DOCUMENT OF THE INTER-AMERICAN DEVELOPMENT BANK

**Guyana**

**Support to Improve Maternal and Child Health**

**(GY-L1058)**

**Annex of The ex ante Economic Analysis**

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# Introduction

* 1. Guyana has shown good macroeconomic indicators and achieved the compliance of important goals in public health, however, it still presents opportunities for improving maternal and neonatal health. The country has experienced 10 consecutive years of real growth with low inflation and stable exchange rate[[1]](#footnote-1). Between 1991 and 2015, Guyana increased its life expectancy in five years and also reached the nutrition, child health and communicable diseases goals defined in the Millennium Development Goals[[2]](#footnote-2). However, the indicators of maternal and neonatal health show significant challenges compared to other countries in Latin America. The maternal mortality ratio is estimated at 121 per 100,000 live births, infant mortality ratio is estimated at 23 per 1,000 live births, and 93% of deaths in children under one year occur in the neonatal period[[3]](#footnote-3). Such indicators are of concern if one takes into consideration that the main causes of maternal deaths, such as post-partum haemorrhage and pregnancy-induced hypertension, and major causes of neonatal deaths, such as prematurity and respiratory diseases, are treatable causes.[[4]](#footnote-4)
	2. The evaluated project aims to contribute to the reduction of maternal, perinatal and neonatal deaths by 2021 in Guyana and is focused in regions 3, 4, and 9. This target has two impact indicators in the results matrix which can be grouped as avoided disability-adjusted life years (DALY). This unit of measurement synthesizes the lost life years due to premature death and disability.

**Illustration 1. Intervention areas of the project**



Notes: In orange, the three regions to be intervened; in blue, the location of the hospitals Georgetown Public Hospital Coorporation (GPHC) and D.C. Nicholson. Source: Prepared by the authors

* 1. The project contemplates three components (see Box 1). The first component is aimed at strengthening maternal and neonatal services with two sub-components: one aimed at improving access and the other quality. The second component seeks to strengthen the network of health services through a network analysis and investment in infrastructure, equipment and transportation. The third component is administration and auditing, and is considered an enabling component of the first two. These three components act synergistically and their full effect can be measured with two impact indicators defined in the results matrix: reduction in maternal and neonatal deaths. The avoided deaths can be referred to in terms of DALYs. This analysis shows all the effects associated to the project. The costs of the three components were registered in the costs section according to the project budget, and other costs, such as the maintenance cost of the created infrastructure, that are not directly assumed by the project itself but that could triggered because of its implementation were added.

**Box 1. Components of the project**

**Component 1. Strengthening reproductive, maternal, and neonatal health services.**

**Sub-component 1. Access and use of reproductive, maternal, and neonatal health services.**

The objective of this component is to increase access and use of reproductive, maternal, and neonatal health services. To achieve this objective, this component will finance: (i) strengthening of the community platform and the primary level of care for service delivery in regions 3, 4, and 9;[[5]](#footnote-5) (ii) procurement of equipment/supplies; (iii) strengthening of the maternity waiting home strategy, including the development of individual and community plans to support women and newborns to access facilities in region 9; and (iv) design and implementation of behavioral change communication strategies, including messages targeted at adolescents, men, and indigenous people.

**Sub-component 2. Quality of reproductive, maternal, and neonatal health services.**

The objective of this component is to improve the quality of reproductive, maternal, and neonatal health services. To achieve this objective, this component will finance: (i) design and implementation of a QIS in hospitals of regions 3, 4, and 9, including the improvement of clinical and management practices and the promotion of patient-centered and culturally-appropriate care; (ii) revision and update of guidelines, protocols, and strategies; (iii) improvements in the supply chain for contraceptive methods, drugs, and blood products,[[6]](#footnote-6) including procurement of equipment; (iv) improvements in health information; and (v) development of skills in the workforce of regions 3, 4, and 9 related to reproductive, maternal, and neonatal health.

**Component 2. Strengthening the healthcare network.**

The objective of this component is to increase the effectiveness of the maternal and neonatal health care network. To achieve this objective, this component will finance: (i) assessment and reorganization of Guyana’s healthcare and referral networks, including the revision and adjustment of the portfolio of services and the roles of different cadres of health workers; (ii) infrastructure improvements to C.C. Nicholson Hospital; (iii) procurement of equipment for health facilities, including GPHC, C.C. Nicholson Hospital, and the Georgetown maternity waiting home; and (iv) ambulances and communication system (radios for health facilities and ambulances) for regions 3, 4, and 9.

**Component 3. Administration, auditing, and evaluation.**

The objective of this component is to support project administration and evaluation activities, including ancillary expenses and strengthening the capacity of the Maternal and Child Health (MCH) Unit of the MoPH, which will assume overall responsibility for project implementation. This component will support the recruitment of five staff: a project coordinator; two fiduciary officers; a health specialist; and a planning, monitoring, and evaluation officer.

Source: Taken from the *Proposal For Operation Development*.

