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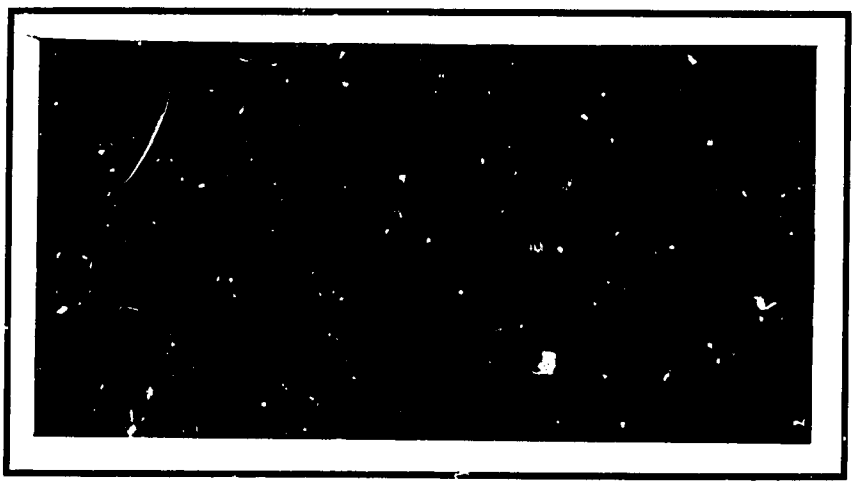

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Economic Analyses of Proposal
Expanded National Immunization Proposal
and
Malaria Control Program for Outer Islands

Republic of Indonesia

International Health Programs
American Public Health Association
1978

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Studies & Report by:	Howard N. Barnum
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Part I

Summary and Scope of Consultation

I. Summary and Scope of Consultation of USAID/Indonesia, HN; March 28 - May 3, 1978

The terms of my consultation were to prepare the economic analyses for the project papers related to:

1) The Expanded Program of Immunization Project (PID #497-0253)
2) The Malaria Control Project (PID #497-0288)
3) The Primary Health Nurse Training Project (PID #497-0289)

The duration of the consultancy was to be four to six weeks beginning on March 22, including time for briefing at AID/Washington, travel, and duty at USAID/Indonesia. From March 27 to April 20 I worked on the Expanded Program in Immunization analysis. Output from this analysis included the estimation of the number of cases and deaths prevented for each of the four diseases in the program as well as the completion of cost effectiveness and cost-benefit studies. The cooperation of other team members and Ministry of Health officials was valuable in the completion of this report. I especially appreciated the help given by Daniel Tarantola (CDC-WHO) and Robert Hogan (CDC-USA). The resulting analysis, which indicates that the proposed immunization program is highly cost effective, is presented in Part II of this report.

On April 20 and 21 I conducted background interviews with Ministry of Health officials in preparation for the economic analysis of the Nurses Training Project. However, it was decided by Dr. Vanderhoof, Chief, office of population and health, AID/Indonesia, to delay preparation on the project paper for this project to give the Indonesian Ministry of Health time to define the structure of the program more precisely and to assemble supporting data. Accordingly, the economic analysis was postponed until a future date at which time it was expected that I will return for three to four weeks to prepare the analysis.

From April 23 to May 3 I worked on the economic analysis of the Malaria Control Project for the Outer Islands. I greatly appreciate the help of Larry Cowper in providing the malariological background for this report. The resulting analysis, which indicates that the proposed malaria control project is marginally economically viable and that the economic viability can be expected to be highly sensitive to the efficiency of administration and management, is presented in Part III below.

With regard to all my duties in Jakarta I greatly appreciate the helpful advice and assistance of Richard Johnson and Lance Downing.

PART II

AN ECONOMIC ANALYSIS OF AN EXPANDED PROGRAM OF IMMUNIZATION IN INDONESIA

Howard Barnum

Summary and Conclusions

The economic analysis reported below indicates that, in addition to the humanitarian benefits of reduced mortality and morbidity, an expanded program of immunization for diptheria, whooping cough, tetanus and tuberculosis, can be expected to be cost effective in comparison with treatment and to provide significant economic benefits for the target population. While it is not possible to quantify the greater part of the benefits from the proposed program, a sufficient part of the benefits can be evaluated to justify the project on purely economic grounds. Sensitivity tests illustrate that this conclusion remains valid even when costs are increased by 20% and benefits reduced by 50%.

While the employment effects are modest (3,000 to 4,000 people) the effects are widely dispersed geographically. In addition the program has highly desirable distributional effects since the largest part of the benefits fall in rural areas and accrue to lower income groups.

Finally, a separate analysis was made of the DPT - TFT and BCG components of the program. The analysis revealed that although the BCG program may not be viable when operated independently its inclusion in a total innoculation program is strongly justifiable on economic grounds (assuming a vaccine efficacy of .5). This result suggests that other immunizations, such as polio and measles, which may not be cost efficient by themselves may be economically justifiable when included as part of a larger immunization program.

An Economic Analysis of an Expanded Program of Immunization in Indonesia

I. Introduction

This analysis is intended to give a conservative assessment of the economic merits of the proposed Expanded Program on Immunization in Indonesia. Two, complementary, procedures are used for the assessment: cost effectiveness analysis and cost benefit analysis.

In both procedures an attempt has been made to use the best information available for the evaluation. However given the paucity of data available a number of assumptions have been made to facilitate the analysis. In some cases we have extrapolated from data available for specific regions on Java to the entire country. Other information such as health service participation rates is highly subjective and derived from consultation with hospital and health ministry officials. Finally, Hospital Record Surveys, have been used in combination with other information in an attempt to reconstruct incidence and fatality rates. Computational details and sources are presented in the Appendix to allow the user of the study to evaluate the assumptions. The difficulties in conducting this analysis with the available data demonstrate the strong need for a careful surveillance system to be incorporated into the early stages of the immunization project. Early surveillance is imperative in order to allow a future retrospective assessment of the program.

The objective of the proposed program is to reduce infant and child morbidity and mortality by expanding the present national program of smallpox and BCG immunization to cover a larger proportion of the population and to include immunization for diptheria, whooping cough and tetanus. The program entails the delivery of BCG[1] and DPT vaccinations in two visits, during the first year of life, and TFT vaccinations of pregnant women. In addition BCG

[1] referred to as BCG I

vaccinations are to be given to children entering and leaving school[1].

The planning horizon for theproject, and the period over which the economic analysis is conducted, is five years. The estimates of the morbidity and mortality impact are therefore conservative since, if the program is continued longer than five years, DPT boosters for children entering school would give extended immunity that is not included in the calculations. In addition the estimates include only the direct effects of immunization and omit the effects of extended community protection as a result of reduced transmission.

The estimates are also conservative since in order to simplify our calculations, we have omitted the effect of TFT on maternal morbidity and mortality and have also omitted the impact of the BCG immunization of children completing school. The effect of these omissions is probably negligible since the incidence of tetanus in women of childbearing age is very low and the number of children completing school is also small.

We have also omitted the costs of the development of Bio Farma's capacity to produce polio and measles vaccine (414.5 x 10^6 Rp.) since the program considered does not include immunizations, and thus does not include benefits, for these diseases. In addition we have omitted the cost of smallpox vaccine (1000.1 x 10^6 Rp.) since the disease does not presently exists in Indonesia and, from an economic standpoint, smallpox immunizations are clearly cost ineffective. The inclusion of these items would give misleading results in trying to estimate the effectiveness and value of the DPT, TFT and BCG components of the program. With these omissions the total cost of the DPT, TFT and BCG part of the project is 15140 x 10^6 Rp. ($36.5 million).

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[1] Referred to as BCG II

II. Cost Effectiveness Analysis

In the following analysis we attempt to ascertain whether at the levels of incidence in Indonesia it is cheaper to treat infection or to prevent infection through the immunization program. Since in fact only a small percentage of the Indonesian population has regular access to and uses the modern health care system the comparison is moot and immunization is the only apparent short term alternative health intervention for DPT and Tuberculosis. However, the comparison is useful for a consideration of long run alternatives and for that percentage of the population which uses the present health care system.

Because the vaccine efficacy and disease incidences differ considerably for BCG and DPT[1] we examine the cost effectiveness of the BCG and DPT components of the program separately as well as looking at the cost effectiveness of the total program. This is done by considering the programs as if they were to be operated separately. That is we consider the cost effectiveness of the BCG program if there were no DPT program. Likewise we consider the cost effectiveness of a DPT program carried out in the absence of a BCG program.

In addition, since most of the capital expenditures (cold chain and transportation) and a large part of the immunization delivery system are used in common by both program components, the sum of the costs of operating both programs separately is greater than the cost of the proposed joint program. It is therefore of interest to examine the cost effectiveness of the component programs considered as marginal. That is, we ask the question "Given an operating DPT (or, alternatively, BCG) program what would be the cost effectiveness, in terms of additional cases and deaths prevented, of

[1] DPT refers here and in the following analyses to both the DPT and TPT immunizations.

adding a BCG (or, alternatively, DPT) program?" The question is of interest since it may be that an immunization program which is not cost effective in itself becomes cost effective when considered as an additional or marginal component to an existing program.

Finally, since the initial program coverage is small although capital expenses are considerable, we examine the cost effectiveness of the final year of the program in order to obtain an indication of the effectiveness of the continuing program beyond the initial start up period. By looking at the final year of the program when the program coverage has been brought to a long run operating level and the delivery system and cold chain are in place we derive an estimate of the cost effectiveness of maintenance of the immunization program.

To review, there will be a total of six cost effectiveness analyses, (1) the total program, (2) BCG only, (3) DPT only, (4) BCG marginal, (5) DPT marginal, and (6) the total program in the final year of the plan. Other analyses are possible; for example one could look at the cost effectiveness of TFT, BCG I and BCG II separately. These analyses would be of interest if appropriately disaggregated cost data were to become available at a future date.

To conduct the analyses information is needed on program impacts in terms of cases and deaths prevented for each disease, the costs of the program and, the costs of treatment for the diseases considered.

A. Cases and Deaths Prevented by the Immunization Program

Estimates of the impact of the program in meeting the objective of reducing child mortality and morbidity are given in table 1 and in more detail in tables I - V in the appendix. The estimates include only the

direct effect of the immunizations and omit any epidemiological protection which might be extended to non immunized persons. The estimates are obtained by tracking immunized cohorts over the life of the vaccine under consideration and accounting for survival and the number of cases and deaths which would have occured in the absence of immunization. Since present disease surveillance is insufficient to provide accurate estimates of initial disease incidence (attack rates) and case fatality rates the table is based on a variety of sources and assumptions including the use of rates observed in other tropical countries with similar population densities. An effort has been made to make the assumptions explicit and to choose assumptions which will provide conservative estimates of the impact of the immunization program. The calculations underlying table 1 and the sources of the basic data are given in the appendix in tables I-V parts b and c. The estimates given in the table indicate that a total of 313020 deaths would be prevented by the five year program.

[1] The estimates presented in Tables I - V were prepared in collaboration with Daniel Tarantola and Robert Hogan.

