A Cost Analysis Study of Vaccine Preventable Disease Surveillance System and Incremental Cost for Measles and Rubella Elimination in Thailand

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I. Rationale & background information

1.1. Project rationale

Surveillance for vaccine-preventable diseases (VPDs) provides continuous, long-term evidence-based information that allows for timely detection and response to disease. Comprehensive VPD surveillance comprises the country, regional, and global systems required to meet the minimal recommended standards for surveillance for a set of priority VPDs, with integration of surveillance functions across other diseases when possible. To support countries to build comprehensive VPD surveillance systems, since 2016, WHO led a series of activities, including a literature review, workshop and expert group discussions, to understand the resources and financial needs of such a system. However, little is known about how much the VPD surveillance system costs in individual countries.

To fill this knowledge gap, WHO with funding support from GAVI and US CDC, initiated a project to develop global guidance on the methodology to estimate the cost of VPD surveillance system. This initiative has produced a "Generic Protocol" that would be adapted to the specifics of each country's context. As an important component of this project, a series of country pilot studies will be conducted to 1) apply the methodology to the field and collect feedback including on the methodology itself; 2) produce country data on surveillance system costs to fill the information gap; and 3) support advocacy for resource mobilization.

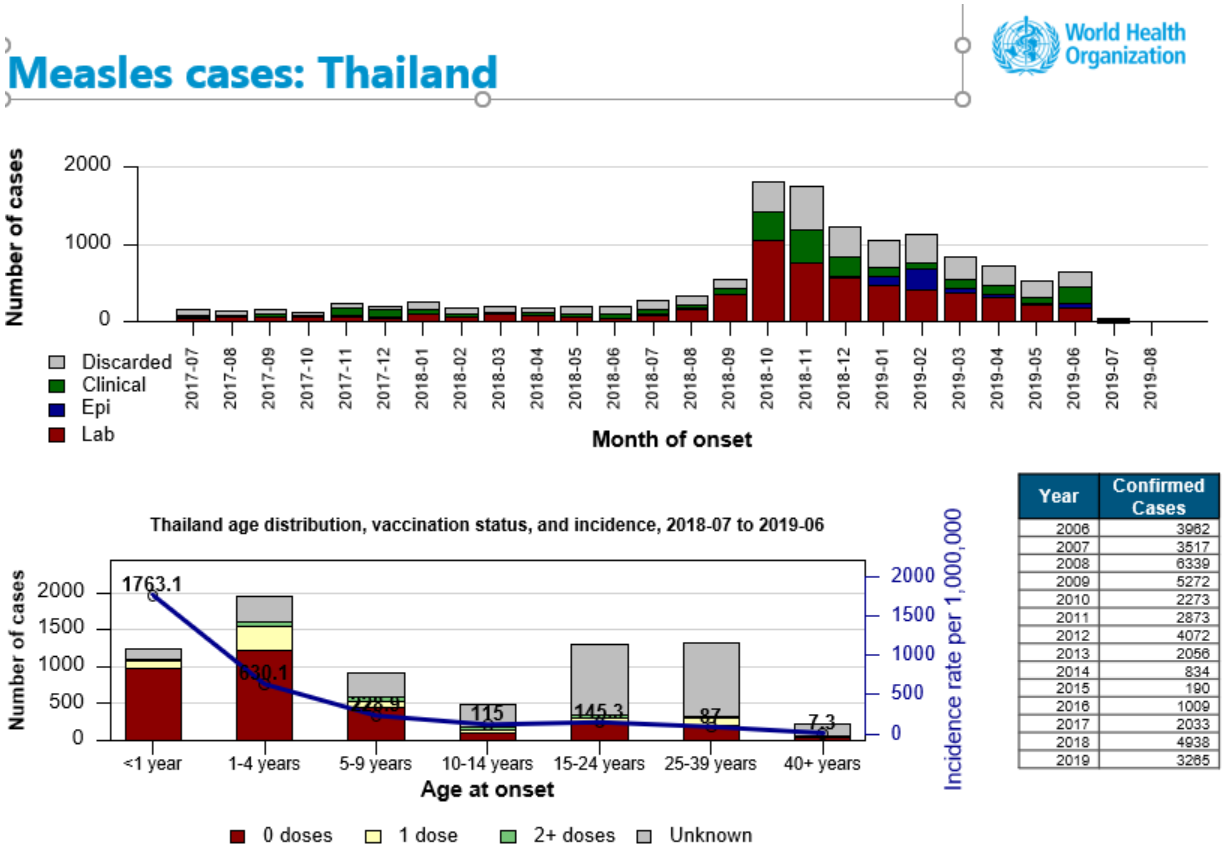
1.2. Country study rationale

Thailand's population is 65 million. The immunization system has been reporting good performance since late 90s. According to WUENIC data, Thailand's DTP3 coverage has been 97% or above since 2000. As an upper-middle income country, Thailand self-finances its immunization programme. The main funding source for VPD surveillance is the government budget.