* 1. As presented in the next section -Assumptions and Alternatives- in the project design there were considered alternatives that were discarded for different reasons such as technical feasibility. At the time of performing this evaluation only two alternatives are relevant: (1) doing the project as is expressed in the Proposal for Operation Development; and (2) not to do it.
	2. The project has low uncertainty and associated risks. Interventions to reduce maternal and neonatal mortality are well known, with abundant reports of effectiveness in the literature, and have also been successfully supported by the IDB in different contexts. In any case, in this evaluation is performed a sensitivity analysis considering the variation ranges of the main variables of the model.
	3. The conclusions section presents the results of this analysis, in which has been found that the project "SUPPORT TO IMPROVE MATERNAL AND CHILD HEALTH " has a good incremental cost effectiveness index. That is, the cost of averting a DALY by the operation is less than the willingness to pay commonly used. So it is possible to say that the implementation of the project would generate a net gain in the welfare of the population of Guyana.
1. **Assumptions and alternatives**
	1. Economic evaluations are classified into two types: Cost Benefit Assessments (CBA) and Cost-Effectiveness Assessments (CEA). In both, costs and outcomes of two or more interventions are compared. However, they differ because in the CBA the analyzed outcome is the net profit measured in monetary units, while in the CEA the analyzed outcome is the net effect that is measured in non-monetary units (Office of Strategic Planning and Development Effectiveness. Inter-American Development Bank, 2012).
	2. It has been chosen a cost effectiveness assessment given that the objective of the project is the reduction of maternal and neonatal deaths. This objective is expressed in the results matrix with two impact indicators: Maternal Mortality Ratio and Neonatal Mortality Rate. These indicators expressed in absolute terms correspond to a number of maternal and neonatal deaths avoided. Neonatal and maternal deaths have different social implications, however, both can be referred to in terms of lost years. Then, the years of life gained can be used as an effect measure that expresses all the expected impact of the project. These years of life could be monetized to get a CBA, but in this case, by having a single measure of effect, was preferred to perform a CEA to make explicit the willingness to pay per year of life gained. The life years gained were adjusted by the average disability in this country to take them to DALYs, which is a measure commonly used in this type of assessments, for which have been established thresholds of willingness to pay.
	3. Different alternatives were considered during the project design such as the renovation of the East Bank Demerara (Diamond) Hospital located in region 4. However, it was required a high investment in infrastructure and equipment. Also, it was considered the construction of a new health unit in region 4, which could be a maternity or a second level hospital. This unit could attend low-risk births and help to decongest Georgetown Hospital, also located in region 4. However, there are important technical issues on whether the demand for services justifies the construction of a new health unit, with its implications in physical infrastructure, equipment, human resources and administrative effort. So, in coordination with government officials, it was considered that strengthening hospitals, such as the regional hospital in region 3, to decrease the number of references to the hospital in Georgetown, and investing strategically in the Nicholson Hospital for a lower amount, allied to strategic interventions in service networks in these regions and in improving clinical practice and hospital management, will strongly improve the care of births in the region. This would reduce the number of births attended in Georgetown hospital, correcting the saturation of its services and, with the support of other interventions, improving quality in their provision. This consensus is expressed in the 3 components of the current formulation of the project.
	4. Considering the above, at the time of this evaluation there are no other alternatives that are competing for the resources of the project, as these have been being discarded in its design, based on the priorities of the country and on their viability. Thus, the relevant alternatives to consider are two: (1) conducting the intervention with all its components with the achievement of the goals expressed in the results matrix, as expressed in the POD; and (2) non-performing the project, ie, maintaining the current situation (counter-factual).
	5. It is worth pointing that the activities of reducing child and maternal mortality that are defined in the project, through access to services and improving their quality, are considered among the most cost-effective activities and among those of greater impact on health that a government can implement in low-income countries, such as Guyana. (World Health Organization - CHOosing Interventions that are Cost-Effective). It can be considered that a project of this type represents an efficient way of using the resources than, for example, interventions aimed at reducing noncommunicable chronic diseases.
	6. Both alternatives of the assessment use population projections of the 2012 census, the indicators published by the Government of Guyana and projections lifted during the mission. An important assumption in the model is that it was considered that the number of births during the time horizon is stable. This assumption is based on that the population of Guyana, according to the official census, has not increased because of, among other factors, high emigration.
	7. The project has a running time of 5 years, in which investments that aim to improve maternal and child health will be implemented. These investments should bring benefits beyond the time of the project implementation. In order to account equitably both costs and benefits of the project, it has been assumed a time horizon of 10 years, taking into account the different useful lives of investments in assets: improvements to buildings, equipment, and renovation of vehicles[[7]](#footnote-7).
	8. All costs considered are presented in international dollars of 2017, the first year of the project implementation, and have been discounted at an effective rate of 12% annually, according to the methodological recommendations of the Bank (World Health Organization - CHOosing Interventions that are Cost-Effective). Costs have been taken from the project budget and, when it comes to costs that are not directly assumed by the project, local prices or international benchmarks have been employed for calculation. When international benchmarks were used, these were adjusted for purchasing power parity or inflation. To weigh the costs with the effect of the project, the avoided DALYs have been discounted at the same rate, 12%, so that it is given a lower value to the averted deaths the further away they are of the beginning of the project.
2. **Economic costs**
	1. Operating costs were estimated from a social perspective taking into account the activities of its components. The cost of not carrying out the operation is considered as base cost to facilitate analysis. Given that it does not affect the rate of cost effectiveness, there will only be considered incremental costs (Drummond, O'Brien, Stoddart, & Torrance, 2001). The incremental costs of performing the annualized operation for each of their compontes and elements are shown below. All costs are shown in constant USD of 2017.
	2. The costs were estimated taking into account the provisions of the project budget and the cost of the activities of the Results Matrix. Among the costs, are also considered other costs triggered by the project, although they are not directly assumed by the operation, as the cost of supplies that will be provided and the variable cost for the care of every birth. Also, there were included costs related to the potential hiring of new human resources in health such as doctors, nurses, midwives and nursing assistants, according to human resource gaps preliminarily estimated by the Project (see Table 2 human resource gap and annual costs).