Table 1

Number of Cases and Deaths Prevented by the Proposed Immunization Program

Year	DPT & TFT		BCG		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
1979-80	205524	16817	1810	408	207334	17225
80 - 81	421904	26787	3703	833	425607	27620
81 - 82	717901	44199	5594	1259	723495	45458
82 - 83	1021070	57603	7727	1739	1024854	59342
83 - 84	1335297	71083	9876	2222	1340085	73305
84 - 85	878380	22122	12160	2736	882880	24858
85 - 86	583536	15408	15045	3385	588291	18793
86 - 87	415905	11207	18251	4106	420982	15313
87 - 88	220227	5794	21728	4889	225634	10683
88 - 89			24925	5608	5608	5608
89 - 90			20869	4696	4696	4696
90 - 91			16088	3620	3620	3620
91 - 92			10948	2462	2462	2462
92 - 93			5319	1197	1197	1197
Total	5799744	272860	174043	39160	5838904	313020

Table 2

Cost Breakdown by Program and Year of Program

(Rp. x 10^6)

Year	Cost if BCG only[2]	Cost if DPT only[2]	Marginal cost of adding DPT to BCG[3]	Marginal cost of adding BCG to DPT[3]	Cost of Total Program
	(1)	(2)	(3)	(4)	(5)
1979-80	1388	2268	1153	273	2541
80 - 81	1457	2384	1197	270	2654
81 - 82	1531	2641	1412	302	2943
82 - 83	1785	3052	1594	327	3379
83 - 84	1817	3267	1806	356	3623[5]
Total	7978	13612	7162	1528	15140
Value of capital remaining at end of five years[4]	1217	1311	115	21	1332
Total costs less value of capital at end of program	6761	12301	7047	1507	13808

[1]The cost of developing the capacity of Biofarma to produce measles and polio vaccine is omitted. The cost of smallpox vaccine is also omitted.

[2]This represents the cost of operating a BCG program without a DPT program (or conversely for column two). The costs of operating the two programs separately do not add up to the costs of the total program since much of the total costs are for shared expenditures.

[3]This represents the added cost if a DPT program is considered as additional to a BCG program (or conversely for column four).

[4]This is the depreciated value of the cold chain, transport, investment in Biofarma, and administrative equipment categories after deducting for maintenance.

[5]Total 1983-84 costs, corrected for depreciation on capital acquired in previous years and the salvage value of capital acquired in 1983-84 are 3737 (x 10^6) Rp. This figure is the basis for the calculations of the cost effectiveness of the program in the final year of the plan.

B. Program Costs

The program costs are given in table 2. The costs of operating the BCG and DPT programs independently were obtained by estimating the portion of total expenditures, in each of the XI categories given in the financial tables, that would be necessary to operate the programs separately. Thus, for instance, the total cost of the cold chain and transport categories is included in both programs but vaccine costs, Bio Farma development and syringes and other equipment are broken into components directly attributable to the separate programs.

The foreign exchange component of project costs has been converted to rupiahs at the current exchange rate ($1 = 415.5 Rp.). It is plausible to argue that this rate significantly overvalues the rupiah, perhaps by 15-25%. Although illegal markets for foreign exchange do not exist in Indonesia, the demand greatly exceeds the supply of import licenses at the current exchange rate. Nevertheless the rupiah is, at present, freely convertible and there appears to be no imminent possibility of devaluation. Rather than make an arbitrary choice of a shadow exchange rate we feel that it is less misleading to use the current exchange rate but to remain aware that actual cost may be underestimated by 10-20%.

The total costs of the program have been adjusted by substracting the value of capital remaining at the end of the five year planning period. Straight line depreciation is used. A life of ten years has been assumed for all capital equipment except for 60% of the transport category which is assumed to have a life of five year.

The total cost of the program after subtracting the costs of smallpox vaccine, the costs of the development of Bio Farma's capacity to produce polio and measles vaccine and the residual value of capital at the end of

the five year planning period is 13303 (x 10^6) Rp. The cost per contact, including fixed and recurrent costs, is 272 Rp. ($0.65) and the cost per fully vaccinated[2] infant is 1532 Rp. ($3.69). The cost per fully vaccinated infant after the program has reached full operating capacity in the last year of the program is 1397 Rp. ($3.37).

C. Treatment Costs

Treatment costs represent the costs of inpatient care for tetanus and diptheria and outpatient care for tuberculosis and pertussis. The cost of

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[1]The total number of contacts for DPT (2 visits), BCG and TFT is 50,760,000.

[2]Adjusting for children who do not return for the second immunization, the predicted number of children fully immunized with DPT and BCG and whose mothers have, if required, received TFT is 9015825.

inpatient care were obtained by multiplying the average length of stay for tetanus and diptheria by the average daily cost[2] of pediatric hospital care for sick children. The costs include drugs, food, nursing, lab tests and doctors salaries. The costs of outpatient care were obtained by the pricing of specific treatment regimes for pertussis and tuberculosis[3]. The resulting estimates of per case costs are 45,000 Rp./case for diptheria, 6,000 Rp./case for pertussis, 55,000 Rp./case for tetanus and 49,000 Rp./case for tuberculosis. The cost of treating one case prevented by the DPT program is a weighted average of the costs of treatment for each of the three diseases involved in the immunization. Similarly the cost of treating one case prevented by the total program is a weighted average of the costs of treatment for each of the four diseases.

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[1]An average length of stay of 13.2 days for tetanus and 10.7 days for diptheria was used. See, U.S. Department of Health, Education and Welfare, Public Health Service, Proposal, Mass Immunization Programs for Central America, June 1972, p.12.

[2]An initial estimate was obtained for the cost per patient day of operating sick child pediatric wards in a Class A and two Class B hospitals. Since the majority of hospitals are of class C and D and have substantially lower costs the estimates were revised downwards by thirty percent. The final estimate of the average daily pediatric costs for all classes of hospitals is 5,600 Rp. The author is indebted to Jeff Lester and Dr. Lopez of the Indonesian Ministry of Health for the estimates of pediatric costs.

[3]The regimes and prices were outlined by Dr. Gunowiseso, Indonesian Ministry of Health.

Table 3

Cost Effectiveness of the
Proposed Immunization Program

	Cost per death Prevented (Rp.)	Cost per case Prevented(Rp.)	Cost of treating one case[1] (Rp.)
Total Program	44112 ($106)	2311	12356
BCG Program only	172651 ($417)	38847	49000
DPT Program only	45082 ($109)	2121	10716
BCG considered as an added Program	38483 ($93)	8659	49000
DPT considered as an added Program	25826 ($62)	823	10716
Total Program in Last Year of Plan (1983-84)	37511 ($90)	2056	12856

[1] This is the weighted average of the costs of treatment of the diseases considered. The weights are the proportions of total prevented cases in each disease category.

D. Results

Results of the cost effectiveness analysis are summarized in Table 3. It is apparent that the total immunization program is highly cost effective. The cost per death prevented is 44,112 Rp. ($106). The cost of preventing an average case is approximately one sixth of the cost of treatment. The program remains cost effective even if we suspect that program costs have been underestimated by, say, 20% and treatment costs overestimated by, say, 33%. In addition, the program gains in efficiency over the five years of the project plan until the cost per death prevented falls to 37,511 Rp.($90) and the cost per case prevented falls to 2,056 Rp. when full operating capacity is reached in the final year (1983-84).

Turning to the individual program components it can be seen that the DPT program would be cost effective if operated alone. Further, if we consider the DPT program as added to an existing BCG program already possessing an adequate cold chain and delivery system, the cost per additional death prevented is only 25,826 Rp. ($62) and the cost per additional case prevented is 823 Rp.

In contrast the BCG program is not as cost effective when operated independently. In fact, if program cost are increased by 20% and treatment cost overestimated by 33% the ratio of cost per case prevented to the cost of treatment is 1.4 and an independent BCG program would be cost ineffective. However, if we consider the cost effectiveness of adding BCG immunization to a DPT program we see that the marginal cost per death prevented is only 38,483 Rp. ($93) and the cost per additional case prevented is substantially less than the cost of treatment. Thus, it is found that a program which is inefficient by itself becomes cost efficient when added as one component of a larger immunization program. This result suggests that once the cold chain and delivery system

are in place the addition of other immunization programs, such as polio and measles, which may not be cost justifiable when operated separately, may be warranted on a cost effectiveness basis.

III. Cost Benefit Analysis

It is widely recognized that cost-benefit analysis is difficult to apply to health projects because,although the costs are usually concrete, a substantial proportion, often a preponderance, of the benefits are intangible. For the present study the intangible benefits include the incalculable value of life and the value of reduced suffering to the child whose illness is prevented and the avoidance of the suffering, bereavement and anxiety of friends and family. Nevertheless an analysis based only on the tangible and quantifiable benefits is useful since it forces recognition of a substantial class of benefits - the economic benefits - which might otherwise be overlooked. For the present study these benefits include the avoidance of treatment costs, the avoidance of lost income through premature death and value of housewives time saved in the care of the sick.

A. Economic Benefits.

a. Avoided treatment costs.

The treatment costs include the costs of treatment by traditional means (jamu medicine) as well as medical care received through outpatient clinics or hospitalization. These costs represent an allocation of resources that would be unnecessary in the absence of the diseases considered. A 1976 study of the marketing and consumption of jamu medicine indicated that approximately 75% of all respondents would use jamu for medication in response to illness[1]

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[1] O. Roesnadi, W. Tahar, Y. Anwar, Report on the Marketing and Consumption of Jamu, P.T. Inscore, Indonesia, 1977, pp 15-17

irrespective of whether or not modern medical care is also received. The indication was that this would be an expenditure in addition to Jamu purchased for other purposes. We have assumed that the expenditure would be 75 Rp. per symptom week (two weeks) for diptheria, pertussis and tetanus and 50 Rp. per symptom week (thirty weeks) for tuberculosis. The total traditional costs avoided are then obtained by multiplying 112.50 (= .75 x 75 Rp. x 2) times the number of DPT cases prevented and 1125 (= .75 x 50 Rp. x 30) times the number of tuberculosis cases prevented.

The proportion of households using modern medical care was estimated at 7%. The total modern medical costs avoided are obtained by the product of .07 times the number of cases prevented times the cost of treatment (See the section on treatment costs under cost effectiveness). The resulting avoided costs of treatment for each disease are given in table VIII of the appendix.

b. Value of mothers time spent in home care.

The inclusion of this benefit recognizes the economic role of women in the agricultural household. Accounts of the use of time over a calendar year indicate that the marginal product of both male and female labor may remain positive and substantial throughout the busy season during which planting or harvesting occur . In the slack season, off farm employment opportunities may exist for men but are often limited for women, as a consequence the marginal value of female labor time falls severely.

This figure was taken after discussions with health officials at the Indonesian Ministry of Health. Some supporting information on usage can be found in Indonesian Health Profile, International Health Program, School of Public Health, University of Hawaii, November 1977.

In the calculations used to derive the value of mothers time in home care we have assumed that, given the two crop cycles in Indonesia, the busy season comprises approximately one fourth of the calendar year.

