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Micro-Costing Analysis for Human Papillomavirus (HPV) Vaccination Services for Out-of-School (OOS) Girls in Indonesia: Evidence from a Pilot Study

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Abstract

Background: Cervical cancer remains a major public health challenge in Indonesia, with Human Papillomavirus (HPV) infection responsible for nearly all cases. The government has integrated HPV vaccination into the national School Children Immunization Month (BIAS). However, out-of-school (OOS) girls remain difficult to reach because they are not covered by the school-based vaccination platform. This study aimed to estimate the cost of delivering a single-dose HPV vaccination program to OOS girls and to project the national-level cost of scaling up the program.

Method: Micro-costing approach was used to estimate both economic and financial costs of delivering HPV vaccination to OOS girls in Bekasi City, Bandar Lampung City, and Bangka Regency. Costs were categorized into outreach and delivery efforts. A scale-up costing analysis was also conducted to estimate national-level costs.

Result: The results show that the cost per vaccinated OOS girl aged 11 ranged from US$ 22.77 to 38.55, while the financial cost range from US$ 12.70 to 29.50, varied by implementation context, with outreach activities, transportation, and vaccine delivery supplies identified as the main cost drivers. The estimated national annual economic and financial cost of scaling-up HPV vaccination for OOS girls are US$ 644,215.23 and US$ 483,138.35, respectively.

Conclusion:

Optimizing OOS girls' outreach and HPV vaccination is essential to achieve sustained full coverage. National cost estimates show that reaching and vaccinating OOS girls accounts for less than 3% of the national immunization budget.

Introduction

Cervical cancer remains one of the major public health challenges in Indonesia, Indonesia ranks third globally in the number of cervical cancer cases compared to other countries [1]. The disease accounts for approximately 40,000 new cases and 20,000 deaths annually. Nearly 99.7% of cervical cancer cases are caused by the Human Papillomavirus (HPV) [2]. Although HPV can also cause other types of cancers in both women and men, cervical cancer remains the most common cancer associated with HPV infection [3].

In response to these challenges, Indonesia has undertaken several steps, including strengthening preventive efforts through HPV immunization and improving screening methods. Through the National Action Plan (RAN) for Cervical Cancer Elimination 2023–2030 [4], the government has set a target of achieving 90% HPV immunization coverage among girls by the age of 15. Implementation of the free HPV vaccination program is integrated into the annual School Children Immunization Month (BIAS), alongside Measles-Rubella (MR) and Tetanus and Diphtheria (DTTD) immunizations.

However, significant challenges remain in achieving equitable HPV immunization coverage. A study in Indonesia highlights persistent disparities in coverage, particularly in ensuring that all girls complete the vaccination series [5]. Recent data from Ministry of Health (MoH), HPV vaccination coverage in Indonesia reached 91.1% in 2025 after the implementation of the single-dose since 2025 [6].

One of the factors contributing to challenges in achieving 100% coverage is the difficulty in reaching out-of-school (OOS) girls, who are not accessible through the formal school-based BIAS mechanism. Current HPV vaccination efforts in Indonesia are predominantly school based through the *Bulan Imunisasi Anak Sekolah* (BIAS) mechanism; however, this system lacks a specific national strategy to reach those outsides of formal settings. Consequently, OOS girls remain underserved. Based on the OOS estimation in this study (Table 3), the estimated number of OOS girls aged in Indonesia is approximately 25,354 nationally. Many of these girls come from marginalized backgrounds, limiting their access to HPV vaccination. Additionally, approximately 12,953 educational institutions, representing 2.34% of all educational institutions in Indonesia, operate as non-formal schools, such as Community Learning Centers (PKBM), Islamic boarding schools, and other alternative education pathways [6].

In Indonesia reaching OOS girls presents challenges related to cultural norms, misinformation, and concerns among some parents regarding HPV vaccination [7]. As HPV vaccination is primarily delivered through schools, religiously affiliated and non-formal education settings may require more intensive engagement, as previous evidence suggests that faith-based school communities may be more hesitant to encourage HPV vaccination. This is also supported by a study in Indonesia showing that the halal–haram status of the HPV vaccine has become increasingly crucial, indicating that religion plays an important role in health decision-making [8, 9]. In addition, parents and teachers may have limited confidence and knowledge to discuss sexual and reproductive health topics with young people, which can affect communication and acceptance of HPV vaccination[10].

Similar challenges are also observed in low and middle-income countries, which require additional community-based strategies and proactive sensitization efforts [11, 12]. The situation is further compounded by socioeconomic vulnerabilities, which many OOS girls live in marginalized communities, engage in informal labor [13], face early marriage, or lack supportive caregiving structures [14]. To respond to these barriers, multiple strategies have been introduced in Bangladesh, Burkina Faso, Ethiopia, The Gambia, Mali, and Senegal including cross-sectoral coordination platforms, stakeholder engagement, and the dissemination of inclusive Communication, Information, and Education (CIE) materials [11, 13].

Subsequently, reaching OOS girls may require additional resources for identification, mobilization, outreach, and the provision of vaccination services, as demonstrated by implementation experiences in Mozambique, Zimbabwe, Peru, Uganda, Vietnam, the UK, Belgium, and several U.S. federal programs [15]. Consequently, the cost per vaccinated OOS girl is estimated to be significantly higher than the cost per vaccinated girl under school-based programs [15–17]. A systematic cost analysis is therefore essential to assess cost per vaccinated OOS girls to ensure the sustainability and effectiveness of HPV vaccination programs, especially for OOS groups who are epidemiologically and socially more vulnerable to gaps in routine health interventions [15]. However, comprehensive cost estimates for Indonesia are currently limited, if any.

This study aims to estimate the cost of delivering a single-dose HPV vaccination program to OOS girls and to project the national-level cost of scaling up the program. The analysis includes mapping outreach processes and identifying cost components at multiple levels of the health system and community. The findings are expected to provide evidence-based input for policy makers to design efficient financing strategies that ensure equal rights to preventive care for all girls. By expanding HPV vaccination coverage among OOS populations, the government can not only advance toward national cervical cancer elimination targets under the 2023–2030 National Action Plan but also mitigate substantial future treatment costs associated with the disease.

The costing is based on an HPV vaccination pilot project targeting OOS girls in Indonesia, implemented by Clinton Health Access Initiative (CHAI) from October to December 2023. The pilot included target identification, outreach, and evaluation conducted in sequential stages at the city and community levels [18, 19]. The pilot was carried out in Bekasi City, Bandar Lampung City, and Bangka Regency, three urban settings with relatively high HPV vaccination coverage in 2024: 86%, 93%, and 88%, respectively. [18, 19]. This pilot emphasized strengthening cross-sectoral coordination and community-based outreach strategies to effectively reach 11-year-old girls who are not enrolled in formal education (i.e. either out of school completely or undergoing informal education) [18]. The pilot was initiated by Clinton Health Access Initiative (CHAI) and involved a wide range of cross-sector stakeholders.