**Table 1. Breakdown of the costs incurred by the operation Project**

| **Products**  | **Total** |
| --- | --- |
| **Component 1. Strengthening reproductive, maternal, and neonatal health services** |  |
| **Sub-Component 1. Access and use of reproductive, maternal, and neonatal health services** |  |
| Community health workers (CHWs) trained and equipped to provide reproductive, maternal, and neonatal services. | $370,000 |
| Communities with plans for institutional birth implemented. | $225,000 |
| Communities with communication strategy for behavior change implemented. | $535,000 |
| Subtotal sub-component 1 | $1,130,000 |
| **Sub-Component 2. Quality of reproductive, maternal, and neonatal health services**  |  |
| Health facilities with integrated health care strategy for women of reproductive age implemented. | $255,000 |
| Health facilities with new family planning strategy implemented. | $170,000 |
| Health facilities with updated model for prenatal, birth, postnatal, and post-partum care implemented. | $125,000 |
| Health facilities with Quality Improvement Strategy for maternal and neonatal health implemented. | $455,000 |
| Health facilities with supply chain management improved. | $100,000 |
| Health workforce trained to provide quality reproductive, maternal, and neonatal care. | $235,000 |
| Health facilities with health information system strengthened. | $350,000 |
| Sub total sub-component 2 | $1,690,000 |
| Sub total component 1 | $2,820,000 |
| **Component 2. Strengthening the healthcare network** |  |
| Integrated healthcare network for reproductive, maternal, and neonatal health enabled. | $759,000 |
| Health facilities with infrastructure improved to provide reproductive, maternal, and neonatal services. | $500,000 |
| Health facilities with equipment improved to provide reproductive, maternal, and neonatal services. | $2,050,000 |
| Ambulances equipped for emergency obstetric and newborn care delivered. | $225,000 |
| Sub total component 2 | $3,534,000 |
| **Component 3: Administration, Auditing, and Evaluation** | $1,196,000 |
| **Total proyect cost** | **$7,550,000[[8]](#footnote-8)** |

Source: Project Budget

**Table 2. Estimated human resources gap and annual costs**

|  |  |  |
| --- | --- | --- |
|  | Unitary Anual Cost | Number |
| Physicians | $13,055.00 | 12.21 |
| Registered nurses | $3,794.00 | 6.49 |
| Midwives | $2,915.00 | 23.97 |
| Asistent nurses | $3,296.00 | 15.03 |

Source: project estimations

* 1. In the case of equipment and infrastructure, it was used a cost worth 10% for the replacement (assuming a useful life of 10 years, see footnote #9) and 7.4% for maintenance**[[9]](#footnote-9)**.
	2. For the variable cost of the attention of the births are considered three values according to the following cases: (i) low risk births attended at the community level or first level of care or district hospitals; (ii) births of low and high risk treated at the second level (regional hospitals); and (iii) births of low and high risk treated at the third level (referral hospitals).
	3. In the case of low risk births attended at the community level or first level or district hospital, it was used a value reported in an experience of community care of birth in Zimbabwe, where it was estimated that the variable cost of attending a birth from the society perspective is $ 8.4 USD of 2011 (Sabian et al, 2012). This cost was adjusted for purchasing power parity -PPP- of 2011 for Zimbabwe (1.98), to bring it into international dollars of 2011. After that, the cost was adjusted for the US inflation between 2011 and 2017, which was 1.08. Finally, was adjusted by the PPP projected for Guyana in 2017 which is 1.80. Thus, it was obtained an estimated value of $ 10.57 USD 2017 for the variable cost of care of a birth. This value includes the required supplies, such as medicines to treat hypertension associated with pregnancy or postpartum hypertension, as well as inputs for immediate care of the newborns. It is assumed that with the improvement in care the supplies used for each birth will increase, taking into account that the project supports the strengthening of the supply chain. Because there were not found any studies of variable costs for births attended in more complex centers in low-income countries, it was decided to extrapolate the proportion of costs reported for Australia between births in low complexity and high complexity (Tracy, Welsh, Hall, & al, 2014). So, to estimate the cost of a low-risk birth in an institution of high complexity, the value of $10.57 USD was multiplied by the ratio between the median cost in an institution of low complexity, and the median cost in a more complex institution reported by Tracy et al, this is 1.70. In the case of high-risk births attended at the regional hospital, the value of $10.57 was multiplied by the ratio of the median cost in low complexity and the first quartile of the cost in high complexity of the study, a factor of 2.50.
	4. Table 3 shows the number of births to be assisted and has been calculated from the total fertility rate in 2011-2014 and the population census of 2012. Assuming that the population remains constant, which is a valid assumption if it is considered that the population of Guyana has a flat trend.

**Table 3. Number of births to be assisted**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Region** | **Local** | **Low risk** | **High risk** | **Total** |
| **3** | Hospital Regional West Demerara | 1,586.4 | 355.2 | **1,941.6** |
| Other health facilities/community | 41.3 |   | **41.3** |
| **Sub-total** | 1,627.6 | 355.2 | **1,982.8** |
| 4 | Georgetown Public Hospital | 4,104.1 | 1,442.0 | **5,546.0** |
| Dr. CC Nicholson Hospital | 787.0 |   | **787.0** |
| Other health facilities/community | 320.0 |   | **320.0** |
| **Sub-total** | 5,211.1 | 1,442.0 | **6,653.0** |
| **9** | Lethem Hospital, health facilities, and community | 500.9 | 92.5 | **593.4** |
|
| **Sub-total** | 500.9 | 92.5 | **593.4** |
| **Total** | **7,339.6** | **1,889.7** | **9,229.3** |

Source: project estimations

* 1. It was considered that the project will not be fully deployed from the start of the operation. The values used for the deployment are presented in Table 2 and are calculated by prorating the value of each product according to the indicators of the Results Matrix. This value is preferred over the value of the bi-annual budget, because it reflects more directly a real consumption of resources since the budget only involves a monetary transfer and not necessarily a resource consumption. In the case of the third component, whose total amount is not broken down into products, it was used the value of every year of the budget.