Based on the results of a labor force participation survey we have evaluated the mothers time at a shadow wage of one half of the average wage during the busy season and one fourth of the average wage during the slack season[2]. Assuming that the disease occurs randomly over the calendar year, the value of mothers time spent in care is

$$(1/2 \cdot 1/4 + 1/4 \cdot 3/4)\ W \cdot DL \cdot C = .3215 \cdot W \cdot DL \cdot C$$

where W is the average wage rate, DL is the average number of days lost in care per illness and C is the number of prevented cases. It is assumed that the total time spent in care is seven working days per case for tuberculosis and three working days per case for diptheria, pertussis and tetanus. The wage rates used assume a growth in the real wage rate of 2% per annum, and are given in table IX b of the appendix. Table IX a gives the estimated value of the avoided loss of mothers time spent in the care of sick children.

c. Value of Income Derived from Prevented Mortality.

The discounted value of the expected stream of lifetime earnings gives an estimate of the present value of the stream of output lost through the premature death of an individual. Since the early years of life, up to entrance in the labor force (assumed to occur at 12 years in Indonesia), are accompanied by outlays for the costs of child rearing it is possible that evaluated on the basis of monetary flows alone the present value of the stream of life time ea nings would be small. However, if we assume that

[2]The activity rates for females between 25 and 35 years of age are approximately .5 during the busy season and .3 during the slack season. See, H.Redmana, H. Join and Daliyo, Labor Force and Labor Force Utilization in Selected Areas in Java: vol. 1, National Institute of Economic and Social Research, Indonesia, 1977, p.77

children are the result of a rational action on the part of parents, then it can be argued that the value of children to the parents at least offsets the costs of child rearing. There is, in fact, a strong argument that besides the consumption value of status and emotional attachment, children provide non market household and farm labor and security for old age. In Indonesia, which is primarily agricultural and where most of the population is not covered by any form of social security there are important, rational reasons for parents to perceive the benefits of children as more than offsetting the costs of childhood. By omitting the stream of costs in the early childhood years before entrance into the labor force we in effect partially quantify an important quasi-tangible benefit and move it into the economic benefit category.

Accepting the argument above, the expected present value of lifetime earnings derived from prevented deaths attributable to the immunization program is given in Table X. The table is based on an age-earnings profile which assumes that the average child enters the labor market at the age of twelve and receives an entering income of approximately one fourth the national average. His expected income than increases with maturity and gains in productivity up to the national average at the age of 20. Assuming a horizon of age 55, his income will continue to increase with gains in productivity (assumed to be .04 per year) from age 20 to 55. A discount rate of .15 has been used and a correction has been made for the probability of survival from the early years of childhood to entrance in the labor force. The calculations used to derive the table are made explicit in the appendix.

Note that by using the national average income an adjustment is implicitly made for the possibility of unemployment or underemployment. That is, the assumption is that infections are approximately random and a child whose death is prevented may grow up to be unemployed, underemployed or a highly productive member of society with probabilities that are exactly reflected by the present distribution of income.

B. Economic Costs

The economic costs are the incremental project costs less the value of capital remaining at the end of the fifth project year. The costs are given in Table 2. (See the discussion of program costs in the cost effectiveness section above).

C. Results of the Cost-Benefit Analysis

Five cost-benefit analyses are conducted. First a comparison of the cost and benefits of the total five year program is made. Then, in an exercise parallel to the cost effectiveness analysis, a cost-benefit analysis is made for the DPT-TFT and BCG components looked at as separate programs and the BCG component looked at as a marginal program. Finally, since the calculations used to derive the costs and benefits are based on assumptions with only tenuous substantiation, a sensitivity analysis is made.

The results of the analyses are given in tables XI through XV in the appendix. At a discount rate of 15%[1] the present value of the planned expenditures for the five year program is 9312 (x 10^6) Rp. while the present value of benefits is 27010 (x 10^6) Rp. This gives a benefit/cost ratio of 2.90 and a net present value of 17698 (x 10^6) Rp. ($42.7 million). The internal rate of return (IRR) is 185%. Even when costs are increased by 20% and benefits decreased by 33% the ratio of benefits to costs remains greater than one and the net present value positive (See Table XV). Clearly, the total project is economically viable and desirable.

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[1] A discount rate of 15-18% has been used in other recent cost benefit studies in Indonesia. This range appears to approximate the present opportunity cost of capital in Indonesia.

Looking at the separate components we see that the benefit cost/ratio for DPT-TFT immunization operated as a separate program is 2.40 with an IRR of 190%. If the BCG program were operated independently the cost benefit ratio would be 1.43 with an IRR of return of 22%. This result will not withsland a sensitivity test. With a 20% increase in costs and 50% decrease in benefits the cost benefit ratio is less than one and the IRR is less than 15%. Yet when BCG is viewed as an added or marginal program the ratio of incremental benefits to incremental costs is 8.65 with an IRR of 90%. As in the cost effectiveness part of this study we conclude that the delivery of a multiple of vaccines makes it possible to include component vaccination programs which, by themselves, may not be economically viable.

IV. Employment Effects of the Program

The total vaccination program will continue the employment of 3,000 people who were employed as part of the smallpox eradication campaign. An additional 1000 people will be added for the cold chain and expanded transport and delivery system. There will also be additional modest gains in employment generated through the multiplier effects of the domestic part of program expenditures. The total employment effects, although modest, will be dispersed regionally.

V. Income Distributional Effects

Because the program is planned for national coverage the benefits will be proportionally dispersed regionally and over urban and rural populations. To the extent that tetanus is a rural disease the benefits will favor rural areas. On the other hand diptheria and tuberculosis transmission is favored by crowding and these diseases are more prevalent in urban areas. Whooping cough is ubiquitous in both urban and rural areas.

From the point of view of distribution among income groups the program is desirable since the largest part of the benefits fall to the poor in which the incidence of childhood diseases is high.

Note to Tables I-VII

The Estimation of Cases and Deaths Prevented

The number of cases in each age cohort for each year is found by multiplying the number of children in the cohort at the time of immunization by program effectiveness times the appropriate attack rate and then by the probability of survival from the initial age of immunization to the year under consideration. The number of deaths is found by multiplying the number of cases by the appropriate case fatality rate. The estimates include only the direct effect of immunization.

No adjustment has been made in any of the tables for the possibility of a decrease in vaccine efficacy due to malnutrition.

Appendix

Table Ia

Number of Cases and Deaths Prevented - Diptheria[1]

(by year of prevented occurence)

Year	Age 0-1		Age 1-2		Age 2-3		Age 3-4		Age 4-5		Total
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases
197[illegible]-[illegible]	[illegible]3	142									[illegible]39
[illegible] - [illegible]1	[illegible]13	203	1[illegible]50	406							[illegible]
[illegible]1 - [illegible]2	13[illegible]	310	2[illegible]43	580	826	145					50[illegible]7
[illegible] - [illegible]	1[illegible]0	375	4351	[illegible]	1180	208	838	127			[illegible]
[illegible]3 - [illegible]4	1[illegible]74	438	5[illegible]1	1073	1605	318	1267	181	945	89	11[illegible]
[illegible]4 - [illegible]5			[illegible]246	1254	2183	384	1940	277	1349	125	11[illegible]13
[illegible]5 - [illegible]6					2550	449	2345	335	2[illegible]6	1[illegible]2	[illegible]11
[illegible] - [illegible]7							2740	392	2[illegible]7	[illegible]	[illegible]37
[illegible]7 - [illegible]									2917	271	[illegible]37
											[illegible]

[illegible]

This is an estimate of the number of cases (and deaths) prevented during the first five years of life. The estimate omits the [illegible] immunization protection beyond five years of age. The table therefore underestimates the benefits provided by the program. The underestimate is small however since the attack rate for ages greater than five is negligible.

Table Ib

Assumptions Underlying the Calculation of Diptheria Cases and Deaths Prevented

Assumptions Related to Year of Program				Assumptions Related to Age			
Year of Program	Number of Children Born	Program Coverage in Total Population	Program Effectiveness	Age	Probability of Surviving one year	Attack Rate[2]	Case Fatality Rate[3]
1979-80	5,800,000	.20	.19	0	.860	.0006	.222
80 - 81	5,920,000	.28	.266	1	.968	.0021	.204
81 - 82	6,040,000	.42	.399	2	.963	.0009	.176
82 - 83	6,160,000	.50	.473	3	.968	.0010	.143
83 - 84	6,280,000	.57	.542	4	.968	.0011	.093

[1]Assumes a vaccine efficacy of .95, Program effectiveness equals vaccine efficacy times program coverage.

[2]See Table IIIc for a derivation of the attack rate for diptheria.

[3]Hospital Record Survey 1971-1976, I.H.O.H.

Table Ic

Estimation of the Attack Rate for Faucial Diptheria from Available Data[1]

Age groups	Proportional distribution of faucial diptheria case[2] (1)	Age specific Schick Test Neg. Rate[3] (2)	Expected No. of children in a pop. of 10000 children of the 0-4 age group[4] (3)	Number of diptheria infections in each age group/ 10000 (4) = (2)x(3)	Number of cases faucial diptheria /10000 in each age group (5)	Age specific attack rate (6) = col(5)/col(3)
0 - 1	.13	.074	2500	185	1.4	.0006
1	.35	.200	1875	375	3.9	.0021
2	.16	.090	1875	169	1.8	.0009
3	.17	.097	1875	182	1.9	.0010
4	.19	.108	1875	202	2.1	.0011
0 - 4	100%	Cum AR=0.57	10000	1113	11.1	2

[1] Assuming that faucial diptheria for all age groups represents 1% of all diptheria infections (col.4), the number of faucial diptheria cases per 1000 in the 0-4 age group is 1.01 of 1113 or 11.1 cases. The number of faucial diptheria cases in each age group (col.5) is estimated by multiplying col(1) time 11.3.

[2] Hospital Record Survey, Indonesian Ministry of Health, 1976.

[3] Nationwide Schick Test Survey, Indonesian Ministry of Health, 1975

[4] Model Life Table.

Appendix

Table IIa

Number of Cases and Deaths Prevented - Pertussis[1]

(by year of prevented occurence)

Year	Age 0-1		Age 1-2		Age 2-3		Age 3-4		Age 4-5		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Dea
1979-80	1[illegible]5600	5104									185600	51
80 - 81	2[illegible]0415	7161	127693	2426							3[illegible]108	[illegible]
81 - 82	[illegible]	11[illegible]	17[illegible]	3[illegible]4	71[illegible]4	1365					[illegible]70	[illegible]
82 - 83	[illegible]	13551	2[illegible]521	5[illegible]	100632	1915	69565	1322			[illegible]	[illegible]
83 - 84	5770[illegible]	15[illegible]	339025	[illegible]41	15[illegible]	3018	97607	1855	67339	1275	1240[illegible]0	[illegible]
84 - 85			[illegible]	7551	190799	3621	153913	2925	94477	1795	[illegible]	19
85 - [illegible]					223[illegible]77	4249	1[illegible]4695	3510	14[illegible]67	2[illegible]30	5[illegible]	[illegible]
[illegible] - 87							216521	4115	17[illegible]765	3[illegible]	[illegible]	[illegible]
87 - [illegible]									209593	3991	2[illegible]3	3[illegible]
											5[illegible]105	1193

[1] This is an estimate of the number of cases (and deaths) prevented during the first five years of life. The entire effect of the benefits of additional protection beyond five years of age. The table therefore underestimates the benefits provided by the program.