Regardless of a generally good performing and financially independent immunization system, Thailand continues to experience sporadic, outbreaks of specific diseases in parts of the country[1]. A typical example is the measles outbreak. In 2018, Thailand's Measles Contained Vaccine first dose (MCV1) coverage was 96%, meanwhile, the country experienced a big measles outbreak (4938 confirmed cases) which continued in 2019 (3265 confirmed cases until June) (Figure 1).

Figure 1. Thailand reported measles cases from July 2017 to July 2019

[1] WHO SEARO, 2014, "EPI-VPD Surveillance in Thailand – Report of a joint national/international review".



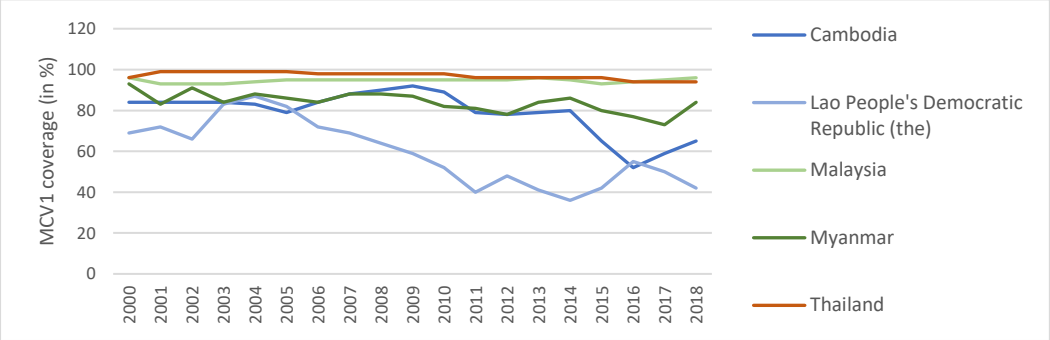
Year	Confirmed Cases
2006	3962
2007	3517
2008	6339
2009	5272
2010	2273
2011	2873
2012	4072
2013	2056
2014	834
2015	190
2016	1009
2017	2033
2018	4938
2019	3265

Data source:
https://www.who.int/immunization/monitoring_surveillance/burden/vpd/surveillance_type/active/measles_monthlydata/en/

At least two factors could potentially contribute to these observed contradictory outcomes: 1) *Unequal vaccination*. According to 2018 Joint Report Form (JRF) data, 10 out of 77 districts (13%) attained MCV1 coverage of 95% or higher. 32 out of 77 districts (42%) reported a MCV1 coverage below 90%. Reasons for low vaccination rates in districts are multifactorial, but the "holes" in vaccine coverage consequently reduces the protection in the population to VPDs.

2) *Large migrant population on the borders*. Thailand is bordered with four countries, Myanmar, Cambodia, Lao PDR, Malaysia. The migrant population is estimated at 3-4 million, predominantly from Myanmar, Cambodia, and Lao PDR. Except for Malaysia which has similar MCV1 coverage as Thailand, all other three countries have lower MCV1 coverage than Thailand (Graph 1). This causes the vaccination gaps on the border. These gaps might not be captured in the national vaccine coverage data, because the migrant population is not counted in the national vaccination coverage calculation. There are more than 3.5 million migrants without Thai nationality living in Thailand, including many long-term residents and children of migrants born in Thailand. The approximately 3.1 million migrants working in Thailand comprise about 8 percent of the labour force. Because of Thailand's relative economic and social stability, it is a primary destination for many regional worker migrants. The large migrant population also increases the difficulties in getting accurate vaccination status data, predicting the additional financial needs to reach unvaccinated migrants, and conducting active surveillance to identify the outbreak risks.

Graph 1. Reported MCV1 coverages for Thailand and its neighbor countries between 2000 and 2018



Data source: http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tscoveragebcg.html

Both factors indicate the existence of immunity gaps. Surveillance system is of particular importance in the countries where there are immunization gaps, because the general vaccinate coverage is not representative of the local configurations and high-risk population continue to exist regardless of reported high national vaccination coverage.

The country committed to achieve measles elimination by 2020. However, with the measles outbreak observed in 2018-2019, it is becoming more and more challenging meeting this goal within the timeline. This recent outbreak drew attention to the quality of surveillance system. As an important tool to monitor disease evolution, measles and rubella (MR) surveillance needs to be strengthened to reach and maintain the disease elimination goal.

Thailand has never estimated the VPD surveillance cost, considering that VPDs are integrated into the country's disease control surveillance systems. However, in order to improve the quality of the MR surveillance system, it is crucial to collect information on the resource needs and corresponding financial requirement for the MR surveillance system. This need becomes even more urgent with the country heading into the last year of the targeted timeline for the measles elimination.