Methods

Study design and overview

The study employed micro-costing analysis to estimate the cost of HPV vaccination outreach and service delivery for OOS girls in Bekasi City, Bandar Lampung City and Bangka Regency. The analysis was conducted from both financial and economic perspectives, capturing direct program expenditures as well as the costs associated with personnel time, equipment, and facility use.

The costing framework covered the outreach and full-service delivery pathway, including target identification and coordination, target validation, stakeholder socialization, and vaccination implementation. OOS girls were defined as 11-year-old girls who were either not enrolled in formal education, attending informal or non-formal educational institutions, or completely out of school.

Cost data were collected through document review, field observation, and in-depth interviews with key stakeholders, including district/city health offices, primary health centers (*puskesmas*), and partner institutions involved in HPV vaccine delivery. In addition to site-level costing, the study developed a national scale-up simulation to estimate the potential cost of expanding a single-dose HPV vaccination strategy for OOS girls across Indonesia.

Definition of OOS girls

Following the intervention by CHAI, we defined OOS girls as those who are not enrolled in formal education, including two main groups. First, those enrolled in informal or non-formal education (i.e., attending non-formal learning settings such as Islamic boarding schools/*pesantren*, homeschooling, and other similar programs). Second, those who are completely out of school (i.e., not attending any educational institution), which includes those residing in non-educational institutions (e.g., orphanages, rehabilitation centers, and similar facilities) as well as those living in the community outside any institutional setting [20]. We limited our analysis to OOS girls aged 11 years.

Study setting and implementation

Study implementation

This study employs a purposive sampling method to select relevant stakeholders from CHAI, district/city health offices (DHO), primary health centers (*puskesmas*), and other stakeholders perform interviews related to costing

analysis. The selection criteria were adjusted based on discussion with DHO and CHAI or through a snowball sampling approach during data collection (Table 7). Data collection was conducted across three locations: (1) Bekasi City from 17/11/2025–10/02/2026, (2) Bandar Lampung City from 01/12/2025–02/02/2026, and (3) Bangka Regency from 12/01/2026–20/01/2026.

Table 7
Respondents

No.	Province	Institution	Number of Respondent
1	West Java	Province Health Office	1
		Bekasi City Health Office	1
		Puskesmas	4
		Community Health Worker (Kader)	4
		Other stakeholders	6
2	Lampung	Province Health Office	1
		Bandar Lampung City Health Office	1
		Puskesmas	4
		Kader	4
		Other stakeholders	6
3	Bangka Belitung Island	Province Health Office	1
		Bangka Regency Health Office	1
		Puskesmas	4
		Kader	4
		Other stakeholders	6

HPV vaccination delivery activities

The activities were based on the pilot initiated by CHAI in 2023. The pilot implementation involved a wide range of cross-sector stakeholders, including City/District Health Offices, *Puskesmas*, Education Offices, the Ministry of Religious Affairs, Social Affairs Offices, Civil Registration Offices, community organizations, and CHAI as the main facilitator [19]. CHAI played a central role in facilitating cross-sector coordination, developing strategies, and documenting lessons learned to support the integration of OOS approaches into the national immunization program [18, 19]. The activities are grouped into four main groups, namely target identification and coordination, target validation, socialization to involved stakeholders, and HPV vaccination (Table 1).

Table 1
Identification of HPV vaccine delivery activities for out-of-school (OOS) girls

Process	Activities	Organizer	Participants
Identification and coordination	Identification of cross-sectoral roles and responsibilities	District/city health office	*Puskesmas*, education office, social affairs office, ministry of religious affairs, and other relevant stakeholders.
	Quantification, identification, and categorization of OOS girls	District/city health office	*Puskesmas*, education office, social affairs office, ministry of religious affairs, and other relevant stakeholders.
	Target identification, outreach planning, and logistics requirement estimation	District/city health office	*Puskesmas*, education office, social affairs office, ministry of religious affairs, and other relevant stakeholders.
Target validation	Target validation: Communication via whatsapp	*Puskesmas*	*Puskesmas* and nonformal school.
	Target validation: School visits	*Puskesmas*	*Puskesmas* and nonformal school.
	Validation of targets from marginalized groups	*Puskesmas*	*Puskesmas* and cadre.
Stakeholder socialization	Socialization with nonformal schools: School visits	*Puskesmas*	*Puskesmas*, cadre and nonformal schools
	Socialization with nonformal schools at the puskesmas	*Puskesmas*	*Puskesmas*, cadre, nonformal schools and other relevant stakeholders.
Vaccination implementation	Implementation of HPV immunization	*Puskesmas*	*Puskesmas* and nonformal school.

CHAI's financing for this project at the district/city level for coordination process was calibrated to match the existing routine activity budgets of the relevant offices to ensure sustainability and institutional alignment, as the activities supported by CHAI were considered an integral part of each stakeholder's established routine activities rather than standalone interventions. In addition, staff working time allocated to CHAI-supported activities was also captured in this calculation, though measured from the perspective of the employees themselves. The routine health office meetings with cross-sectoral stakeholders conducted four times per year, with the presentation on the School Children Immunization Month (BIAS) activities for HPV vaccination delivered once a year, covering socialization and data collection on the target population of OOS girls. This implementation scheme was applied across all study locations.

Costing framework

Costing approach

We used micro-costing, complemented by document review and in-depth interviews, to provide contextual insights regarding the cost data and their background. The framework (Fig. 1) begins by identifying key inputs

(e.g. human and financial resources) utilized in the delivery process to deliver a single dose HPV vaccination program, encompassing logistics, vaccine storage, transportation, administration, as well as information, education, and communication (IEC) activities. It also includes the identification and validation of OOS girls and community mobilization efforts. The use of resources and associated expenditure related to these activities are systematically assessed through cost analysis to determine both recurrent and capital costs. We calculated the total cost of each stakeholder in relation to respective activities, as shown in Table 1.

Sources: Authors, adapted from [21, 22]

Capital costs encompass expenditures associated with health workforce training and capacity development, equipment, and buildings. Recurrent costs include the value of healthcare workers' time devoted to program activities and annual needs for service delivery (e.g. vaccines, syringes, and safety boxes). By combining capital and recurrent cost components, this study calculates the program's total expenditure and subsequently derives the unit cost per OOS girl fully vaccinated against HPV.

Micro-costing components and assumption

The summary of assumptions, cost components, and data sources are presented in Table 2, and we aligned our approach with the CHEERS checklist (Table 8) [23], thus our costing method is comparable to other studies. We present our results both as financial and economics costs. The financial costs only encompass costs related to items that are utilized specifically for the implementation (e.g. consumable supplies, transportation), while economic costs encompass all items included in financial costs as well as other costs related to the implementation from health system perspective (e.g. wage, building).