[illegible] since the attack rate for ages greater than five is negligible.

Table IIb

Assumptions Underlying the Calculation of Pertussis Cases and Deaths Prevented

Assumptions related to year of program					Assumptions related to age			
Year of Program	Number of Children born	Program Coverage	Program Effectiveness[1] Age 0-1	Program Effectiveness[1] Age 1-5	Age	Probability of surviving one year	Attack Rate[2]	Case Fatality rate[3]
1979-80	5,800,000	.20	.08	.16	0	.860	.40	.0275
1980-81	5,920,000	.28	.11	.22	1	.968	.16	.019
1981-82	6,040,000	.42	.17	.34	2	.968	.08	.019
1982-83	6,160,000	.50	.20	.40	3	.968	.08	.019
1983-84	6,280,000	.57	.23	.46	4	.968	.08	.019

[1] It is assumed that only .5 of all newborn children will be protected by the age of six months. The program effectiveness for the first year is therefore one half the effectiveness in the 1-5 age group.

[2] Indonesian Ministry of Health, Communicable Disease Center.

[3] Approximated by reference to a study in Kenya by David Morley, which indicates that approximately 60% of all pertussis mortality occurs in the first year, and by reference to a Hospital Record Survey, Indonesian Ministry of Health, 1976.

Appendix

Table IIIa

Number of Cases and Deaths Prevented - Tetanus[1]

(by year of prevented occurence)

Year	Age 0-1		Age 1-2		Age 2-3		Age 3-4		Age 4-5		[illegible]	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
1979-80	19285	11571									19285	11571
80 - 81	[illegible]	15618	4062	973							[illegible]	[illegible]
81 - 82	[illegible]	35305	[illegible]	[illegible]	2942	408					[illegible]	[illegible]
82 - 83	[illegible]	[illegible]	14531	2106	2119	593	2936	567			[illegible]	[illegible]
83 - 84	[illegible]	35735	12[illegible]55	2572	4424	8[illegible]5	4054	811	24[illegible]	500	[illegible]	[illegible]
84 - 85			15017	[illegible]	5400	[illegible]	6144	1229	3547	714	[illegible]	[illegible]
85 - 86					6[illegible]	1261	7500	1500	5407	1012	[illegible]	[illegible]
86 - 87							8762	1752	[illegible]	1320	[illegible]	[illegible]
87 - [illegible]									7717	3542	[illegible]	[illegible]
											[illegible]	[illegible]

[illegible]

[illegible] is an estimate of the number of cases (and deaths) prevented during the first five years of life. The estimate omits the benefits of additional protection beyond five years of age. Also omitted is an estimate of the number of cases and deaths prevented in women of childbearing age. The table therefore underestimates the benefits provided by the program.

Appendix

Table IIIb

Assumptions Underlying the Calculation of Tetanus Cases and Deaths Prevented

Assumption Related to Year of Program				Assumptions Related to Age			
Year of Program	Number of Children born[1]	Program Coverage[2]	Program Effectiveness[3]	Age	Probability of Surviving one year[4]	Attack Rate[5]	Case Fatality Rate[6]
1979-80	5,800,000	.20	.190	0	.860	.0175	.6
80 - 81	5,920,000	.28	.266	1	.968	.0053	.2
81 - 82	6,040,000	.42	.399	2	.968	.0023	.2
82 - 83	6,160,000	.50	.478	3	.968	.0033	.2
83 - 84	6,280,000	.57	.542	4	.968	.0030	.2

[1] Assumes a 2.5% growth rate

[2] Program coverage as a proportion of total children born.

[3] Program efficiency = coverage x vaccine efficacy; vaccine efficacy is .95

[4] Infant mortality rate is 140/1000; Probability of surviving for other ages is approximated from U.S. Department of Commerce, Levels and Trends of Mortality in Indonesia 1961 to 1971, International Research Document No. 2, October 1975, p.9.

[5] See table IIIC for derivation of the age specific attack rates.

[6] Based on hospital records, Communicable Disease Center, Indonesian Ministry of Health, 1976.

Appendix

Table IIIc

Calculations to Estimate Attack Rate
for Tetanus from Available Data[1]

Age Group	Proportion of total tetanus cases in each age group[2]	Population in age group/ 100,000[3]	Number of cases/ 100,000	Age Specific Attack Rate
	COL 2	Col 3	Col 4	col 5=(col 4 / col 3)
0 < 1	.21	4000	70	.0175
1 - 2	.05	3000	16	.0053
2 - 3	.02	3000	7	.0023
3 - 4	.03	3000	10	.0033
4 - 5	.03	3000	9	.0030
> 5	.66	84000	213	.0003
Total	1.00	100000	333	

[1] The birth rate is estimated to be approximately 4000/100,000 total population. Given an estimate[4] of neonatal tetanus of 15/1000, the number of cases of neonatal tetanus per 100,000 total population will be 60 (= .15 x 4,000). Neonatal tetanus is estimated[1] to be .18 of all tetanus, therefore the total number of cases of tetanus per 100,00 population is 33 (= 60/ .18). The number of cases in each age group per 100,000 total population (column 4) is estimated by multiplying the proportion of total tetanus cases in each age group (column 2) by 333.

[2] Hospital Record/Survey, reported in unpublished Indonesian Government document, 1976. The use of a hospital survey may imply an underestimate of neonatal tetanus.

[3] Model Life Table.

[4] Indonesian Communicable Disease Center, From a survey of Central Java, 1972.

Appendix

Table IVa
Number of Cases and Deaths Prevented - Tuberculosis, BCG I
(by year of prevented occurence)

Year	Age 0-1		Age 1-2		Age 2-3		Age 3-4		Age 4-5		Age 5-6		Age 6-7		Age 7-8		Age 8-9		Age 9-10		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
79-80	941	212																			941	212
80-81	1010	228	805	182																	[illegible]	410
81-82	1112	250	[illegible]	155	785	177															[illegible]	[illegible]
82-83	1237	279	949	214	841	198	758	171													[illegible]	[illegible]
83-84	[illegible]	343	1063	239	917	205	813	184	735	165											[illegible]	1077
84-85			1075	245	1029	232	887	199	788	177	711	159									[illegible]	1013
85-86					1049	236	996	223	860	193	763	171	1047	243							[illegible]	[illegible]
86-87							1016	229	904	218	831	187	1169	260	1077	241					[illegible]	[illegible]
87-88									984	222	926	210	1272	286	1159	258	1067	239			[illegible]	1217
88-89											952	214	1413	323	[illegible]	273	1149	255	[illegible]	[illegible]	[illegible]	1313
89-90													1456	327	1405	320	1249	281	1137	253	[illegible]	[illegible]
90-91															1483	324	1393	317	[illegible]	[illegible]	[illegible]	[illegible]
91-92																	1430	321	[illegible]	[illegible]	[illegible]	[illegible]
92-93																			1417	[illegible]	[illegible]	[illegible]
Total																					[illegible]	[illegible]

Appendix

Table IV 5

Assumptions Underlying Estimates
of the Number of Tuberculosis Cases and Deaths
Prevented by the Immunization Program, 80 I

Assumptions related to year of program				Assumptions Related to Age			
Year of Program	Number of Children Born	Program Coverage	Program Effectiveness[1]	Age	Probability of Surviving one year[2]	Effective Attack Rate[3]	Case Fatality Rate[4]
1979-80	5,800,000	.59	.295	0	.860	.00055	.225
80 - 81	5,920,000	.62	.310	1	.968	.00055	.225
81 - 82	6,040,000	.67	.335	2	.968	.00055	.225
82 - 83	6,160,000	.73	.365	3	.968	.00055	.225
83 - 84	6,280,000	.73	.365	4	.968	.00055	.225
				5	.991	.00055	.225
				6	.991	.00085	.225
				7	.991	.00085	.225
				8	.991	.00085	.225
				9	.991	.00085	.225
				10	.991	.00085	.225

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[1] Vaccine efficacy is assumed = .5

[2] Levels and Trends of Mortality in Indonesia 1961 to 1971, International Research Document No. 2, October 1975, p. 9.

[3] The effective attack rate = the infection rate x the percentage of infected cases that develop tuberculosis. For the 0-5 age group the infection rate is .011; for the 6-10 age group the infection rate is .017; for the 11-15 age group the infection rate is .058. The percentage of infections developing the disease is .05 for all age groups. Source: Indonesian Ministry of Health, Communicable Disease Center

[4] Indonesian Ministry of Health, Communicable Disease Center

Appendix

Table V a

Number of Cases and Deaths Prevented - Tuberculosis, CG II

(At year of prevented occurrence)

Year	Age 6-7		Age 7-8		Age 8-9		Age 9-10		Age 10-11		Age 11-12		Age 12-13		Age 13-14		Age 14-15		Age 15-16		Total	
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
1979-80	[illegible]	[illegible]																			[illegible]	[illegible]
[illegible] - 1	[illegible]	[illegible]	[illegible]	[illegible]																	[illegible]	[illegible]
1 - 2	[illegible]	[illegible]	[illegible]	210	[illegible]	[illegible]															[illegible]	[illegible]
2 - 3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]													[illegible]	[illegible]
3 - 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]											[illegible]	[illegible]
4 - 5			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	770									[illegible]	[illegible]
5 - 6					[illegible]	[illegible]	[illegible]	[illegible]	1003	[illegible]	[illegible]	[illegible]	3422	770							[illegible]	[illegible]
6 - 7							[illegible]	[illegible]	[illegible]	247	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	[illegible]
7 - 8									[illegible]	257	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
8 - 9											4029	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9 - 10													[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10 - 11															[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11 - 12																	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12 - 13																			[illegible]	[illegible]	[illegible]	[illegible]
Total																					[illegible]	[illegible]

VI-30

Appendix

Table V b

Assumptions Underlying Estimates
of the Number of Tuberculosis Cases and Deaths
Prevented by the Immunization Program, BCG II

Assumptions Related to Year of Program				Assumptions Related to Age			
Year of Program	Number of Children 6-7 years[1]	Program Coverage[2]	Program Effectiveness[3]	Age	Probability of Survival to next year	Effective Attack Rate[4]	Case Fatality Rate[5]
1979-80	4,350,000	.47	.235	6	.991	.00085	.225
80 - 81	4,440,000	.50	.250	7	.991	.00085	.225
81 - 82	4,530,000	.54	.270	8	.991	.00085	.225
82 - 83	4,620,000	.58	.290	9	.991	.00085	.225
83 - 84	4,710,000	.59	.295	10	.992	.00085	.225
				11	.992	.0029	.225
				12	.992	.0029	.225
				13	.992	.0029	.225
				14	.992	.0029	.225
				15	.992	.0029	.225

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[1] 3% of Projected Population

[2] Corrected for the fact that only .8 of all children enter school.