**Table 4. Deployment of the Project**

|  |  |
| --- | --- |
|  | **Year** |
| **1** | **2** | **3** | **4** | **5** |
| Percentage of births attended within the project. | 10% | 50% | 90% | 100% | 100% |
| Percentage of births highly complex of the regions 3 and 4 attended | 4% | 23% | 42% | 61% | 80% |
| Percentage of births highly complex of the region 9 | 0% | 3% | 5% | 8% | 10% |
| Community health workers (CHWs) trained and equipped to provide reproductive, maternal, and neonatal services. | 0% | 47% | 100% | 100% | 100% |
| Communities with plans for institutional birth implemented. | 0% | 57% | 100% | 100% | 100% |
| Communities with communication strategy for behavior change implemented. | 0% | 22% | 67% | 100% | 100% |
| Health facilities with integrated health care strategy for women of reproductive age implemented. | 0% | 35% | 70% | 100% | 100% |
| Health facilities with new family planning strategy implemented. | 0% | 35% | 70% | 100% | 100% |
| Health facilities with updated model for prenatal, birth, postnatal, and post-partum care implemented. | 0% | 70% | 100% | 100% | 100% |
| Health facilities with Quality Improvement Strategy for maternal and neonatal health implemented. | 0% | 13% | 50% | 100% | 100% |
| Health facilities with supply chain management improved. | 0% | 0% | 63% | 100% | 100% |
| Health workforce trained to provide quality reproductive, maternal, and neonatal care. | 0% | 47% | 82% | 100% | 100% |
| Health facilities with health information system strengthened. | 0% | 0% | 42% | 84% | 100% |
| Integrated healthcare network for reproductive, maternal, and neonatal health enabled. | 0% | 33% | 100% | 100% | 100% |
| Health facilities with infrastructure improved to provide reproductive, maternal, and neonatal services. | 0% | 0% | 100% | 100% | 100% |
| Health facilities with equipment improved to provide reproductive, maternal, and neonatal services. | 0% | 0% | 40% | 100% | 100% |
| Ambulances equipped for emergency obstetric and newborn care delivered. | 0% | 100% | 100% | 100% | 100% |
| Physicians | 20% | 40% | 60% | 80% | 100% |
| Nurses | 20% | 40% | 60% | 80% | 100% |
| Midwifery | 20% | 40% | 60% | 80% | 100% |
| Nursing assistants | 20% | 40% | 60% | 80% | 100% |

Source: assumption of the model and estimation based on the results matrix.

* 1. Table 4 shows the annualized costs in dollars of 2017 obtained from the model designed with a discount factor of 12% for the alternative to performing the operation (Office of Strategic Planning and Development Effectiveness. Inter-American Development Bank, 2012). Table 5 shows undiscounted costs.

**Table 5. Incremental annualized costs by activity in USD 2017 discounted at 12%**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Valor Presente | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
| **\*Component 1. Strengthening reproductive, maternal, and neonatal health services** |  |  |  |  |  |  |  |  |  |  |  |
| **-Sub-Component 1. Access and use of reproductive, maternal, and neonatal health services** |  |  |  |  |  |  |  |  |  |  |  |
| Community health workers (CHWs) trained and equipped to provide reproductive, maternal, and neonatal services. | $311,618 | $0 | $155,462 | $156,156 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Communities with plans for institutional birth implemented. | $191,598 | $0 | $114,144 | $77,455 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Communities with communication strategy for behavior change implemented. | $422,640 | $0 | $106,151 | $189,555 | $126,934 | $0 | $0 | $0 | $0 | $0 | $0 |
| Subtotal sub-component 1 | $925,857 | $0 | $375,757 | $423,166 | $126,934 | $0 | $0 | $0 | $0 | $0 | $0 |
| -Sub-Component 2. Quality of reproductive, maternal, and neonatal health services  | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with integrated health care strategy for women of reproductive age implemented. | $205,264 | $0 | $79,608 | $71,078 | $54,578 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with new family planning strategy implemented. | $136,843 | $0 | $53,072 | $47,386 | $36,385 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with updated model for prenatal, birth, postnatal, and post-partum care implemented. | $108,011 | $0 | $78,047 | $29,964 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with Quality Improvement Strategy for maternal and neonatal health implemented. | $348,732 | $0 | $50,781 | $136,021 | $161,930 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with supply chain management improved. | $76,554 | $0 | $0 | $50,173 | $26,381 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health workforce trained to provide quality reproductive, maternal, and neonatal care. | $194,272 | $0 | $98,354 | $65,862 | $30,056 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with health information system strengthened. | $257,373 | $0 | $0 | $117,070 | $104,527 | $35,776 | $0 | $0 | $0 | $0 | $0 |
| Sub total sub-component 2 | $1,327,050 | $0 | $359,862 | $517,555 | $413,857 | $35,776 | $0 | $0 | $0 | $0 | $0 |
| Sub total component 1 | $2,252,907 | $0 | $735,618 | $940,721 | $540,792 | $35,776 | $0 | $0 | $0 | $0 | $0 |
| \*Component 2. Strengthening the healthcare network |  |  |  |  |  |  |  |  |  |  |  |
| Integrated healthcare network for reproductive, maternal, and neonatal health enabled. | $629,273 | $0 | $225,893 | $403,380 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with infrastructure improved to provide reproductive, maternal, and neonatal services. | $398,597 | $0 | $0 | $398,597 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Health facilities with equipment improved to provide reproductive, maternal, and neonatal services. | $1,529,189 | $0 | $0 | $653,699 | $875,490 | $0 | $0 | $0 | $0 | $0 | $0 |
| Ambulances equipped for emergency obstetric and newborn care delivered. | $200,893 | $0 | $200,893 | $0 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| Sub total component 2 | $2,757,951 | $0 | $426,786 | $1,455,676 | $875,490 | $0 | $0 | $0 | $0 | $0 | $0 |
| Component 3: Administration, Auditing, and Evaluation | $985,264 | $263,300 | $249,631 | $247,203 | $66,575 | $158,555 | $0 | $0 | $0 | $0 | $0 |
| Total proyect cost | $5,996,122 | $263,300 | $1,412,035 | $2,643,600 | $1,482,856 | $194,330 | $0 | $0 | $0 | $0 | $0 |
| Maintenance cost | $853,113 | $0 | $14,866 | $91,143 | $146,164 | $130,504 | $116,521 | $104,037 | $92,890 | $82,937 | $74,051 |
| Replacement cost | $85,311 | $0 | $1,487 | $9,114 | $14,616 | $13,050 | $11,652 | $10,404 | $9,289 | $8,294 | $7,405 |
| Sub total maintenance and remplacement cost | $938,425 | $0 | $16,353 | $100,257 | $160,780 | $143,554 | $128,173 | $114,440 | $102,179 | $91,231 | $81,456 |
| Birth variable cost communitary level | $294,897 | $6,016 | $26,856 | $43,161 | $42,819 | $38,231 | $34,135 | $30,478 | $27,212 | $24,297 | $21,693 |
| Birth variable cost low risk hsptl Regional | $157,981 | $3,223 | $14,387 | $23,122 | $22,939 | $20,481 | $18,287 | $16,327 | $14,578 | $13,016 | $11,621 |
| Birth variable cost high risk hsptl Regional | $225,635 | $4,603 | $20,548 | $33,024 | $32,762 | $29,252 | $26,118 | $23,319 | $20,821 | $18,590 | $16,598 |
| Sub total Birth variable cost | $678,513 | $13,841 | $61,791 | $99,308 | $98,519 | $87,964 | $78,539 | $70,124 | $62,611 | $55,903 | $49,913 |
| Physicians | $722,192 | $31,876 | $56,921 | $76,233 | $90,754 | $101,288 | $90,436 | $80,746 | $72,095 | $64,370 | $57,474 |
| nurses | $111,521 | $4,922 | $8,790 | $11,772 | $14,014 | $15,641 | $13,965 | $12,469 | $11,133 | $9,940 | $8,875 |
| midwifery | $316,610 | $13,974 | $24,954 | $33,421 | $39,787 | $44,405 | $39,647 | $35,399 | $31,606 | $28,220 | $25,196 |
| Nursing assistants | $224,469 | $9,907 | $17,692 | $23,695 | $28,208 | $31,482 | $28,109 | $25,097 | $22,408 | $20,007 | $17,864 |
| Subtotal Human Resources | $1,374,793 | $60,680 | $108,357 | $145,121 | $172,763 | $192,816 | $172,157 | $153,711 | $137,242 | $122,538 | $109,409 |
| Cost lives saved | $631,546 | $12,883 | $57,514 | $92,434 | $91,700 | $81,875 | $73,103 | $65,270 | $58,277 | $52,033 | $46,458 |
| **Total Cost** | $9,619,399 | $350,704 | $1,656,050 | $3,080,719 | $2,006,619 | $700,539 | $451,972 | $403,546 | $360,309 | $321,705 | $287,236 |