Table 2
Assumption and Values Used on Micro-costing Analysis

Items	Economic cost	Financial cost	Values Measured/Used or Type of Resources Costed	Source
Exchange Rate (2025)			16,392.77 per US$	Average of official exchange rate (2025) published by Bank of Indonesia
Discount Rate			3%	Drummond *et al.* (2015)
Personnel Cost			Number of personnel	Interviews with healthcare workers and available records from health facilities, as well as field visits.
	ü		Personnel wage	Interviews with healthcare workers and records held by the institution. If wage data were not obtained from field visits, the researchers used an alternative approach by collecting information on job position, highest educational attainment, and length of employment. These were then converted into wage estimates using the government employee salary scale based on Government Regulation of the Republic of Indonesia Number 15 of 2019.
			Personnel time allocation	Interviews with healthcare workers regarding the amount of time spent on activities related to the delivery of HPV vaccines to OOS girls.
	ü		Personnel honorarium	Interviews with healthcare workers and records held by the institution. If honorarium data were not obtained from field visits, the researchers used the 2025 regional minimum wage (district/city) as a proxy and then converted it into an hourly wage, based on the following assumptions.
				Regional Minimum Wage 2025 / Salary per hour (US$)
				Bekasi City: 347.04 / 2.17
				Bandar Lampung City: 201.57 / 1.26
				Bangka Regency: 236.41 / 1.48
Consumable Supplies Cost			Quantity of consumable supplies	Interviews with healthcare workers and records available from health facilities during field visits.
	ü	ü	Price of consumable supplies	The prices of consumable supplies were obtained from records maintained by health facilities. When such price data were unavailable, the researchers used procurement

Items	Economic cost	Financial cost	Values Measured/Used or Type of Resources Costed	Source
				prices listed in the e-*katalog* (https://katalog.inaproc.id/) and/or market prices from online marketplaces as reference points.
Equipment, Building and Space Cost			Quantity of equipment, space, and buildings	Interviews with each stakeholder, institutional records, and field observations.
	ü		Price of equipment, space, and buildings	The prices of equipment, space, and buildings were obtained from records maintained by health facilities. When price data were unavailable, the researchers used procurement prices listed in the *e-katalog* (https://katalog.inaproc.id/) and/or market prices from online marketplaces as reference points. To estimate the value of rooms and buildings, the researchers used land and building tax values.
			Allocation % of equipment, space, and buildings	Interviews with each stakeholder regarding the use of equipment, rooms, and buildings for activities related to the delivery of HPV vaccines to OOS girls.
			% use of equipment, space, and building	The ratio between the allocated use and the total operational time of each stakeholder, based on the following assumptions:
				Puskesmas = Total operating hours of the community health center in one year
				District office = Total operating hours of the district office in one year
				Pondok pesantren = Total study hours at the Islamic boarding school (3,600 hours per year)
				Community Learning Center = Total study hours in non-formal education institutions (2,000 hours per year)
				If the total allocated time for the use of equipment, rooms, and buildings was not available, the researchers used a ratio-based approach based on the number of targets and/or HPV vaccination coverage among OOS girls relative to the total vaccination and immunization activities implemented.

Items	Economic cost	Financial cost	Values Measured/Used or Type of Resources Costed	Source		
Other Activities Cost	ü	ü	Activity Identification	Interviews were conducted with each stakeholder and relevant activity documents were reviewed in relation to the distribution of HPV vaccination for out-of-school girls. Activities related to the delivery of HPV vaccination for out-of-school girls were grouped into coordination and identification, validation, socialization, and vaccination implementation activities. Details of the activity identification can be seen in the appendix (Table 12).		
			Allocation of time for activities related to HPV vaccine delivery to OOS girls	Interviews with each stakeholder and activity documents related to HPV vaccine delivery for OOS girls.		
	ü	ü	Transportation costs	Interviews with each stakeholder and activity documents related to HPV vaccine delivery for OOS girls. If the data were unavailable, the researchers used the official business travel standards for each district/city, based on the following assumptions:		
						Transportation cost per person per day (US$)
				Bekasi City	=	6.10
				Bandar Lampung City	=	3.05
				Bangka Regency	=	1.52
	ü	ü	Consumption cost	Interviews with each stakeholder and activity documents related to HPV vaccine delivery for OOS girls.		

Table 8
CHEERS 2022 Checklist Report

	Item	Guidance for Reporting	Reported in section
TITLE			
Title	1	Identify the study as an economic evaluation and specify the interventions being compared.	Title, Page 1
ABSTRACT			
Abstract	1	Provide a structured summary that highlights context, key methods, results and alternative analyses.	Abstract, Page 2
INTRODUCTION			
Background and objectives	3	Give the context for the study, the study question and its practical relevance for decision making in policy or practice.	Introduction, Page 2–5
METHODS			
Health economic analysis plan	4	Indicate whether a health economic analysis plan was developed and where available.	Method – Study design and overview, Page 5–6
Study population	5	Describe characteristics of the study population (such as age range, demographics, socioeconomic, or clinical characteristics).	Methods – Study implementation, Page 6 Appendix – Table 7, Page 26
Setting and location	6	Provide relevant contextual information that may influence findings.	Methods – Study Settings and Sample, Paragraph 1–3 Methods – Scale-up simulation strategy, Paragraph 1 Methods – Scale-up simulation strategy, Table 3, Page 12
Comparators	7	Describe the interventions or strategies being compared and why chosen.	Not Applicable
Perspective	8	State the perspective(s) adopted by the study and why chosen.	Methods – Costing Approach, Paragraph 1
Time horizon	9	State the time horizon for the study and why appropriate.	Not Applicable
Discount rate	10	Report the discount rate(s) and reason chosen.	Methods - Micro-costing component and assumption, Table 2, Page 10

	Item	Guidance for Reporting	Reported in section
TITLE			
Selection of outcomes	11	Describe what outcomes were used as the measure(s) of benefit(s) and harm(s).	Methods – Study design and overview, Paragraph 1–2 Methods – Costing approach, Paragraph 1
Measurement of outcomes	12	Describe how outcomes used to capture benefit(s) and harm(s) were measured.	Method – Study design and overview, Pragraph 3 Methods – Scale-up simulation strategy, Paragraph 1
Valuation of outcomes	13	Describe the population and methods used to measure and value outcomes.	Methods – Study implementation, Page 6 Appendix – Table 9, Page Methods – HPV vaccination delivery activities, Paragraph 1 Methods – Costing approach, Paragraph 1
Measurement and valuation of resources and costs	14	Describe how costs were valued.	Methods – Study design and overview, Paragraph 1–3 Methods – HPV vaccination delivery activities, Paragraph 1 Methods – Costing approach, Paragraph 1
Currency, price date, and conversion	15	Report the dates of the estimated resource quantities and unit costs, plus the currency and year of conversion.	Methods - Micro-costing component and assumption, Table 2, Page 10
Rationale and description of model	16	If modelling is used, describe in detail and why used. Report if the model is publicly available and where it can be accessed.	Not Applicable
Analytics and assumptions	17	Describe any methods for analysing or statistically transforming data, any extrapolation methods, and approaches for validating any model used.	Methods – Scale-up simulation strategy, Paragraph 1 Methods – Scale-up simulation strategy, Table 3, Page 12
Characterizing heterogeneity	18	Describe any methods used for estimating how the results of the study vary for sub-groups.	Methods – Scale-up simulation strategy, Table 3, Page 12