[3] Vaccine efficacy = .5

[4] See footnote three on table IV b

[5] See footnote three on table IVb

Table VI

Summary Table

Potential Morbidity and Mortality Reduction attributable to the Proposed DPT and TT Immunization Programs

Year	Diptheria		Pertussis		Tetanus		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
1979-80	639	142	185600	5104	19285	11571	205524	16817
80 - 81	2903	609	388108	9587	30893	16591	421904	26787
81 - 82	5067	1035	661670	16062	51164	27102	717901	44199
82 - 83	8109	1598	945636	22156	67275	33849	1021070	57603
83 - 84	11252	2098	1240650	28479	83395	40506	1335297	71083
84 - 85	11618	2040	836633	15895	30129	6027	878380	22122
85 - 86	6961	976	557359	10589	19216	3843	583536	15408
86 - 87	5237	624	395306	7511	15362	3072	415905	11207
87 - 88	2917	271	209593	3981	7717	1542	220227	5794
Totals	54703	9393	5420605	119364	324436	144103	5799744	272860

Table VI (continued)

Potential Morbidity and Mortality Reduction

attributable to the BCG Immunization Programs

(Tuberculosis)

Year of Benefit	BCG I (3-14 mos.)		BCG II (6 years)		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
1979-80	941	212	869	196	1810	408
80 - 81	1898	410	1805	406	3703	833
81 - 82	2765	622	2829	636	5594	1259
82 - 83	3784	851	3943	887	7727	1739
83 - 84	4788	1077	5088	1145	9876	2222
84 - 85	4500	1013	7660	1724	12160	2736
85 - 86	4755	1070	10290	2315	15045	3385
86 - 87	5077	1142	13174	2964	18251	4106
87 - 88	5407	1217	16321	3672	21728	4889
88 - 89	5836	1313	19089	4295	24925	5608
89 - 90	5247	1180	15622	3515	20869	4696
90 - 91	4047	916	12041	2711	16088	3620
91 - 92	2810	632	8138	1831	10948	2462
92 - 93	1417	319	3902	878	5319	1197
Total	53299	11993	120744	27167	174043	39160

Table VI (continued)

Morbidity and Mortality Reduction

Attributable to Combined (DPT+BCG+TFT)

Immunization Program

Year of Benefit	All Target Diseases	
	Cases	Deaths
1979-80	207334	17225
80 - 81	425607	27620
81 - 82	723495	45458
82 - 83	1024854	59342
83 - 84	1340085	73305
84 - 85	882880	24858
85 - 86	588291	18793
86 - 87	420982	15313
87 - 88	225634	10683
88 - 89	5608	5608
89 - 90	4696	4696
90 - 91	3620	3620
91 - 92	2462	2462
92 - 93	1197	1197
Total	5838904	313020

APPENDIX
Table VII

Cases and Deaths Prevented in Last Year of Plan
(83-84)[1]

Diseases	Cases Prevented	Deaths Prevented
Diptheria	16327	2804
Pertussis	1624915	35782
Tetanus	97372	43298
Total DPT	1738614	81884
BCG I	53299	11974
BCG II	25625	5766
Total BCG	78924	17740
Total DPT + BCG	1817538	99624

[1]Obtained by following immunized cohorts for the 1983-84 program year diagonally through tables Ia-Va.

Appendix

Table VIII

Benefits - Value of Treatment Costs Avoided by Immunization Program (Rp. x 10^6)

Year	DPT Program			BCG Program			Total Program		
	Medical Treatment	Traditional Self Medication	Total	Medical Treatment	Traditional Self Medication	Total	Medical Treatment	Traditional Self Medication	Total
1979-80	154.2	23.1	177.3	7.4	2.0	9.4			186.7
80 - 81	291.1	47.5	338.6	15.1	4.2	19.3			357.9
81 - 82	490.8	80.8	571.6	22.8	6.3	29.1			600.7
82 - 83	681.7	114.9	796.6	31.4	8.7	40.1			836.7
83 - 84	877.6	150.2	1027.8	40.2	11.1	51.3			1079.1
84 - 85	504.0	98.8	602.8	49.5	13.7	63.2			666.0
85 - 86	330.0	65.6	395.6	61.2	16.9	78.1			473.7
86 - 87	241.7	46.8	288.5	74.3	20.5	94.8			383.3
87 - 88	126.9	24.8	151.7	88.4	24.4	112.8			264.5
88 - 89				101.4	28.0	129.4			129.4
89 - 90				84.9	23.5	108.4			108.4
90 - 91				65.5	18.1	83.6			83.6
91 - 92				44.6	12.3	56.9			56.9
92 - 93				21.6	6.0	27.6			27.6
	3698.0	652.5	4350.5	708.3	195.8	904.1			5254.6

Appendix

Table IX a

Benefits - Value of Avoided Loss of Mothers Time Spent in Care of Sick Children (Rp. x 10^6)

Year	DPT[1]	BCG[2]	Total
1979-80	69.7	1.2	70.9
80 - 81	114.6	2.6	117.2
81 - 82	215.2	3.9	219.1
82 - 83	364.5	5.5	370.0
83 - 84	488.7	7.2	495.9
84 - 85	326.8	9.0	335.8
85 - 86	222.3	11.5	233.8
86 - 87	161.0	14.1	175.1
87 - 88	87.2	17.2	104.4
88 - 89		20.0	20.0
89 - 90		17.2	17.2
90 - 91		13.5	13.5
91 - 92		9.4	9.4
92 - 93		4.6	4.6
Total			

---

[1] Assumes 3 days lost per illness

[2] Assumes 6 days lost per illness

Appendix

Table IX b

Projection of Daily Real Wage Rates
(Rupiah/day)

Year	Real Wage[1]	Shadow Wage Rate for Female Labor[2]
1979-80	360	113
80 - 81	367	115
81 - 82	374	117
82 - 83	382	119
83 - 84	389	122
84 - 85	397	124
85 - 86	405	127
86 - 87	413	129
87 - 88	421	132
88 - 89	430	134
89 - 90	438	137
90 - 91	447	140
91 - 92	456	143
92 - 93	465	145

---

[1] The real wages are derived from a baseline estimate of 313 Rp./day in 1972 and an assumption of a 2% per year growth in the real wage. The wage estimates are derived from an urban survey. Because wages tend to be higher in urban areas these figures provide an overestimate of the average national wage. Source: Annual Labor Report, American Embassy, Jakarta, June 1977, p.13.

[2] The shadow wage is calculated as .3125 times the real wage. See the discussion in the text for an explanation of the correction factor.

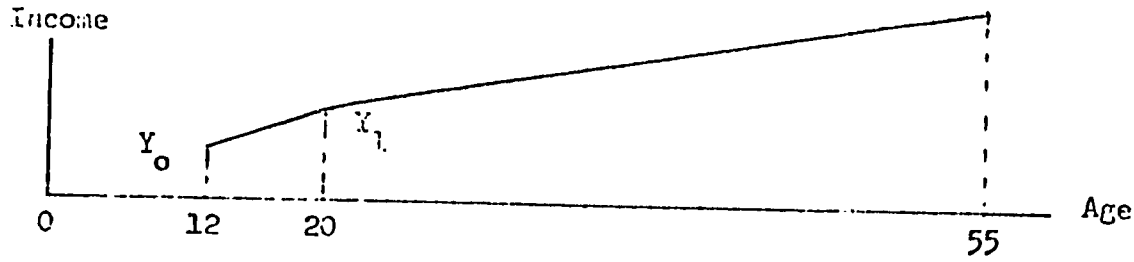
Appendix

Note to Table X

Value of Income Derived From

Prevented Mortality

I. The age earnings profile used in the calculation of the present value of life-time earnings appears as:



The following assumptions have been made:

1) Costs of child rearing before age 12 are offset by the consumption benefits to parents.

2) At 12 the child enters the labor market at income Y_o

3) From age 12 to age 20 income increases at a rate of r_1 both from gains in productivity and experience up to a national norm for labor at age 20, Y_1

4) From 20 to 55 income increases with productivity at rate r_2 (assumed = .04)

5) Y_o is assumed to be 20,000 Rp./yr.[1]

6) Y_1 is assumed[1] to be (80,000 Rp./yr.) $\cdot$ $e^{.04(8)}$ = 110,170 Rp./yr. (That is using the average income for 1976 of approximately 80,000 Rp./yr. and assuming gains in productivity of .04 per year the national average income will be 101,700 Rp./yr. by the time the new entrant, who is presently 12, reaches full income at age 20.)

7) r_1 = .213 (growth rate implied by Y_o, Y_1)

8) i = .15

9) The probability of survival at time t between 12 and fifty five is approximated by $e^{.0003\,t}$ (more precisely $e^{.0008\,t}$ is the probability density function and .0008 is the force of mortality at time t.)[2]

II. From the point of view of a child of age 12 in 1979-80 the expected present value of lifetime earnings can be broken into two components, the first derived from the discounted stream of earnings between 12 and 20,

$$V_I = Y_o \int_0^8 e^{r_1 t} \cdot e^{-it} \cdot e^{-.0003\,t} \cdot dt$$

$$= 20000 \int_0^8 e^{.0622\,t} \cdot dt = \frac{20000}{.0622} \left[e^{.0622\,t} \right]_0^8$$

$$= 207321 \text{ Rp.}$$

and the second derived from the discounted stream of earnings between 20 and 25

$$V_{II} = Y_1 \int_8^{43} e^{r_2 t} \cdot e^{-it} \cdot e^{-.0008\,t} \cdot dt$$

$$= 110\,170 \int_8^{43} e^{-.1108\,t} \cdot dt = \frac{110170}{-.1108} \left[e^{-.1108\,t} \right]_8^{43}$$

$$= 608635 \text{ Rp.}$$

The value of the stream of lifetime earnings at age 12 in 1979-80 is thus:

$$V_{12}\ (1979\text{-}80) = V_I + V_{II} = 608635 \text{ Rp.}$$

III. The value of lifetime earnings for other ages between 12 and 20 is obtained similarly to V_{12} after a suitable change of the limits of integration.

IV. The expected present value of lifetime earnings from the point of view of a child age of age a, less than 12, is

$$V_a = s_a \cdot \frac{V_{12}}{(1+i)^{(12-a)}}$$

where s_a is the probability of survival from age a to age 12 derived from a life table[2].

Value for V_1 through V_{12} in 1979-80 have been calculated and are given in table X b. Values at each age in subsequent years are obtained after a correction for gains in productivity.

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[1] Source for the estimate of labor force participation at age 12: Redmana, H.; Noir, H.; Daligo, Labor Force and Labor Utilization in Selected Areas in Java; Results of an experimental survey, Vol. 1, National Institute of Economic and Social Research, Indonesia, August 1977:

and for the estimate of average annual income (1976): AID/Indonesia, Annex to Annual Budget Submission FY 1979.

[2] Sources for survival probabilities: U.S. Department of Commerce, Levels and Trends of Mortality in Indonesia, 1961 to 1971, International Research Document No. 2, 1975.