Source: model result

**Table 6. Incremental annualized costs by activity in USD 2017 undiscounted**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Valor Presente | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
| **\*Component 1. Strengthening reproductive, maternal, and neonatal health services** |  |  |  |  |  |  |  |  |  |  |  |
| **-Sub-Component 1. Access and use of reproductive, maternal, and neonatal health services** |  |  |  |  |  |  |  |  |  |  |  |
| Community health workers (CHWs) trained and equipped to provide reproductive, maternal, and neonatal services. | $370,000 | $0 | $174,118 | $195,882 | $0 | $0 |  |  |  |  |  |
| Communities with plans for institutional birth implemented. | $225,000 | $0 | $127,841 | $97,159 | $0 | $0 |  |  |  |  |  |
| Communities with communication strategy for behavior change implemented. | $535,000 | $0 | $118,889 | $237,778 | $178,333 | $0 |  |  |  |  |  |
| Subtotal sub-component 1 | $1,130,000 | $0 | $420,847 | $530,819 | $178,333 | $0 |  |  |  |  |  |
| -Sub-Component 2. Quality of reproductive, maternal, and neonatal health services  |  | $0 | $0 | $0 | $0 | $0 |  |  |  |  |  |
| Health facilities with integrated health care strategy for women of reproductive age implemented. | $255,000 | $0 | $89,161 | $89,161 | $76,678 | $0 |  |  |  |  |  |
| Health facilities with new family planning strategy implemented. | $170,000 | $0 | $59,441 | $59,441 | $51,119 | $0 |  |  |  |  |  |
| Health facilities with updated model for prenatal, birth, postnatal, and post-partum care implemented. | $125,000 | $0 | $87,413 | $37,587 | $0 | $0 |  |  |  |  |  |
| Health facilities with Quality Improvement Strategy for maternal and neonatal health implemented. | $455,000 | $0 | $56,875 | $170,625 | $227,500 | $0 |  |  |  |  |  |
| Health facilities with supply chain management improved. | $100,000 | $0 | $0 | $62,937 | $37,063 | $0 |  |  |  |  |  |
| Health workforce trained to provide quality reproductive, maternal, and neonatal care. | $235,000 | $0 | $110,156 | $82,617 | $42,227 | $0 |  |  |  |  |  |
| Health facilities with health information system strengthened. | $350,000 | $0 | $0 | $146,853 | $146,853 | $56,294 |  |  |  |  |  |
| Sub total sub-component 2 | $1,690,000 | $0 | $403,045 | $649,221 | $581,440 | $56,294 |  |  |  |  |  |
| Sub total component 1 | $2,820,000 | $0 | $823,893 | $1,180,040 | $759,773 | $56,294 |  |  |  |  |  |
| \*Component 2. Strengthening the healthcare network |  | $0 | $0 | $0 | $0 | $0 |  |  |  |  |  |
| Integrated healthcare network for reproductive, maternal, and neonatal health enabled. | $759,000 | $0 | $253,000 | $506,000 | $0 | $0 |  |  |  |  |  |
| Health facilities with infrastructure improved to provide reproductive, maternal, and neonatal services. | $500,000 | $0 | $0 | $500,000 | $0 | $0 |  |  |  |  |  |
| Health facilities with equipment improved to provide reproductive, maternal, and neonatal services. | $2,050,000 | $0 | $0 | $820,000 | $1,230,000 | $0 |  |  |  |  |  |
| Ambulances equipped for emergency obstetric and newborn care delivered. | $225,000 | $0 | $225,000 | $0 | $0 | $0 |  |  |  |  |  |
| Sub total component 2 | $3,534,000 | $0 | $478,000 | $1,826,000 | $1,230,000 | $0 |  |  |  |  |  |
| Component 3: Administration, Auditing, and Evaluation | $1,196,000 | $263,300 | $279,587 | $310,091 | $93,533 | $249,489 |  |  |  |  |  |
| Total proyect cost | $7,550,000 | $263,300 | $1,581,480 | $3,316,131 | $2,083,306 | $305,783 |  |  |  |  |  |
| Maintenance cost | $1,568,430 | $0 | $16,650 | $114,330 | $205,350 | $205,350 | $205,350 | $205,350 | $205,350 | $205,350 | $205,350 |
| Replacement cost | $156,843 | $0 | $1,665 | $11,433 | $20,535 | $20,535 | $20,535 | $20,535 | $20,535 | $20,535 | $20,535 |
| Sub total maintenance and remplacement cost | $1,725,273 | $0 | $18,315 | $125,763 | $225,885 | $225,885 | $225,885 | $225,885 | $225,885 | $225,885 | $225,885 |
| Birth variable cost communitary level | $511,337 | $6,016 | $30,079 | $54,142 | $60,157 | $60,157 | $60,157 | $60,157 | $60,157 | $60,157 | $60,157 |
| Birth variable cost low risk hsptl Regional | $273,930 | $3,223 | $16,114 | $29,004 | $32,227 | $32,227 | $32,227 | $32,227 | $32,227 | $32,227 | $32,227 |
| Birth variable cost high risk hsptl Regional | $391,240 | $4,603 | $23,014 | $41,425 | $46,028 | $46,028 | $46,028 | $46,028 | $46,028 | $46,028 | $46,028 |
| Sub total Birth variable cost | $1,176,508 | $13,841 | $69,206 | $124,571 | $138,413 | $138,413 | $138,413 | $138,413 | $138,413 | $138,413 | $138,413 |
| Physicians | $1,275,029 | $31,876 | $63,751 | $95,627 | $127,503 | $159,379 | $159,379 | $159,379 | $159,379 | $159,379 | $159,379 |
| nurses | $196,890 | $4,922 | $9,845 | $14,767 | $19,689 | $24,611 | $24,611 | $24,611 | $24,611 | $24,611 | $24,611 |
| midwifery | $558,974 | $13,974 | $27,949 | $41,923 | $55,897 | $69,872 | $69,872 | $69,872 | $69,872 | $69,872 | $69,872 |
| Nursing assistants | $396,300 | $9,907 | $19,815 | $29,722 | $39,630 | $49,537 | $49,537 | $49,537 | $49,537 | $49,537 | $49,537 |
| Subtotal Human Resources | $2,427,192 | $60,680 | $121,360 | $182,039 | $242,719 | $303,399 | $303,399 | $303,399 | $303,399 | $303,399 | $303,399 |
| Cost lives saved | $1,095,070 | $12,883 | $64,416 | $115,949 | $128,832 | $128,832 | $128,832 | $128,832 | $128,832 | $128,832 | $128,832 |
| **Total Cost** | $13,974,043 | $350,704 | $1,854,777 | $3,864,454 | $2,819,155 | $1,102,311 | $796,529 | $796,529 | $796,529 | $796,529 | $796,529 |