	Item	Guidance for Reporting	Reported in section
TITLE			
Characterizing distributional effects	19	Describe how impacts are distributed across different individuals or adjustments made to reflect priority populations.	Not Applicable
Characterizing uncertainty	20	Describe methods to characterize any sources of uncertainty in the analysis.	Not Applicable
Approach to engagement with patients and others affected by the study	21	Describe any approaches to engage patients or service recipients, the general public, communities, or stakeholders (e.g., clinicians or payers) in the design of the study.	Methods – Study design and overview, Paragraph 1–3 Methods – Costing approach, Paragraph 1
RESULTS			
Study parameters	22	Report all analytic inputs (e.g., values, ranges, references) including uncertainty or distributional assumptions.	Methods – Costing approach, Paragraph 1 Method - HPV vaccination delivery activities, Paragraph 1 Method - HPV vaccination delivery activities, Table 1 Methods – Scale-up simulation strategy, Paragraph 1 Methods – Scale-up simulation strategy, Table 3, Page 12
Summary of main results	23	Report the mean values for the main categories of costs and outcomes of interest and summarise them in the most appropriate overall measure.	Results – Table 4, page 13 Result – Table 5, Page 14 Result – Table 6, Page 16 Appendix – Table 9, Page 27
Effect of uncertainty	24	Describe how uncertainty about analytic judgments, inputs, or projections affect findings. Report the effect of choice of discount rate and time horizon, if applicable.	Not Applicable
Effect of engagement with patients and others affected by the study	25	Report on any difference patient/service recipient, general public, community, or stakeholder involvement made to the approach or findings of the study	Results – Table 4, page 13 Result – Table 5, Page 14

	Item	Guidance for Reporting	Reported in section
TITLE			
			Result – Table 6, Page 16 Appendix – Table 9, Page 27
DISCUSSION			
Study findings, limitations, generalizability, and current knowledge	26	Report key findings, limitations, ethical or equity considerations not captured, and how these could impact patients, policy, or practice.	Discussion, Page 17–20
OTHER RELEVANT INFORMATION			
Source of funding	27	Describe how the study was funded and any role of the funder in the identification, design, conduct, and reporting of the analysis	Not Applicable
Conflicts of interest	28	Report authors conflicts of interest according to journal or International Committee of Medical Journal Editors requirements.	Not Applicable

Scale-up simulation strategy

The scale-up simulation was developed to estimate the costs of a single-dose vaccination strategy specifically for OOS girls when expanded up to the national level. First, we mapped each province into three categories representing similarities in characteristics and implementation needs with the three study areas. This mapping determined the reference cost used for each province based on the corresponding study area, thereby ensuring that the costing approach remained consistent with the context of the study sites used as benchmarks. Second, we adjusted the reference unit costs using a regional remuneration adjustment coefficient, namely the 2025 INKINDO Index, to capture differences in cost levels across provinces. Finally, the unit cost of outreach and delivery for each province was multiplied by the target population of OOS girls aged 11, as explained in Table 3. The resulting costs for each age group were then summed to obtain the total national scale-up cost. The assumption for scale up estimation is presented in Table 3. either fully out of school + those who undergo informal schooling

Table 3
Assumption and Values Used on Scale-up Estimation

Item	Values Measured/Used or Types of Resources Accounted For	Source
Total Cost	Cost of HPV vaccination outreach for OOS girls per target	A micro-costing estimate conducted at *puskesmas* level, presented in detail (US$), using the target population for HPV vaccination among OOS girls as the denominator.
	Cost of HPV vaccine delivery for OOS girls per target	A micro-costing estimate conducted at *puskesmas* level, presented in detail (US$), using successfully vaccinated OOS girls as the denominator.
Adjustment Coefficient	Adjustment coefficient	The 2025 Provincial Standard Remuneration Index. This index was used as a cost adjustment coefficient across regions to adjust the cost estimates obtained from the study sites to reflect differences in labor cost levels in other provinces. By using this standard remuneration index, the scale-up cost estimates are expected to better capture variations in operational cost conditions across regions in Indonesia (INKINDO, 2025).
Target of OOS girls	Number of OOS girls aged 11 years	The number of OOS girls was estimated by combining school participation rates (APS) with population data. The calculation followed the formula: $OOS = (1 - APS) \times N_{11}$. APS data were obtained from Statistics Indonesia (BPS) publications for 2025, representing the proportion of children attending school within the relevant age group[24]. Meanwhile, the population of 11-year-old girls $(N_{11})$was derived from the 2020 Population Census (BPS)[25]. This method provides an estimate of the number of girls who are not enrolled in school within each province.

Results

Based on the results of the micro-costing estimation conducted at the district/city level (Table 4), the three study sites showed relatively small variations in total costs. However, when analyzed based on the unit cost at each Community Health Center, greater cost variation was observed, given that each district/city has a different number of Community Health Centers. Among the three sites, Bekasi City had the lowest unit cost at US$ 2.56.

Table 4
Estimated Financial and Economic Cost of HPV Immunization for OOS Girls at the District/City Level (US$)

	Bekasi City		**Bandar Lampung City**		**Bangka Regency**	
	Financial (%)	**Economic (%)**	**Financial (%)**	**Economic (%)**	**Financial (%)**	**Economic (%)**
District health office	12.20 (100%)	82.33 (60.75%)	15.44 100%)	77.34 (59.58%)	71.48 100%)	99.33 (72.59%)
Others district government office*	-	53.13 (39.22%)	-	52.47 (40.42%)	-	37.50 (27.41%)
Total cost	**12.20**	**135.46**	**15.44**	**129.81**	**71.48**	**136.83**
Number of *puskesmas*	53	53	15	15	12	12
Unit cost	*0.23*	*2.56*	*1.03*	*8.65*	*5.96*	*11.40*
Source : Authors' calculation						

Based on the type of activity, target validation and socialization conducted by *puskesmas* through school visits were activities implemented in all study areas for this program. Meanwhile, online socialization with schools was conducted only in Bekasi City. In addition, the calculations presented in Table 4 also included the estimated cost per *puskesmas* for activities carried out at the district/city health office level. Bekasi City emerged as the study location with the highest total cost for outreach and HPV immunization implementation. When calculated per target, the outreach and immunization cost per child in Bekasi was relatively high, amounting US$ 38.55 per vaccinated target. In-depth interviews suggested that the higher unit cost observed in Bekasi was associated with the labor-intensive process of identifying and verifying eligible OOS targets within a highly dynamic urban setting. Informants reported that non-formal institutions were often unstable or no longer operational, requiring repeated physical verification and extensive data matching, which increased time and personnel requirements. Additional operational inputs were also reported when reaching marginalized populations, including the involvement of multi-sectoral outreach teams and higher travel allowances due to security considerations.

