacity development will be patient- and community-centered, and geared toward effective and efficient use of resources.

14. The SDP also supports a package of improvements to information technology-enabled systems that will help overcome inefficiencies in public expenditure. It supports the continuing rollout of the electronic national health information system (eNHIS), which will modernize the collection and data transfer of vital health status indicators. Digitization of health information not only raises the efficiency of collection, processing, and analysis of health information, but also feeds into better evidence-based health service planning and management, which should improve the needs-based allocation of scarce health resources across focus areas.

15. Distribution of medicine and other medical supplies is currently outsourced to seven different logistics providers. Complexity has led to stocks running out in various health facilities on a regular basis, undermining the quality of patient care. The SDP supports strengthening of the medical supplies system by rolling out *mSupply*, a pharmaceutical supply chain software solution, in selected project provinces. This will help reduce logistics costs, minimize losses from mis-deliveries and leakages, and improve the availability of medical supplies across PNG.

5. Proxy Cost–Benefit Analysis

16. Efficiency gains from the combination of improvement to regulatory frameworks and systems, and capacity development interventions supported by the project are expected to generate extra fiscal space, which in turn can be channeled toward more productive expenditure. This analysis conservatively assumes that such efficiency gains can build up to 0.25% of total government expenditure 5 years after project completion. Indirect benefits are also derived from multiplier effects of more efficient spending on the broader economy.[9] Overall, the cost–benefit ratio for the improvement components of the SDP (better regulatory frameworks and systems plus capacity development) is estimated at about 2.8:1.0 (Table 4).

Table 4: Cost–Benefit Ratio of System Improvements and Capacity Building

Costs ($ million)	**Benefits** ($ million)	**Cost–Benefit Ratio**
21.0	59.1 *(increased fiscal space and multiplier effects on GDP)*	2.8

GDP = gross domestic product.

[9] ADB analysis suggests that fiscal multipliers are in the order of 0.9 for less import-dependent Pacific economies such as Fiji. See: ADB. 2009. *Taking the Helm: A Policy Brief on a Response to the Global Economic Crisis.* Manila.