Source: model result

1. **Cost-effectiveness measures**
	1. The results matrix considers multiple indicators of process/output, outcome and impact. Taking into account the guidelines of the IDB methodology guide, it was preferred to analyze the impact indicators that subsume the effects of other indicators. Two indicators of impact for the project are: Maternal Mortality Ratio and Neonatal Mortality Rate (see Table 7). These indicators expressed in absolute terms correspond to a number of maternal and neonatal deaths avoided. It is worth pointing that the goals of these indicators can be considered conservative if they are contrasted against similar experience; see for example (Mangham-Jefferies, Chaterine, S, & al., 2014).
	2. Project targets for reductions in Guyana’s maternal mortality ratio and neonatal mortality rate were estimated based on global and regional estimates for the annual change in mortality in different socioeconomic percentiles[[10]](#footnote-10) and the estimated annual change in mortality in Guyana. The final estimation is a combination of the expected change with no intervention plus the expected change with intervention. For more information, please see Monitoring and Evaluation Plan.
	3. Neonatal and maternal deaths have different social implications, however both can be added in terms of lost years. Then, the years of life gained can be used as an effect measure that expresses all the expected impact of the project. These years of life could be monetized to get a CBA, but in this case, in which there is a single measure of effect, it was preferred to perform a CEA to make explicit the willingness to pay per year of life gained. The life years gained were adjusted for the average disability of the country to take them into DALYs, which is a measure commonly used in this type of assessments in which have been established thresholds of willingness to pay.

**Table 7. Impact indicators of results matrix**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Indicators** | **Unit**  | **Baseline** | **Goals** | **Means of verification** | **Observations** |
| **Value** | **Year** | **Value** | **Year** |
| **Objective: Contribute to the reduction of maternal, perinatal, and neonatal deaths in Guyana by 2020** |
| Maternal Mortality Ratio | Maternal deaths x 100,000 | 121.7 | 2014 | 87.9 | 2020 | Chief Medical Officer Report | Maternal Mortality Ratio at the national level estimated using preliminary data from the CMO Report. |
| Neonatal Mortality Rate | Neonatal deaths x 1,000 | 21.7 | 2014 | 15.2 | 2020 | Chief Medical Officer Report | Neonatal Mortality Rate at the national level estimated using preliminary data from the CMO Report. |

Source: results matrix of the project

1. **Assessment of cost effectiveness**
	1. Table 6 shows the results of the assessment of incremental cost effectiveness between the two alternatives for the time horizon of 10 years with a discount rate of 12%. It is found that the incremental cost effectiveness ratio (ICER) of the alternative of performing the operation is $3,504 USD 2017 per DALY avoided. Following the discussions of WHO, it was taken as a benchmark the value of GDP per capita per year of full health to classify an intervention as highly cost effective (World Health Organization - CHOosing Interventions that are Cost-Effective). Also, considering that the GPD per capita of Guyana for 2017 is projected at $4.545[[11]](#footnote-11), the ICER estimated per DALY avoided can be considered as highly cost effective.