Appendix

Table X a

Benefits - Value of Lifetime Earnings from Deaths Prevented[1]

(Rp. x 10^6)

Year	DPT	BCG	Total
1979-80	1342.4	66.2	1408.6
80 - 81	2343.4	153.7	2497.1
81 - 82	4088.6	268.7	4357.3
82 - 83	5799.7	421.6	6221.3
83 - 84	7709.0	607.1	8316.1
84 - 85	3763.7	1110.1	4873.8
85 - 86	2975.5	1766.1	4741.6
86 - 87	2467.6	2491.0	4958.6
87 - 88	1463.2	3314.6	4777.8
88 - 89		4082.8	4082.8
89 - 90		3613.8	3613.8
90 - 91		2883.6	2883.6
91 - 92		2027.0	2027.0
92 - 93		1017.4	1017.4
Total			

[1] The values in the table represent $\sum_a V_{ax} \cdot D_{ax}$ where

a is the age at which death is prevented, x is the year in which the death is prevented, V is the present value of the stream of lifetime earnings and D is the number of deaths prevented in age group a in year x.

Appendix

Table X b

Discounted Present Value of Lifetime Earnings for an average surviving child in 1979-80[1] in age groups 0 through 15

Age of Prevented Death	V_a (Rp. x 10^3)
0	80
1	109
2	129
3	154
4	183
5	216
6	251
7	291
8	338
9	392
10	455
11	531
12	609
13	595
14	573
15	550

[1] The values at each age in years subsequent to 1979-80 can be corrected for increases in productivity by multiplying the values in table X b by $e^{.04x}$ where x is the number of years after 1979-80 in which the death is prevented. This correction was made to the entries in Table X_a.

APPENDIX
Table XI

Cost-Benefit Analysis - Total Immunization Program (DPT & BCG)
(Rp. x10^6)

Year	Program Costs [1]	Program Benefits [2]
1979-80	2541	1666
80-81	2654	2972
81-82	2943	5177
82-83	3379	7428
83-84	3623	9891
84-85	1332	5876
85-86		5449
86-87		5517
87-88		5147
88-89		4332
89-90		3739
90-91		2986
91-92		2093
92-93		1050
Present value at 15% discount rate	9312	27010

Benefit/Cost Ratio at 15% doscount rate = 2.90
Net Present Value at 15% discount rate = 17698 ($42,7 million)
Internal Rate of Return = 185%

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[1] See table 2 in the text
[2] This column is the sum of the undiscounted value of program benefits in tables VIII, IX and X.

APPENDIX
Table XII

Cost-Benefit Analysis - DPT&TFT Program Only
(Rp. x10^6)

Year	Program Costs[1]	Program Benefits[2]
1979-80	2268	1589
80-81	2384	2749
81-82	2641	4875
82-83	3052	6961
83-84	3267	9226
84-85	-1311	4693
85-86		3593
86-87		2917
87-88		1702
Present value at 15% discount rate	8337	20021

Benefit/Cost Ration at 15% discount rate = 2.40
Net Present Value at 15% discount rate = 11684 ($28.2 million)
Internal Rate of Return = 190%

---

[1]See table 2 in the text
[2]This column is the sum of the undiscounted value of benefits accruing to the DPT-TFT inoculations. See tables VIII, IX and X.

APPENDIX
Table XIII

Cost-Benefit Analysis - BCG Program Only
(Rp. x10^6)

Year	Program Costs[1]	Program Benefits[2]
1979-80	1388	77
80-81	1457	223
81-82	1531	302
82-83	1785	467
83-84	1817	666
84-85	1217	1182
85-86		1856
86-87		2600
87-88		3445
88-89		4332
89-90		3739
90-91		2986
91-92		2093
92-93		1050
Present value at 15% discount rate	4728	6989

Benefit/Cost Ratio at 15% discount rate = 1.48
Net Present Value at 15% discount rate = 2261 ($5.45 million)
Internal Rate of Return = 22%

[1] See table 2 in the text.
[2] This column is the sum of the undiscounted value of benefits accruing to the BCG inoculations, see tables VIII, IX and X.

APPENDIX
Table XIV

Cost-Benefit Analysis of BCG Viewed as an Added Program (Rp. x10^6)

Year	Incremental Program Costs[1]	Incremental Benefits[2]
1979-80	273	77
80-81	270	223
81-82	302	302
82-83	327	467
83-84	356	666
84-85	-21	1182
85-86		1856
86-87		2600
87-88		3445
88-89		4332
89-90		3739
90-91		2986
91-92		2093
92-93		1050
Present value at 15% discount rate	808	6989

Benefit Cost Ratio at 15% discount rate = 8.65
Net present value at 15% discount rate = 6181 ($14.9 million)
Internal Rate of Return = 90%

[1]See table 2 in the text

[2]See footnote 2 on table XIII

APPENDIX
Table XV

Cost Benefit Analysis - Sensitivity Test of Total Program
(Rp. x10^6)

Year	Program Costs[1] +20%	Program Benefits[2] -50%
1979-80	3050	833
80-81	3169	1486
81-82	3532	2589
82-83	4055	3714
83-84	4348	4946
84-85	-1598	2938
85-86		2725
86-87		2759
87-88		2574
88-89		2166
89-90		1870
90-91		1493
91-92		1047
92-93		525
Present value at 15% discount rate	11191	13506

Benefit Cost Ration at 15% discount rate = 1.21
Net Present Value at 15% discount rate = 2315 ($5.6 million)

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1 Total Program costs in table XI multiplied by 1.2.
2 Total Program benefits in table XI multiplied by .5

PART III

AN ECONOMIC ANALYSIS OF A MALARIA CONTROL PROGRAM IN THE OUTER ISLANDS OF INDONESIA

Howard Barnum

PART III

D. ECONOMIC ANALYSIS

Summary and Conclusions

The economic analysis reported below indicates that the proposed program of malaria control in the Outer Islands is marginally economically viable when evaluated on the basis of quantifiable economic benefits. Under assumptions which are intended to represent the most plausible operating conditions the benefit cost ratio, evaluated at a 15% discount rate, is 1.07 and the internal rate of return is 17%. The low benefit/cost ratio leaves little margin for inefficiency in program administration or deviation from the targeted schedule of population coverage. These results are primarily attributable to the high cost of program operations, which is caused by the low population density and consequently high cost of delivery in the Outer Islands.

Offsetting these results is the fact that, as with all health projects, a substantial part of the benefits are humanitarian but unquantifiable and have been omitted from the calculation of the benefit/cost ratio. In addition, it has not been possible to incorporate the benefits derived from the contribution that malaria control in the Outer Islands would make to the encouragement of transmigration. Nor has it been possible to include the benefits derived from reduced reintroduction of the disease, and thus lowered control costs, on Java-Bali-Madura. The importance of these omitted benefits in offsetting the results based on the quantifiable economic benefits is judgemental but potentially decisive.

The program would have large employment effects, providing directly for the training of 20,000 workers. Both the employment and benefits would be dispersed regionally and would have desirable income distributional effects. Malaria occurs disproportionately in agricultural families and the benefits would favor rural areas (See Annex 8).

I. Introduction

This analysis is intended to give an assessment of the economic merits of the proposed program of malaria control in the Outer Islands. The analysis cannot be considered a definitive study because of the lack of accurate data with regard to malaria incidence, fatality rates and health service usage in the Outer Islands. The parameters used in the analysis are judgemental and are based on the opinions of malariologists among the present evaluation team and consultation with Ministry of Health officials. The difficulties in conducting this analysis with the available data demonstrate the strong need for a baseline malariometric study, based on a stratified random sample of both high and low incidence areas in the Outer Islands, before sizable program expenditures are commenced. Such a study is being planned and will allow a firm basis upon which to evaluate program achievements.

The objective of the proposed program is to reduce the incidence of malaria in the total population of the Outer Islands from the estimated present incidence of .1 to a level of .02 over the five years of the program.

The program is comprised of two parts: 1) a spraying operation and 2) drug treatments for malaria. Benefits from spraying are derived from the prevention of morbidity and mortality. Benefits from treatments are derived from the reduced severity and duration of the disease through presumptive treatment as well as radical cures.

The incidence of malaria is unevenly distributed throughout the Outer Islands with pockets of very high incidence, thought to be much greater than .1, and other areas in which the incidence is low, probably below .02. The theory under which the proposed program was designed is that by concentrating the spraying operation on high incidence areas, with 16,000,000 in population, the incidence of malaria in the sprayed areas will be dramatically reduced and there will be substantial secondary effects from the reduced transmission of malaria to the remainder of the population. The predicted result is a reduction of the incidence of malaria in the total 50,000,000 population to .02. As the program expands over the five year planning horizon from an initial level of 3,750,000 to a final level of 16,000,000 the proportional effective coverage in the total population of 50,000,000 will expand accordingly as given in column (2) of Table 1.[1] The analysis in this paper rests fundamentally on the validity of these epidemiological assumptions underlying the program design.

We have omitted the proposed expenditures and thus the benefits from the malaria control operation in the DDT resistant areas of Banjarnegara on Java in order to obtain a better evaluation of the economic merits of the program in the Outer Islands which constitutes the bulk of the proposed project. With this omission the total cost of the Outer Island program, including GOI, AID and other contributions, is 23662 x 10^6 Rp. ($69.1 million) using 1978 prices.

II. Cost Benefit Analysis

It is widely recognized that cost benefit analysis is difficult to apply to health projects because, although the costs are usually concrete, a substantial proportion of the benefits are intangible. In the present study the intangible benefits include the incalculable value of life and the value of reduced suffering to the person whose illness is prevented and the avoidance of the suffering bereavement and anxiety of friends and family. The importance of intangible benefits makes it infeasible to compare the results of a cost-benefit analysis in the health sector with the results of analyses of projects in other sectors of the economy. Nevertheless, an analysis based only on the tangible and quantifiable benefits of a health project is useful since it forces recognition of a class of benefits - the direct economic benefits which might otherwise be overlooked. In addition, although difficulties still remain, the results of the analysis might provide some guidance in the comparison of projects within the health sector.

A. Economic Costs

The economic costs are the incremental project costs less the value of capital remaining at the end of the planning period. The costs represent the sum of expenditures from all sources and have been derived from the financial flow

[1] Tables 1-7 are included in the Appendix

tables after subtracting a 5% per annum inflation factor and the cost of expenditures on Java and Bali. The costs, in terms of 1978 prices, are given in Table 2.[1]

The foreign exchange component of project costs has been converted to rupiahs at the current exchange rate ($1 = 414.5 Rp.). It is plausible to argue that this rate significantly overvalues the rupiah, perhaps by 15-25%. Although illegal markets for foreign exchange do not exist in Indonesia, the demand greatly exceeds the supply of import licenses at the current exchange rate. Nevertheless the rupiah is, at present, freely convertible and there appears to be no imminent possibility of devaluation. Rather than make an arbitrary choice of a shadow exchange rate we feel that it is less misleading to use the current exchange rate but to remain aware that actual cost may be underestimated by 10-20%.

An estimate of the cost effectiveness of the proposed program can be obtained by using the population data, and the estimates of the number of cases and deaths prevented, shown in Table 1, together with the cost information on Table 2. The total cost of the program per person in the Outer Islands (1981 population) is 512 Rp. ($1.23) over the five years of the program or 102 Rp. ($ .25) per person per project year. The estimated average cost per case prevented or treated[2] is 1,841 Rp. ($4.44). The estimated average cost per death prevented is 2,006,692 Rp. ($4,841.24).