Table 5
Estimated Economic Cost of HPV Immunization for Out-of-School (OOS) Girls (US$)

Activities	**Bekasi City**	**Bandar Lampung City**	**Bangka Regency**
Target identification, outreach planning, and logistics requirement estimation	239.01 (18.79%)	42.52 (3.31%)	23.31 (7.88%)
Target validation: Communication via *whatsapp*	3.41 (0.27%)	7.07 (0.55%)	13.88 (4.69%)
Target validation: School visits	53.69 (4.22%)	74.44 (5.80%)	22.56 (7.62%)
Socialization with nonformal schools at the *puskesmas*	181.65 (14.28%)	67.67 (5.28%)	-
Socialization with nonformal schools: School visits	70.54 (5.55%)	50.92 (3.97%)	52.85 (17.86%)
Socialization with nonformal schools: Online	2.01 (0.16%)	-	-
Validation of targets from marginalized groups	42.63 (3.35%)	43.27 (3.37%)	-
Cost of activities at the district/city office level (Table 6)	2.56 (0.20%)	8.65 (0.67%)	11.40 (3.85%)
Total outreach cost	**595.49 (46.81%)**	**294.55 (22.97%)**	**124.00 (41.90%)**
Number of outreach targets	79	73	54
Outreach cost per target	*7.54*	*4.03*	*2.30*
Total cost of HPV vaccination: Single Dose	**676.64 (53.19%)**	**988.00 (77.03%)**	**171.96 (58.10%)**
Number of targets successfully vaccinated	33	56	13
HPV vaccination cost per target successfully vaccinated	*20.50*	*17.64*	*13.23*
Total outreach and HPV vaccination cost	**1,272.13**	**1,282.55**	**295.96**

Note : The percentage for each cost component is calculated by dividing the component cost by the total outreach and HPV vaccination cost.

Source : Authors' calculation

Cost structure and main drivers

Activities	Bekasi City	Bandar Lampung City	Bangka Regency
Outreach and HPV vaccination cost per target successfully vaccinated	*38.55*	*22.90*	*22.77*
Note : The percentage for each cost component is calculated by dividing the component cost by the total outreach and HPV vaccination cost.			
Source : Authors' calculation			
Cost structure and main drivers			

We found that the economic cost of the HPV vaccination program for OOS girls was driven largely by routine operational expenditures, such as labor costs, consumable supplies, and outreach activities, rather than by major one-time capital expenditures (for example, equipment purchases). Labor costs consistently represented the largest recurrent cost component, reflecting the labor-intensive nature of the program in identifying, mobilizing, and following up OOS girls. In this study, labor costs are treated as actual expenditures rather than opportunity costs, given that the program resulted in a heightened workload for healthcare personnel. Findings from in-depth interviews indicated that personnel time was heavily utilized for target identification, data validation, and cross-sectoral coordination activities. In addition, transportation costs also constitute an important component of the program, particularly for outreach activities requiring field visits and community engagement. Training costs did not appear because vaccination services for OOS girls followed the same HPV vaccination procedures as those applied in formal schools, therefore did not require additional training for health workers. Using the financial costs results, the cost of outreach is mostly dominated by, among others, transportation and consumption costs. On the other note, the cost of HPV vaccination for OOS girls is dominated by supplies costs (e.g. vaccine) and vaccination related activities (e.g. target identification, validation, and outreach).

Scale-up cost of HPV vaccination for OOS girls

The scale-up results below present estimates of the costs required for outreach and delivery of HPV vaccination for OOS girls in each province, based on the HPV vaccination costs for OOS girls observed in Bekasi City, Bandar Lampung City, and Bangka Regency.

Table 6
Estimated Scale-Up Financial and Economic Cost of HPV Vaccination Outreach for Out-of-School Children by Province

Province	Total Outreach Cost		Total Full Pathway Cost	
	Financial	Economic	Financial	Economic
Aceh	723.58	1,319.52	5,821.21	7,489.85
North Sumatra	1,508.69	2,751.25	12,137.42	15,616.59
West Sumatra	406.09	740.55	3,267.01	4,203.49
Riau	28.22	388.61	2,149.23	3,852.73
Jambi	30.79	423.93	2,344.62	4,202.98
South Sumatra	945.09	1,723.46	7,603.21	9,782.66
Bengkulu	300.26	547.56	2,415.60	3,108.03
Lampung	718.66	1,310.55	5,781.61	7,438.90
Bangka Belitung Islands	10.63	146.36	809.45	1,451.03
Riau Islands	132.90	242.36	1,069.20	1,375.69
Special Capital Region of Jakarta	3,517.19	4,645.52	18,182.08	23,757.74
West Java	12,572.95	16,606.42	64,995.72	84,927.09
Central Java	8,179.83	10,803.96	42,285.53	55,252.67
Special Region of Yogyakarta	646.84	854.35	3,343.83	4,369.24
East Java	13,866.63	18,315.12	71,683.38	93,665.57
Banten	3,315.06	4,378.54	17,137.13	22,392.35
Bali	835.50	1,103.53	4,319.12	5,643.60
West Nusa Tenggara	2,156.13	2,847.83	11,146.10	14,564.13
East Nusa Tenggara	1,452.09	2,648.02	11,682.02	15,030.65
West Kalimantan	86.87	1,196.10	6,615.18	11,858.41
Central Kalimantan	21.44	295.24	1,632.86	2,927.07
South Kalimantan	822.03	1,499.05	6,613.21	8,508.87
East Kalimantan	20.89	287.67	1,590.99	2,852.02
North Kalimantan	8.61	118.60	655.94	1,175.83
North Sulawesi	359.33	655.27	2,890.81	3,719.45
Central Sulawesi	70.01	963.94	5,331.22	9,556.77

Source : Authors' calculation

Province	Total Outreach Cost		Total Full Pathway Cost	
	Financial	Economic	Financial	Economic
South Sulawesi	1,311.80	2,392.20	10,553.42	13,578.53
Southeast Sulawesi	42.89	590.48	3,265.72	5,854.15
Gorontalo	253.50	462.28	2,039.40	2,623.99
West Sulawesi	34.82	479.45	2,651.65	4,753.37
Maluku	11.73	161.50	893.19	1,601.13
North Maluku	21.08	290.19	1,604.95	2,877.04
West Papua	411.01	542.87	2,124.73	2,776.29
Southwest Papua	5,424.02	7,164.08	28,039.42	36,637.89
Papua	1,954.00	2,580.85	10,101.16	13,198.74
South Papua	1,212.83	1,601.91	6,269.68	8,192.32
Central Papua	7,095.03	9,371.15	36,677.65	47,925.10
Highland Papua	12,653.81	16,713.21	65,413.70	85,473.25
Indonesia	**83,162.85**	**119,163.48**	**483,138.35**	**644,215.23**
Source : Authors’ calculation				