**Table 8. Results of the assessment of cost effectiveness, discounted 12%**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Cost USD 2016** | **DALYs** | **Incremental Cost** | **DALYs avoided** | **ICER****DALYs avoided/USD 2017** |
| Not to perform the operation | $0\* | 11,877 | $9,619,399 | 2,745 | $3,504 |
| Perform the operation |  $9,619,399 |  9,131 |

Source: model results. Notes: \*Only incremental costs are being considered.

* 1. Table 8 provides a breakdown of DALYs avoided by region and impact indicator.

**Table 9. Breakdown of DALYs by impact and region**

|  |  |  |
| --- | --- | --- |
|  | **Region** | **Total** |
| **3** | **4** | **9** |
| Accumulated neonates DALY | 561 | 1883 | 168 | **2613** |
| Accumulated maternl DALY | 28 | 96 | 9 | **133** |
| Accumulated total DALY | **590** | **1979** | **177** | **2745** |

Source: model results.

* 1. DALYs for each alternative were calculated as the sum of the DALYs for maternal deaths and neonatal deaths. DALYs for maternal deaths were calculated as the number of maternal deaths deducted for each year and the number of years of life without disabilities that a mother would have if she doesn’t die in the childbirth, considering an average gestational age of 27 years (according to the census 2002[[12]](#footnote-12)), a life expectancy of 67 years and the average disability is 0.048[[13]](#footnote-13). The number of DALYs by death was calculated using a formula of present value for a series of payments, as follows:

$$DALYs=-\frac{\left(1-0.048\right)\left(1+12\%\right)\left(\frac{\left(1+12\%\right)^{\left(67-27-1\right)}-1}{12\%}\right)}{\left(1+12\%\right)^{\left(67-27-1\right)}}+\left(1-0.048\right)$$

* 1. Maternal deaths were calculated as the product of the number of births, the indicator of *Maternal Mortality Ratio*, and the number of expected births for each year. The deaths were discounted using a rate of 12%, giving less weight to future deaths. For the alternative of not performing the operation, the current value of *Maternal Mortality Ratio* was used. For the alternative of performing the operation, it was applied the target value of the indicator for a proportion of births that increased progressively according to the values of the deployment of the project, see Table 3.
	2. The DALYs for neonatal deaths are calculated analogously using the following formula for DALYs per neonate:

$$DALYs=-\frac{\left(1-0.048\right)\left(1+12\%\right)\left(\frac{\left(1+12\%\right)^{\left(67-1\right)}-1}{12\%}\right)}{\left(1+12\%\right)^{\left(67-1\right)}}+\left(1-0.048\right)$$

1. **Sensitivity analysis**
	1. Thre types of sensitivity analysis were performed: a bivariate analysis for different scenarios of time horizons and discount rates; and a multivariate analysis Monte Carlo type and a breakdown effectiveness analysis. The result of the bivariate analysis is shown in Table 9 with different scenarios of discount rates and time horizons. It is observed that, by increasing the time horizon, the ICER falls as a result of accounting the future effects on neonatal deaths avoided with the intervention. It also notes that the model is more sensitive to changes in the time horizon than to changes in the discount rate.

**Table 10. Bivariate analysis sensitivity: different time horizons and discount rates**

Source: model results.

* 1. For the Montecarlo multivariate analysis, it was used a normal distribution with a standard deviation of 10% of the average for the *Neonatal Mortality Rate*, *Maternal Mortality Ratio*, the number of births, the percentage of the replacement cost, equipment maintenance and infrastructure and variable cost for the care of every birth. There were performed 1,000 simulations whose results are shown in Illustration 2. It is noted that 95% of cases are highly cost effective. The maximum value of the ICER obtained in the simulations was $ 9,500, which can be considered cost effective.

**Illustration 2. Results of sensitivity analysis Monte Carlo type**

Source: model results.

* 1. The breakdown effectiveness analysis was performed to search the minimum size effect at which the intervention remains cost effective. It was used a range of goal effect in Neonatal Mortality Rate and Maternal Mortality Ratio from the case base goal to the same value of the baseline (none effect). There were performed 100 cases whose results are shown in Illustration 3. The red line in the illustration is the frontier where the intervention remains cost effectiveness. For all cases with goal in NMR inferior to 20.26, mean that with just a reduction of 7% in NMR, and with nothing in MMR the intervention is cost effectiveness.

**Illustration 3. GDP per DALY for sevreal values of effect in MMR and NMR**



Source: model results. Notes: The red line is the fronteir off cost effectivenes.

1. **Additional analysis: impact on current spending**
	1. This economic analysis leads to the conclusion that the project "SUPPORT TO IMPROVE MATERNAL AND CHILD HEALTH" (GY-L1058) provides a net welfare gain to the society of Guyana. This analysis considered the direct costs of the operation and the increase in the current spending of the government. However, besides considering whether the project represents an efficient use of resources, it is important to establish whether it is financeable, especially taking into account the increase in recurrent expenditure that the government should assume. By assuming the cathegories of inputs for an improved birth care, maintenance of infrastructure and equipment, infrastructure and equipment replacement, and salaries of the professionals needed to close the gap in human resources, in Table 11 is presented an annualized breakdown of these undiscounted expenses, which shows that for each of the ten years of analysis the recurring costs associated with the project remain below 0.9% of the health expenditures.