Since the initial program coverage is small, although capital expenses and start up costs are large, we have also examined the cost effectiveness of the final year of the program in order to obtain an indication of the effectiveness of continuing the program beyond the initial start up period. The actual cost of 1983 operations, including an addition for depreciation on capital accumulated in prior years less the value of current investments, is 7934×10^6 Rp. The total cost of operations in the fifth year per person in the outer islands in 1983 is 147 Rp. ($ .36). The estimated average cost per case prevented or treated is 1,636 Rp. ($3.95). The estimated average cost per death prevented is 1,732,262 Rp. ($4,179.16).

B. Economic Benefits

For the present study the economic benefits from malaria control include the avoidance of income lost from morbidity, the avoidance of the extra caloric intake associated with malaria morbidity, the avoidance of treatment costs, the avoidance of lost income through premature death and the value of avoided time in the care of the sick.

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[1] Tables 1-7 are included in the annex to the project paper.

[2] Over the five years of the program there will be an estimated total of 12,099,000 cases prevented, 2,400,000 malaria cases treated and 13,299 deaths prevented.

a. Avoided Income Loss from Morbidity

Income (or production) to society is lost when members of the labor force are prevented from working or when at work they are less efficient due to malaria. In the present study, we attempt to measure only the lost output from lost work days due to malaria in the labor force. We have assumed the rate of unemployment is nine (9) percent and have subtracted out the unemployed from the labor force estimates. In addition, we have assumed that the rate of underemployment is thirty percent of the labor force and that the shadow wage, or value of output per day lost to illness, for the underemployed is fifty percent of the real wage for the fully employed[1].

b. Avoidance of Extra Caloric Intake

Individuals suffering from a febrile disease require extra calories. For malaria the excess caloric requirement is 400 kilo calories or 100 grams of carbohydrates per day for the duration of the attack. We have valued this at 20 Rp. per day[2].

c. Avoidance of Treatment Costs

The treatment costs include the cost of treatment by traditional means[3] (Jamu medicine) as well as medical care received through self treatment with conventional drugs, outpatient clinics or hospitalization. These costs represent an allocation of resources that would be unnecessary in the absence of malaria[3].

d. Value of Income Received from Prevented Mortality

The discounted value of the expected stream of lifetime earnings gives an estimate of the present value of the stream of output lost through the premature death of an individual. We have based our calculation on an estimate[4] of the present average per annum income of 80,000 Rp. and an assumption of a 4% annual increase in productivity. By using the national average income, an adjustment is implicitly made for the possibility of unemployment and underemployment. That is, the assumption is that infection is approximately random and a person whose death is prevented by malaria control may be unemployed, underemployed or fully employed with probabilities that are reflected by the present distribution of income. This somewhat overestimates the value of this benefit since malaria rates are probably higher in rural lower income groups for whom exposure is greater.

[1]For further discussion of this point see GOI/AID/WHO, In Depth Evaluation of of the Malaria Control Program - Indonesia, August, 1977, Economic Analysis, pp. 88-89

[2]Source: GOI/AID/WHO, In Depth ....., Economic Analysis, pg. 100.

[3]A 1976 study of the marketing and consumption of jamu medicine indicated that 70-75% of respondents would use jamu for medication irrespective of whether or not modern medical care is also received. O. Koesnadi, W. Tahar, Y. Anwar, Report on Marketing and Consumption of Jamu, P.T. Inscore, Indonesia, 1977, pp. 16-17.

[4]AID/Indonesia, Annex to Annual Budget Submission FY 1979.

e. Value of Time Spent in Home Care

The inclusion of this benefit recognizes the economic role of women in the agricultural household. Over a calendar year, the marginal product of both male and female labor may remain substantial throughout the busy season. In the slack season off farm employment opportunities may exist for men but are often limited for women, as a consequence the marginal value of female labor time falls severely. In the calculations used to derive the value of time in home care, we have assumed that, given the two crop cycles in Indonesia, the busy season comprises approximately one-fourth of the calendar year.

Based on the results of a labor force participation survey we have evaluated female labor time at a shadow wage of one half the average wage during the busy season and one fourth of the average wage during the slack season[1]. Assuming that the disease occurs randomly over the calendar year (this probably provides an underestimate of this benefit since malaria is more prevalent in the busy season) the value of female time spent in care is .3125 times the average real wage[2].

The calculated values of the benefits under alternative assumptions of six and eight days duration of illness per case are given in Table 5 (Appendix).

C. Results of the Cost-Benefit Analysis

Three cost-benefit analyses are conducted. A discount rate of 15% is used[3].

1. An analysis is made over the span of the five year program with the benefits evaluated under the assumption that the average duration of illness, used in the calculation of avoided income lost, avoided time in care and so on, is six days per case (See Part A of Table 5). This assumption is used because it provides a comparison with the cost benefit analysis of a hypothetical malaria program for the Outer Islands conducted in the GOI/AID/WHO In-Depth Review of August, 1977. The 1977 study found that a 2075 x 10^6 Rp. ($50 million) program evaluated over a five year program span would have a benefit/cost ratio of 1.63 and an internal rate of return (IRR) of more than 50%. In contrast the results for the present program, summarized in Table 6, are a benefit/cost ratio of .92 and an IRR of -4%. This is true in spite of the use of slightly higher prices and wages and the addition of two more benefit categories (avoided mortality and avoided family care) in the present analysis.

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[1] The activity rates for females are approximately .5 during the busy season and .25 - .30 during the slack season. See H. Redmana, H. Moir and Daliyo, Labor Force and Labor Force Utilization in Selected Areas in Java: vol. 1, National Institute of Economic and Social Research, Indonesia, 1977, pg. 77.

[2] $(1/2 \cdot 1/4 + 1/4 \cdot 3/4) = .3125$

[3] A discount rate of 15-18% has been used in other recent cost benefit studies in Indonesia. This range appears to approximate the present opportunity cost of capital in Indonesia.

In order of importance the major reasons for this divergence are:

i) The present proposed program is 38% more costly than the program considered in the 1977 analysis.

ii) It was assumed in the hypothetical program considered in the 1977 analysis that the incidence of malaria would be reduced to the control level in the entire population from the first year of the program whereas we have assumed that the control level is reached in a proportion of the total population that grows over the five years of the project in accordance with the planned growth in program coverage.

iii) The 1977 analysis assumed a reduction in malaria incidence to .01 whereas the present analysis uses the target rate of .02.

2. An argument can be made that six days is an overly conservative estimate of the number of days lost to an attack of malaria. The actual average may be greater due to increased susceptibility to other diseases and recurrent attacks. To test the sensitivity of the analysis to the duration of illness assumption we have calculated the benefits using eight days as an alternative, and we feel a more reasonable, estimate. The results of the analysis using the alternative assumptions are given in Table 7 which shows a benefit/cost ratio of 1.16 and an IRR of 25%. Thus the change in the assumption changes the results from an unfavorable benefit/cost ratio of less than one to a more favorable value somewhat greater than one, and we conclude that the analysis is highly sensitive to the assumption regarding the duration of illness.

3. In the final cost-benefit comparison we have kept the eight day duration assumption but have made two changes in the analysis which are intended to provide a more accurate description of the actual flow of costs and benefits under which the program should be evaluated. First we feel that it is erroneous to evaluate the program on the basis of only the initial five years since these years include substantial start up costs before the major part of program benefits begin to be realized. The program is designed to be continued into an equilibrium control stage which is not reached during the initial five years. Thus we have conjectured a probable flow of costs and benefits over a ten year period. The path of costs reflects the fact that cost can be expected to be reduced gradually from a peak in the fifth through the seventh years to a control-maintenance level of approximately fifty percent of peak expenditures in the tenth year.

The second change is to introduce an efficiency factor. The previous analyses have assumed that program efficiency, i.e. the quality of spraying, administration and distribution, is 100%. In the final analysis we have assumed that program efficiency[1] is considerably less than perfect in the initial two years and increases to a peak level of 85% in the final years.

[1]The values for the efficiency rates were chosen in consultation with a team member having considerable experience in the administration of malaria control projects.

Under these assumptions (See Table I) the benefit/cost ratio is 1.07 and the IRR is 17%. This result, which we feel most clearly reflects the actual operating conditions, demonstrates the sensitivity of the economic viability of the program to the efficiency of program operations. This underscores the importance of program administration and the feasibility of the targeted coverage. There is clearly no margin in these results for a failure to meet the schedule of targeted coverage.

D. Two Significant Omitted Economic Benefits

The results of the above cost benefit analysis, which shows that the proposed program is only marginally economically viable, should be tempered by a consideration of two additional classes of benefits which it has not been feasible to include in the time given for this study and which would in any case prove difficult to incorporate. The first omitted benefit is that the program can be viewed as one component of the necessary infrastructure for planned transmigration to the Outer Islands. To the extent that the program proceeds on target and effectively reduces the level of malaria to .02 in the Outer Islands it will encourage transmigration and the settlement of new areas and a part of the economic benefits from this economic expansion would be attributable to the malaria control program. The second omitted class of benefits is derived from the reduced rate of reinfestation on Java-Bali-Madura accompanying inter island population movement. A reduced incidence of malaria on the Outer Islands would therefore, potentially reduce the cost of control on Java-Bali-Madura. The importance of these omitted benefits is judgemental but they are potentially sizable enough to offset the high cost of the program and provide a highly favorable benefit/cost ratio and IRR.

III. Employment and Income Distributional Effects of the Program

The program provides for the training and employment of approximately 20,000 workers involved in spraying, transport, microscopy and administration. There will also be additional gains in employment through the multiple effects of the domestic part of program expenditures and through the encouragement of transmigration. The substantial employment effects will be dispersed regionally.

Because the incidence of malaria is higher in agricultural families the benefits will favor rural areas. From the point of view of distribution among income groups the program is favorable since incomes in rural areas tend to be low.

Table I

Cost-Benefit Analysis with Best Estimate of Program Efficiency (Quality of Coverage), Program Extended into Maintenance Phase (Assuming Eight Ill Days per Year per Case) (Rp. x 10^6)

Year	Program Costs[1] (Planned Five Year Expenditures)	Possible Program Costs in Additional Five Years[2]	Assumed Program Efficiency[2]	Program Benefits[3]
1979	4170		.6	1472
1980	4198		.6	2036
1981	5601		.7	4725
1982	6828		.8	7151
1983	7865		.85	9962
1984		780[illegible]	.85	10000
1985		7800	.85	10000
1986		6800	.85	10000
1987		5600	.85	10000
1988		4100	.85	10000
Present value at 15% discount rate		29430	31630	

Benefit/cost ratio at 15% discount rate = 1.07
Net present value at 15% discount rate = 2200 ($5.3 million)
Internal rate of return = 17%

[1]See Table 4 in the appendix.

[2]See the discussion in the text.

[3]The benefits are derived by multiplying program efficiency times the yearly estimated benefits in Table 5, Part B. It is assumed that the level of protection in the fifth year is continued into the maintenance phase.