Table 9
Detailed Assumption of Scale-up Total Cost Estimation

Province	Scale-up Mapping	INKINDO 2025 Index	Number of 11 Years old OOS girl
Aceh	2	0.963	294
North Sumatra	2	0.976	613
West Sumatra	2	0.947	165
Riau	1	1.080	154
Jambi	1	0.908	168
South Sumatra	2	0.929	384
Bengkulu	2	0.889	122
Lampung	2	0.899	292
Bangka Belitung Islands	1	0.910	58
Riau Islands	2	1.101	54
Special Capital Region of Jakarta	3	1.000	522
West Java	3	0.847	1866
Central Java	3	0.823	1214
Special Region of Yogyakarta	3	0.838	96
East Java	3	0.979	2058
Banten	3	0.950	492
Bali	3	0.958	124
West Nusa Tenggara	3	0.877	320
East Nusa Tenggara	2	0.841	590
West Kalimantan	1	0.937	474
Central Kalimantan	1	0.925	117
South Kalimantan	2	0.918	334
East Kalimantan	1	1.030	114
North Kalimantan	1	1.086	47
North Sulawesi	2	0.944	146
Central Sulawesi	1	0.908	382
South Sulawesi	2	0.970	533
Source : Authors’ calculation			

Province	Scale-up Mapping	INKINDO 2025 Index	Number of 11 Years old OOS girl
Southeast Sulawesi	1	0.947	234
Gorontalo	2	0.924	103
West Sulawesi	1	0.909	190
Maluku	1	0.934	64
North Maluku	1	0.940	115
West Papua	3	1.202	61
Southwest Papua	3	1.194	805
Papua	3	1.113	290
South Papua	3	1.114	180
Central Papua	3	1.130	1053
Highland Papua	3	1.153	1878
Source : Authors’ calculation			

Table 10
Financial Cost: Estimated Cost of HPV Immunization for Out-of-School (OOS) Girls (US$)

Activities	**Bekasi City**	**Bandar Lampung City**	**Bangka Regency**
Target identification, outreach planning, and logistics requirement estimation	191.84 (19.70%)	21.39 (2.15%)	-
Target validation: Communication via *whatsapp*	-	2.26 (0.23%)	1.52 (0.92%)
Target validation: School visits	32.27 (3.32%)	52.13 (5.23%)	1.52 (0.92%)
Socialization with nonformal schools at the *puskesmas*	165.53 (17.00%)	30.49 (3.06%)	-
Socialization with nonformal schools: School visits	30.49 (3.13%)	27.44 (2.75%)	-
Socialization with nonformal schools: Online	-	-	-
Validation of targets from marginalized groups	30.49 (3.13%)	26.78 (2.69%)	-
Cost of activities at the district/city office level (Table 6)	0.23 (0.02%)	1.03 (0.10%)	5.96 (3.61%)
Total outreach cost	**450.85 (46.31%)**	**161.52 (16.20%)**	**9.01 (5.45%)**
Number of outreach targets	79.00	73.00	54.00
Outreach cost per target	*5.71*	*2.21*	*0.17*
Total cost of HPV vaccination	**522.72 (53.69%)**	**835.29 (83.80%)**	**156.09 (94.55%)**
Number of targets successfully vaccinated	33.00	56.00	13.00
HPV vaccination cost per target successfully vaccinated	*20.50*	*17.64*	*13.23*
Total outreach and HPV vaccination cost	**973.58**	**996.81**	**165.10**
Outreach and HPV vaccination cost per target successfully vaccinated	*29.50*	*17.80*	*12.70*

Note : The percentage for each cost component is calculated by dividing the component cost by the total outreach and HPV vaccination cost.

Source : Authors' calculation

Table 6 presents the estimated provincial scale-up cost of HPV vaccination for OOS girls in Indonesia. The table summarizes the total costs required for activities related to outreach and vaccine delivery. These scale-up costs represent the main operational components required to support HPV vaccination outreach for OOS girls across provinces. Approximately 18.50% is allocated to outreach activities, which include efforts to identify, mobilize, and engage OOS girls across provinces. The remaining 81.50% is dedicated to vaccine delivery, covering the logistical and operational components necessary to administer the HPV vaccine. At the national level, the total estimated vaccine delivery economic cost for OOS girls was US$ 644,215.23 per year (median US$ 7,464.37, IQR 25% US$ 3,260.89 – IQR 75% US$ 14,564.13) or US$ 38.56 per fully vaccinated OOS girl. Using financial cost, the total estimated vaccine delivery for OOS girls US$ 483,138.35 per year (median US$ 5,556.42, IQR 25% US$ 2,198.08 – IQR 75% US$ 11,548.04) or US$ 28.92 per fully vaccinated OOS girl.

Discussion

We have shown the total and unit cost to provide HPV vaccination for OOS girls. The yearly total financial cost reached around US$ 483,000 (1.76% of the national immunization budget allocation in 2025) or US$ 28.92 per fully vaccinated OOS girl, and more than 80% of the total cost are spent on the cost of vaccinating OOS girls aged 11 years. The cost driver at all sites is labor cost and different cities' characteristics result in different approaches, which in turn results in different total and unit costs. Our results have led to the following observations.

First, our findings suggest that differences in unit costs across study sites were influenced by variation in local implementation context. In Bekasi, the highest unit cost per successfully vaccinated OOS girl was accompanied by labor-intensive target identification and verification processes. Qualitative findings indicated that non-formal institutions were often unstable or no longer operational, requiring repeated physical verification and extensive data matching, which increased time and personnel inputs. Additional operational costs were reported due to security considerations when accessing marginalized populations, involving multi-sectoral teams and higher travel allowances further contributed to program costs. In addition, Bekasi city has the largest population, almost double the population of Bandar Lampung and Bangka city, which may explain the larger unit cost to perform the outreach and vaccination program as it requires extra activities. The approach in Bekasi city requires more coordination and socialization with more stakeholders. Despite these additional operational efforts, the number of vaccinated OOS girls in Bekasi remained lower than in Bandar Lampung, suggesting that greater resource input did not necessarily translate into higher program reach. Local context plays a significant role in this case. Indeed, if we stripped the activities in Bekasi city and only calculated bare minimum activities, the unit costs between regions do not differ much, but it may not reflect the real condition in Bekasi city. In Bandar Lampung city, the largest number of vaccinated OOS girls was achieved through intensive coordination and advocacy activities. Informants described extensive cross-sectoral collaboration and partner-supported target confirmation before field deployment. Personnel time was also required to validate institutional data, as some registered non-formal education facilities did not have eligible OOS girls within the target age group. In Bangka city, implementation was characterized by the integration of OOS outreach into existing community-based activities and the use of localized knowledge from village-level health workers and community leaders. Qualitative findings also highlighted the importance of field validation and travel to geographically dispersed areas in identifying eligible targets. Together, these findings suggest that regional differences in unit costs reflect different operational requirements for reaching OOS girls. Urban target identification in Bekasi,

coordination-intensive approaches in Bandar Lampung, and locally integrated outreach in Bangka each contributed to the resources required for program implementation.

Second, the yearly total cost of reaching and vaccinating OOS girls nationally requires around US$ 640,000 per year (28.92 per vaccinated OOS girl), or roughly $2.2 million (PPP). [27–32]Our financial cost national estimate only constitutes around 1.76% of the national immunization budget allocation in 2025 (approximately US$ 27.5 million) [26] and 4.95% of the HPV vaccine budget in 2022 (around US$ 9.7 million), so there is a possibility of economic feasibility to cover the amount, although further assessment is needed. A quick calculation of treating 25% of Indonesian OOS girls (based on national target) of cervical cancer using median treatment cost from a study in Vietnam [27], resulted in around US$ 78.4 million (PPP), basically 35 times of our national coverage and vaccination cost calculation. Given this magnitude, national scale up should be highly considered and the current outreach and HPV vaccination of OOS girls should be optimized to result in higher number of OOS girls getting vaccinated.