**Table 11. Health expenditure and recurrent expenditure associated with the project**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** |
| Maintenance cost | $0 | $16,650 | $114,330 | $205,350 | $205,350 | $205,350 | $205,350 | $205,350 | $205,350 | $205,350 |
| Replacement cost | $0 | $1,665 | $11,433 | $20,535 | $20,535 | $20,535 | $20,535 | $20,535 | $20,535 | $20,535 |
| Sub total maintence and remplacemetn cost | $0 | $18,315 | $125,763 | $225,885 | $225,885 | $225,885 | $225,885 | $225,885 | $225,885 | $225,885 |
| Birth variable cost communitary level | $6,016 | $30,079 | $54,142 | $60,157 | $60,157 | $60,157 | $60,157 | $60,157 | $60,157 | $60,157 |
| Birth variable cost low risk hsptl Regional | $3,223 | $16,114 | $29,004 | $32,227 | $32,227 | $32,227 | $32,227 | $32,227 | $32,227 | $32,227 |
| Birth variable cost high risk hsptl Regional | $4,603 | $23,014 | $41,425 | $46,028 | $46,028 | $46,028 | $46,028 | $46,028 | $46,028 | $46,028 |
| Sub total Birth variable cost | $13,841 | $69,206 | $124,571 | $138,413 | $138,413 | $138,413 | $138,413 | $138,413 | $138,413 | $138,413 |
| Physicians | $31,876 | $63,751 | $95,627 | $127,503 | $159,379 | $159,379 | $159,379 | $159,379 | $159,379 | $159,379 |
| Nurses | $4,922 | $9,845 | $14,767 | $19,689 | $24,611 | $24,611 | $24,611 | $24,611 | $24,611 | $24,611 |
| Midwifery | $13,974 | $27,949 | $41,923 | $55,897 | $69,872 | $69,872 | $69,872 | $69,872 | $69,872 | $69,872 |
| Nursing assistants | $9,907 | $19,815 | $29,722 | $39,630 | $49,537 | $49,537 | $49,537 | $49,537 | $49,537 | $49,537 |
| Subtotal Human Resources | $60,680 | $121,360 | $182,039 | $242,719 | $303,399 | $303,399 | $303,399 | $303,399 | $303,399 | $303,399 |
| **Total estimated recurrent costs** | **$149,042** | **$417,762** | **$864,748** | **$1,214,034** | **$1,335,394** | **$1,335,394** | **$1,335,394** | **$1,335,394** | **$1,335,394** | **$1,335,394** |
| **Total health expenditures\*** | **$121,441,463** | **$128,958,160** | **$136,474,857** | **$143,991,554** | **$151,508,251** | **$159,024,948** | **$166,541,645** | **$174,058,342** | **$181,575,039** | **$189,091,736** |
| ***Estimated recurrent cost as % of total health expenditures*** | ***0.12%*** | ***0.32%*** | ***0.63%*** | ***0.84%*** | ***0.88%*** | ***0.84%*** | ***0.80%*** | ***0.77%*** | ***0.74%*** | ***0.71%*** |

Source: Model results and own projections from the government budget. Note: \* linear model from reported spending between 2005 and 2016.

1. **Conclusions**
	1. An ex ante economic assessment was performed of the cost-effectiveness type for the components of the operation "SUPPORT TO IMPROVE MATERNAL AND CHILD HEALTH" (GY-L1058). This analysis was performed from the perspective of society with a discount rate of 12% and following other guidelines for the economic assessment of projects financed by the IDB. A case basis was analyzed with a time horizon of 10 years. The effectiveness data were obtained from the goals of the results matrix and were confronted with the effectiveness results reported for similar interventions in comparable contexts. The costs were obtained from the project budget. For costs not directly assumed by the project, the references published in the literature were used. Throughout the analysis we chose to overestimate the costs of operation and underestimate the effect achieved in order to have a conservative approach to the cost-effectiveness of the operation.
	2. For the base case was estimated an ICER of $ 3,504 USD 2017 per DALY avoided. These calculations were performed with an average of 8.8 years without disability, a discount rate of 12%, a life expectancy of 67 years and an average disability of 0.048. There were considered DALYs won by avoiding both neonatal and maternal deaths. The comparison of this value per DALY avoided with the GDP per capita of 2017 ($ 4,545 USD) allows to consider the operation as highly cost effective according to the commonly accepted standards.
	3. In addition, sensitivity analysis with different time horizons and discount rates were made. Similarly, it was tried out with variations of the main variables of the results matrix and for several changes in effect size. It was found that the model results are robust to changes in these variables.
	4. Taking into account the results of the base case and sensitivity analyzes and accepting the limitations and assumptions of this assessment, it can be considered that the proposed operation is highly cost effective and its implementation would generate an increase in net welfare of the people of Guyana.

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2. PAHO Basic Indicators. [↑](#footnote-ref-2)
3. CMO Annual Report 2014. In LAC, maternal mortality is 62.9 and infant mortality is 15.7 (PAHO Basic Indicators 2014). [↑](#footnote-ref-3)
4. CMO Annual Report 2014. [↑](#footnote-ref-4)
5. The distribution of repellent and insecticide-treated mosquito nets for the prevention of malaria and other mosquito-borne diseases, such as dengue and zika, will be included. Currently, only 7% of pregnant women sleep under insecticide-treated mosquito nets (MICS 2014). [↑](#footnote-ref-5)
6. Consultancy services to analyze bottlenecks that may be contributing to disruptions in the supply chain (critical activities to guarantee the availability of inputs, such as purchasing, storage, and distribution). [↑](#footnote-ref-6)
7. The exact times of useful life used as reference for accounting vary according to the type of medical equipment, vehicle and infrastructure improvement. In any case, 10 years is a conservative approach. <http://www.ofm.wa.gov/policy/30.50.htm> [↑](#footnote-ref-7)
8. It is not included the amount related to contingencies. [↑](#footnote-ref-8)
9. <http://www.ncbi.nlm.nih.gov/pubmed/7176994> [↑](#footnote-ref-9)
10. IHME. 2011. “Target Setting Guidelines.” Seattle, WA: Institute for Health Metrics and Evaluation, University of Washington. [↑](#footnote-ref-10)
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12. The last census of 2012 does not report the average age of gestation [↑](#footnote-ref-12)
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