Table 1

Number of Cases and Deaths Prevented
by the Proposed Malaria Program

Part I. Spraying

Year	Population[1] (000) (1)	Planned Program Coverage[2] (proportion) (2)	Population Affected by Program (000) (3)=(1) x (2)	Cases Prevented[3] (000) (4)= .08 x (3)	Mortality Avoided[4] (5)= .001 x (4)
1979	50167	.234	11739	939	939
1980	51155	.313	16012	1281	1281
1981	52163	.563	29368	2349	2349
1982	53191	.750	39893	3191	3191
1983	54235	1.000	54235	4339	4339

Part II. Treatment

Year	Planned Number of Presumptive Treatments (000) (6)	Assumed incidence of malaria in patients[5] treated (7)	Number of Cases Affected by treatment (000) (8)=(6)x(7)	Mortality Avoided[6] (9)= .0005 x (8)
1979	600	.30	180	90
1980	1000	.24	240	120
1981	4000	.18	720	360
1982	6000	.12	720	360
1983	9000	.06	540	270

[1] A population weighted index of the annual outer islands growth rate, based on 1961-1971 census data, is 1.97% for all of the Provinces in the Outer Islands. Source: Central Bureau of Statistics, Social Indicators - 1973/74.

[2] Based on the program plan from the Ministry of Health.

[3]It is assumed the average incidence of malaria (proportion of population per year) is .1. The malaria control from the present program is targeted to reduce the incidence to .02 in the covered population. The target of the program is thus to prevent a total number of cases equal to 8% of the covered population.
It is important to recognize that the incidence rate is a very uncertain estimate. The rates in specific geographic areas will differ markedly. Rates reported from clinics are subject to wide margins of error. Moreover, malariometric surveys in the outer islands have not been systematic and in most island areas we simply do not know the rate of malaria.
The .1 rate was taken from: In-Depth Evaluation of the Malaria Control Programme - Indonesia, GOI/AID/WHO Joint Team, Jakarta, August 1-31, 1977, Economic Analyses, p. 98.

[4]The true case fatality rate is unknown. The rate can very greatly depending on conditions and the relative prevalence of different malaria strains. We have arbitrarily used a case fatality rate of .001 after consultation with other team members and Ministry of Health officials.

[5]There is almost no basis on which to estimate the proportion of treated patients who will actually have malaria. We have arbitrarily assumed that the incidence of malaria in patients treated will be three times the probable incidence rate in the population in each of the five program years. If the incidence is actually higher the benefits from treatment provided by the planned program will be underestimated.

[6]It is assumed that the case fatality rate will be reduced by one half by treatment.

Table 2

Number of Cases Prevented in the Labor Force

Year	Labor Force[1] (000) (1)	Labor Force Affected by Program[2] (000) (2)	Cases Prevented in Labor Force (000) (3) = .08 x (2)	Cases in Labor Force Affected by treatment[3] (000) (4)
1979	26298	6153	492	94
1980	26981	8445	676	127
1981	27683	15586	1247	382
1982	28403	21302	1704	384
1983	29141	29141	2331	290

[1]The projections are based on the assumption that the labor force will continue to grow at 2.6% per annum. Source: American Embassy Jakarta's Annual Labor Report, June 10, 1977, p.3 and GOI/AID/WHO, In Depth ...., Economic Analysis, p. 96.

[2]Col (2) (table 1) x Col (1) (table 2).

[3]Col (1) (table 2) % Col (1) (table 1) x Col (8) (table 1)

Economic Analysis

Table 3

Daily Real Wage Rates

(Rupiah/Day)

Year	Wage Rate for Employed[1]	Shadow Wage Rate for Underemployed[2]	Shadow Wage Rate for family care[3]
1979	447	224	140
1980	457	229	143
1981	466	233	146
1982	475	238	148
1983	485	243	152

[1]The wage projections are based on an extrapolation of the 1972 wage (baseline index = 390). It is assumed that the real wage increases by two percent per annum. The wage estimates are derived from an urban survey. Because wages tend to be higher in urban areas these figures provide an overestimate of the average national wage. Source: Annual Labor Report, American Embassy, Jakarta, June 1977, p. 18 and GOI/AID/WHO, In Depth ....., Economic Analysis, p. 97.

[2]The shadow wage rate for underemployed is assumed to be one half the real wage for the employed.

[3]The shadow wage for female labor time spent in family care of the ill is calculated as .3125 times the real wage. This factor includes a consideration of busy versus slack season labor participation rates for women.

Annex

Economic Analysis

Table 4

Costs by Year of Program[1]
(Rp. x 10^6)

Year	Category			Total
	Training	Depreciable Equipment	Wages and Supplies	
1979	567	725	2878	4170
1980	255	412	3531	4198
1981	327	404	4870	5601
1982	249	257	6322	6828
1983	208	257	7400	7865
Total	1606	2055	25001	28662
Value of Capital remaining at end of five years[2]	1129	846		1975
Total costs less value of capital at end of five years	477	1209		26687

[1]The 5% per annum inflation factor used in the financial section has been removed to obtain the costs in real terms presented in this table. These costs represent the planned program expenditures from all sources (GOI + AID + other sources).

[2]This is the depreciated value of training and equipment at the end of five years. An attrition rate of .10 is assumed for the value of training. Straight line depreciation, assuming a life of six years, was used for equipment.

Table 5

Benefits from the Planned Malaria Program

in Outer Islands

(Rp. x 10^6)

A. Assuming six days lost per year per case of untreated malaria

Year	Value of Avoided Income Loss[1]	Value of Avoided Calorie Loss[2]	Value of Avoided Treatment Costs[3]	Value of Lifetime Earnings from Prevented Mortality[4]	Value of Avoided time in family care[5]	Total Benefits
1979	1131	127	196	324	178	1956
1980	1581	173	267	432	247	2700
1981	3191	339	490	826	496	5342
1982	4245	441	662	1090	652	7090
1983	5583	564	906	1430	857	9340

B. Assuming eight days lost per year per case of untreated malaria

Year	Avoided Income Loss	Avoided Calorie Loss	Avoided Treatment Costs	Avoided Mortality	Avoided time in family care	Total Benefits
1979	1521	172	196	324	240	2453
1980	2127	234	267	432	334	3394
1981	4297	462	490	826	675	6750
1982	5702	597	666	1090	884	8939
1983	7472	759	906	1430	1153	11720

[1]The value of avoided income loss due to spraying is calculated by multiplying the number of cases of malaria avoided by the average number of sick days per year for untreated malaria times the average daily real wage rate. For the underemployed the same procedure is used except that we substitute the shadow wage for the wage rate. The value of avoided income loss due to program treatment is calculated similarly except that we multiply by the average number of sick days per year less two days under the assumption that there will be an average of two sick days per case receiving program treatment.

[2]The value of avoided excess caloric intake attributable to spraying is the product of the number of cases of malaria avoided times the cost of excess rice per day of illness (Rp. 20/day) times the average number of sick days per year per case. The value of avoided excess caloric intake attributed to program treatment is obtained similarly except that the number of ill days prevented per case is two less than under spraying.

[3]The value of treatment costs is the sum of drug costs plus outpatient clinic cost plus hospitalization cost. Drug cost is obtained by multiplying the number of cases of malaria who will be self-treated (.67 of all malaria) by 125 Rp. (the current cost of chloroquine, 100 Rp., plus 25 Rp. as an estimated cost of extra Jamu (traditional medicine) taken. Clinic cost is the number of malaria cases that will be clinic treated (assumed to be .07) multiplied by the cost of one clinic visit (500 Rp.). Finally, a small fraction of the malaria cases will require hospitalization. We use an average daily hospital cost of 3,000 Rp. and an average of five days of hospitalization. The estimates of health service usage are subjective and acquired from consultation with Ministry of Health officials.

[4]The estimated discounted average value of lifetime earnings for the average death prevented is 314,000 Rp. This is derived as a weighted average of the value of lifetime earnings from the average prevented death in separate age groups. The weights are the proportion of total deaths in each age group and are derived with reference to a life table for Indonesia and under the assumption that the case fatality rate in the 0-10 year age group is approximately five times the rate in the over 10 age group. The value of lifetime earnings at any age is derived by discounting future earnings at a rate of 15%. The age earnings profile used assumes that the average child enters the labor force at age twelve and receives an entering income of approximately one fourth the national average. His expected income then increases with maturity and gains in productivity up to the national average at the age of 20. Assuming a horizon of age 55, his income will continue to increase with gains in productivity (assumed to be .04 per year) from age 20 to 55. A correction has been made for the probability of survival over time. An important assumption is that the costs of child rearing before age 12 are offset by the consumption benefits of children to parents. A detailed discussion of the derivation of the present value of lifetime earnings is given in the appendix to the economic analyse for the Expanded Program of Immunization in Indonesia (USAID Project Paper).

[5]It is assumed that the total time spent in care is 20% of the total number of ill days. The value of avoided time spent in family care of the ill is thus .2 times the number of cases prevented times the number of ill days per case per year multiplied by the shadow wage rate for female labor. The number of ill days avoided through program treatment is two less per case than the number of ill days avoided through prevention.

Economic Analysis

Table 6

Cost - Benefit Analysis of the Planned Malaria

Program in the Outer Islands

(Assuming Six Days Lost)
(Rp. x 10^6)

Year		Program Costs[1]	Program Benefits[2]
79		4170	1956
80		4198	2700
81		5601	5342
82		6828	7090
83		5890	9340
Present value at 15% discount rate		17320	15955

Benefit/cost ratio at 15% discount rate = .92
Net present value at 15% discount rate = -1365
Internal Rate of Return = - 4%

[1]See table 4, note that costs in 1983 are net of the value of capital remaining at the end of the planning period.

[2]See table 5, part A.

Economic Analysis

Table 7

Cost-Benefit Analysis of the Planned Malaria Program

in the Outer Islands

(Assuming Eight Days Lost)

(Rp. x 10^6)

Year		Program Costs[1]	Program Benefits[2]
79		4170	2453
80		4198	3394
81		5601	6750
82		6828	8939
83		5890	11720
Present value at 15% discount rate		17320	20079

Benefit/cost ratio at 15% discount rate = 1.16
Net present value at 15% discount rate = 2759 ($6.7 million)
Internal rate of return = 25%

[1]See table 4, note that the costs in 1983 are net of the value of capital remaining at the end of the planning period.

[2]See Table 5, Part B.

PERSONNEL CONTACTED DURING THE CONSULTATION

USAID/Indonesia

Dr. Edward S. Vanderhoof

Dr. Richard Johnson

Mr. Philip Smart

Mr. Lance Downing

Mr. Ken Smith

Government of Indonesia, Ministry of Health, CDC, immunization

Dr. Setiady

Dr. Tarantola

Dr. Gunowiseso

Dr. Nolo

Mr. Santarelli

Government of Indonesia, Ministry of Health, CDC, Malaria

Dr. Arwati

Dr. Adyatma

Government of Indonesia, PUSTIKLAT

Dr. Wiryawan

Mrs. Fardiah

Ms. Yipp

Ms. Hegas

Ms. Walsh

World Health Organization, Consultants to Government of Indonesia

Dr. Frester

Dr. Lopez

Consultants to AID/Indonesia

Mr. Robert Hogan (immunization)

Dr. Marc LaForce (immunization)

Mr. Lawrence Cowper (malaria)

Mr. Jon Rohde (malaria)