While the present study primarily highlights the financial and operational aspects of OOS HPV vaccination, findings from an upcoming study [28] indicate that socio-cultural and trust-related factors may substantially influence uptake. Stakeholders reported concerns regarding vaccine safety, lingering distrust associated with previous immunization programs, and questions surrounding halal status, particularly in some communities. These findings suggest that strengthening community engagement, trust-building initiatives, and locally tailored communication strategies may be as important as ensuring adequate financing.

This study is not without limitations. First, our study only includes several areas in Indonesia. While this restricts the generalizability of our micro costing analysis, our scale up cost estimation method has addressed this limitation and try to accommodate the varied characteristics of regions in Indonesia. However, care still needs to be taken in interpreting our results. Second, the qualitative component was intended to provide explanatory context for the costing findings rather than a comprehensive assessment of implementation barriers. Therefore, additional qualitative research across broader settings may be needed to better understand contextual factors influencing OOS HPV vaccination delivery. Nevertheless, integrating qualitative findings strengthened interpretation of the costing results by providing insight into contextual and operational factors influencing implementation.

Conclusion

Optimizing OOS girls' outreach and HPV vaccination is essential to achieve sustained full coverage. Our national cost estimate has shown that reaching and vaccinating OOS girls only costs less than 3% of the national immunization budget, so there is a possibility of economic feasibility, although further assessment is needed. Factors such as local context and implementation challenges should be recognized as they may directly influence the cost and hinder program to scale up.

Declarations

Ethics approval and consent to participate

Ethical approval was granted by the Research Ethics Committee of Universitas Padjadjaran (No. 1025/UN6.KEP/EC/2025). Site-level permits were obtained from local authorities in Bekasi City (No.

400.14.5.4/1764/DINKES.SDK), Bandar Lampung City (No. 070/02368/IV.05/2025), and Bangka Belitung Province (No. 503/17/KESBANGPOL/DPMPTSP/2025). This study complies with the ethical principles of the Declaration of Helsinki. Participation was entirely voluntary, and written informed consent was obtained from all respondents prior to their engagement, confirming their understanding of the study's purpose, procedures, and right to withdraw. All participants were adults aged 18 years and above; no minors were involved.

Consent for publication

Not applicable

Availability of data and materials

The data underlying the results presented in this study contain potentially identifying or sensitive information collected from health facility staff and program implementers in Bekasi City, Bandar Lampung City, and Bangka District, Indonesia. Due to ethical restrictions imposed by Universitas Padjadjaran Ethics Committee. Data cannot be made publicity available. The data set used in this study is available from the corresponding author on a reasonable request.

Competing interests

Authors declare that there is no conflict of interest in the study. SM, RA, NW, TH, AA, and SP are employees of the Clinton Health Access Initiative (CHAI), which provided support for this study. DA, EBH, and PY are employees of the Directorate of Immunization, Ministry of Health, Indonesia, which provided administrative and regulatory support for this study. CHAI and the Ministry of Health had no role in data collection, analysis, interpretation of data, or the decision to submit this work for publication.

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Authors' contributions

AYMS, RR, and PH conceptualized the study. AYMS, IA, RR, PH, and FMA developed the methodology, performed formal analysis, and wrote the original draft of the manuscript. RR, PH, and FMA conducted the investigation and data curation. FMA contributed to visualization. AYMS and IA provided supervision and validation. Funding acquisition was carried out by RR, PH, FMA, LNIS, SM, RA, NW, TH, and AA. Project administration was managed by RR, PH, FMA, LNIS, SM, RA, NW, TH, AA, SP, DA, EBH, and PY. AYMS, IA, RR, PH, and FMA critically reviewed and edited the manuscript. All authors read and approved the final manuscript.

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References

1. World Health Organization (WHO). Cancer Today. https://gco.iarc.who.int/today/en/dataviz/pie. 2022. https://gco.iarc.who.int/today/en/dataviz/pie. Accessed 26 Nov 2026.
2. Okunade KS. Human papillomavirus and cervical cancer. J Obstet Gynaecol. 2020;40:602–8. https://doi.org/10.1080/01443615.2019.1634030.
3. CDC. Cancers Caused by HPV | HPV | CDC. 2025. https://www.cdc.gov/hpv/about/cancers-caused-by-hpv.html. Accessed 20 Mar 2026.
4. Ministry of Health of the Republic of Indonesia. National Cervical Cancer Elimination Plan for Indonesia 2023–2030. Jakarta; 2023.
5. Yap J, Satria FB, Alona I, Siregar IM, Chen S, Yung CF, et al. Challenges in Expanding Access to the HPV Vaccine Among Schooling Girls: A Mixed-Methods Study from Indonesia. Vaccines (Basel). 2025;13. https://doi.org/10.3390/vaccines13090948.
6. Ministry of Primary and Secondary Education of Indonesia. Data Induk Satuan Pendidikan | Portal Data Kemendikdasmen. 2026. https://data.kemendikdasmen.go.id/data-induk/satpen/jumlah?jalur=non-formal&bentuk=pkbm,pondok-pesantren. Accessed 23 Mar 2026.
7. UNICEF. A future without cervical cancer: Protecting Indonesia's girls through HPV immunization | UNICEF Indonesia. 2025. https://www.unicef.org/indonesia/parenting-village/health/stories/future-without-cervical-cancer-protecting-indonesias-girls-through-hpv-immunization. Accessed 23 Mar 2026.
8. Athifa A, Mohamed Y, Overmars I, Danchin · Margie, Kaufman J. The behavioral and social drivers of HPV vaccination among parents and young people in Indonesia: a scoping review. 2027;36:1275–89. https://doi.org/10.1007/s10552-025-02027-x
9. HPV, Vaccine. Introduction in Indonesia Findings from Key Informant Interviews.
10. Dewi SM, Bennett LR, Barrett A. Exploring Indonesian Primary Schoolgirls' Experiences of School-based HPV Vaccination, Knowledge of HPV Risks and Prevention, and Preferences for Cervical Cancer Education. Asian Pac J Cancer Prev. 2024;25:1285. https://doi.org/10.31557/APJCP.2024.25.4.1285.
11. Rosser EN, Wysong MD, Rosen JG, Limaye RJ, Park S. HPV Vaccine Delivery Strategies to Reach Out-of-School Girls in Low- and Middle-Income Countries: A Narrative Review. Vaccines (Basel). 2025;13. https://doi.org/10.3390/VACCINES13050433.
12. Tippins A, Mutamba G, Boyd EM, Coy KC, Kriss JL. Human Papillomavirus Vaccination Coverage Among Adolescent Girls Aged 13–17 Years — U.S.-Affiliated Pacific Islands, 2013–2023. MMWR Morb Mortal Wkly Rep. 2024;73:715–21. https://doi.org/10.15585/MMWR.MM7333A2.
13. PATH. Reaching out-of-school girls with HPV vaccination | PATH. https://www.path.org/our-impact/articles/reaching-out-of-school-girls-with-hpv-vaccination/. 2024. https://www.path.org/our-impact/articles/reaching-out-of-school-girls-with-hpv-vaccination/. Accessed 25 Nov 2025.
14. Watson-Jones D, Mugo N, Lees S, Mathai M, Vusha S, Ndirangu G, et al. Access and Attitudes to HPV Vaccination amongst Hard-To-Reach Populations in Kenya. PLoS ONE. 2015;10:e0123701.

https://doi.org/10.1371/JOURNAL.PONE.0123701.

15. Akumbom AM, Lee JJ, Reynolds NR, Thayer W, Wang J, Slade E. Cost and effectiveness of HPV vaccine delivery strategies: A systematic review. Prev Med Rep. 2022;26:101734. https://doi.org/10.1016/J.PMEDR.2022.101734.
16. Hidle A, Brennan T, Garon J, An Q, Loharikar A, Marembo J, et al. Cost of human papillomavirus vaccine delivery at district and health facility levels in Zimbabwe: A school-based vaccination program targeting multiple cohorts. Vaccine. 2022;40:A67–76. https://doi.org/10.1016/J.VACCINE.2022.01.024.
17. Simuyemba MC, Chama-Chiliba CM, Chompola A, Sinyangwe A, Bchir A, Asiimwe G, et al. An Evaluation of the Cost of Human Papilloma Virus (HPV) Vaccine Delivery In Zambia. Res Sq. 2023. https://doi.org/10.21203/RS.3.RS-2919637/V1. :rs.3.rs-2919637.
18. Project CHAIP. Strategy to reach out-of-school girls with HPV vaccination in Indonesia - TechNet-21. 2023. https://www.technet-21.org/en/resources/report/pilot-project-strategy-to-reach-out-of-school-girls-with-hpv-vaccination-in-indonesia. Accessed 26 Mar 2026.
19. Sari LNI, Wemas RM, Wicaksono DH, Setiawan Y, Out-Of CHAI. -School Pilot Project: Indonesia Country Report by Districts - TechNet-21. 2023. https://www.technet-21.org/en/resources/report/out-of-school-pilot-project-indonesia-country-report-by-districts. Accessed 26 Mar 2026.
20. Indonesia Ministry of Health. Petunjuk Teknis Imunisasi HPV Tahun 2025. Jakarta; 2025.
21. Siregar AYM, Juwita MN, Hardiawan D, Akbar A, Rachman ZH, Haekal MDF, et al. Cost of implementing HIV pre-exposure prophylaxis at community-based clinics in Indonesia. Trop Med Int Health. 2024;29:13–22. https://doi.org/10.1111/tmi.13946.
22. Hardiawan D, Juwita MN, Vadra J, Prawiranegara R, Mambea IY, Wisaksana R, et al. Cost of improved test and treat strategies in Indonesia. AIDS. 2023;37:1189–201. https://doi.org/10.1097/QAD.0000000000003547.
23. Husereau D, Drummond M, Augustovski F, de Bekker-Grob E, Briggs AH, Carswell C, et al. Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement: updated reporting guidance for health economic evaluations. BMC Med. 2022;20:23. https://doi.org/10.1186/s12916-021-02204-0.
24. Indonesia Statistics. Angka Partisipasi Sekolah (APS) Menurut Provinsi dan Kelompok Umur. 2025. https://www.bps.go.id/id/statistics-table/2/MjIxMSMy/angka-partisipasi-sekolah--aps--menurut-provinsi-dan-kelompok-umur.html. Accessed 27 Mar 2026.
25. Indonesia Statistics. Proyeksi penduduk Indonesia 2020–2050: hasil sensus penduduk 2020. Jakarta: Badan Pusat Statistik; 2023.
26. Indonesia Ministry of Health. Program Prioritas Kementerian Kesehatan 2024–2025. Jakarta; 2025.
27. Van Minh H, My NTT, Jit M. Cervical cancer treatment costs and cost-effectiveness analysis of human papillomavirus vaccination in Vietnam: A PRIME modeling study. BMC Health Serv Res. 2017;17. https://doi.org/10.1186/s12913-017-2297-x.
28. Indah Amelia; Rahma. Priscillya Hotma; Faisal Madjid Alyasa; Adiatma YM. Siregar. Barriers and Enablers in the Implementation of of HPV Vaccination for Out-of-School Girls: A Multi-Regional Thematic Analysis in Indonesia. Unpublished.

Figures

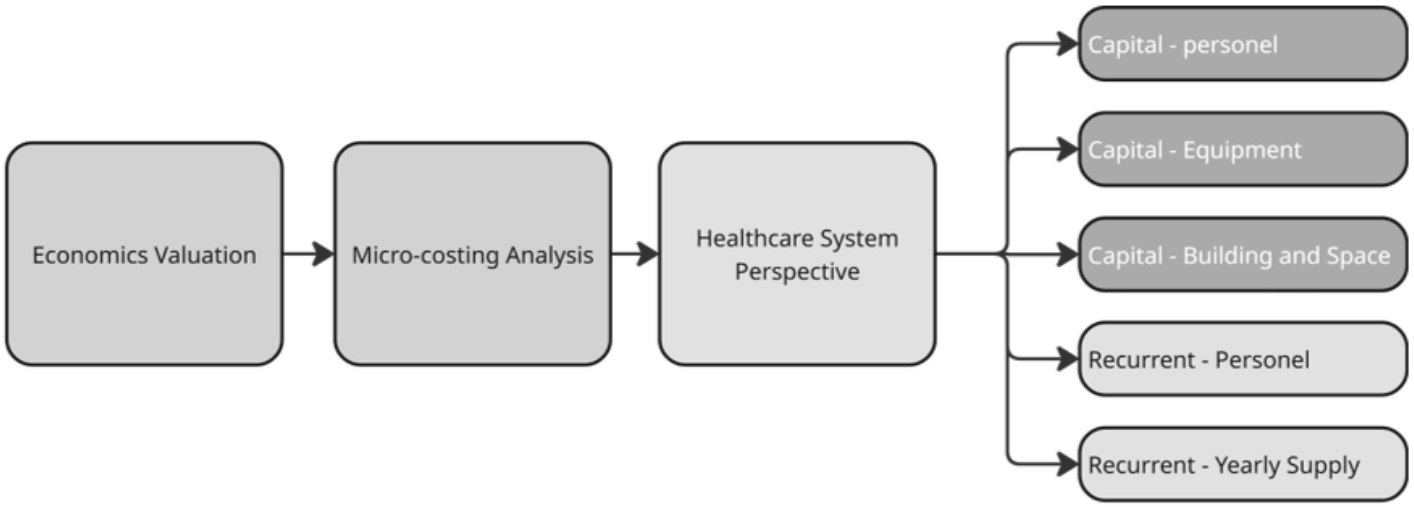


Figure 1

Micro-costing Framework

Supplementary Files

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- Appendix.docx