II. Study goals and objectives

The goal of this pilot study is to produce country level estimates on the economic and financial costs of the MR surveillance and collect feedback to improve the global guidance on cost analysis methodology.

There are two specific objectives for the proposed pilot study in Thailand

1- Estimate the total economic and financial costs of the current measles and rubella surveillance system, with a special interest in the economic and financial costs by surveillance activities.
2- Estimate the incremental economic and financial costs for strengthening the current MR surveillance system in need of achieving measles elimination.

III. Background on measles and rubella surveillance global recommendations and Thai VPD surveillance system

3.1. Measles and Rubella surveillance global recommendations

1) WHO global guidance on VPD surveillance recommends following objectives of measles surveillance[2]:

- Detect and confirm cases to ensure proper case management and control further transmission
- Investigate cases to determine the source of infection
- Identify populations and areas with low coverage and at higher risk of outbreaks that require enhanced vaccination efforts.
- Verify the absence of endemic measles cases

[2] WHO Vaccine Preventable Diseases Surveillance Standards – Measles. https://www.who.int/immunization/monitoring_surveillance/burden/vpd/WHO_SurveillanceVaccinePreventable_11_Measles_R2.pdf?ua=1

As rubella and measles have similar clinical symptoms, such as rash, WHO recommends an integrated approach for both diseases' surveillance.

2) Surveillance standards

Minimal surveillance in elimination mode

- Case-based surveillance: detect, notify and investigate suspected cases and outbreaks. Collected information should indicates whether the cases are confirmed (based on laboratory test) or discarded[3].
- Active surveillance at health facilities, schools, borders, and other high-risk spots
- Nationwide with inclusion of all health facilities (both private and public)
- Have a zero-reporting system

3.2. Thailand's MR surveillance system

1) Thailand comprehensive vaccine preventable diseases (VPD) surveillance system

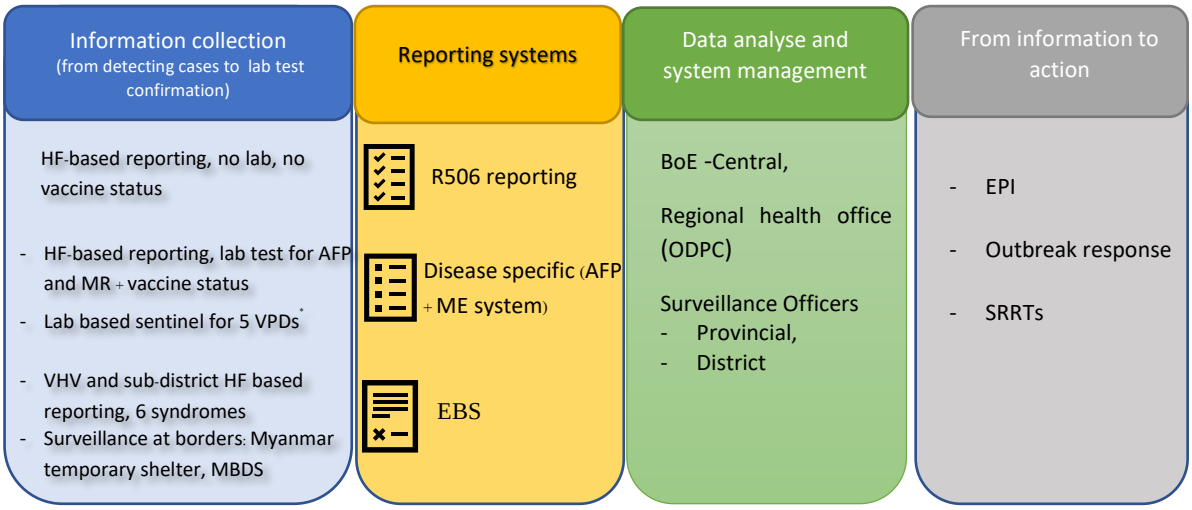
In general Thailand VPD surveillance system is composed of three pillars (Diagram 1).

- *Pillar one*: national communicable disease surveillance network, i.e. 506 system. It is based on the health facility reporting, with no laboratory test nor record on vaccine status. Bureau of Epidemiology (BoE) responds in maintenance the reporting system, data analysis and interpretation. Patient information, date of diagnosis and treatment, as well as discharge status are collected in the 506 system, which is unable to be an indication to eliminate measles in Thailand.
- *Pillar two:* disease specific reporting system, It complements the general surveillance network and is composed of health-facility-based reporting, laboratory test for Acute Flaccid Paralysis (AFP), measles and rubella specimens, and laboratory-based sentinel surveillance sites for five VPDs, i.e. diphtheria, pertussis, pneumococcal, Hib, meningococcus. For measles and rubella, there is a specific reporting system, called measles elimination (ME) system which was established in 2012. (https://apps.boe.moph.go.th/measles/) Also, BoE responds in maintenance the reporting system, data analysis and interpretation. Beyond the general information of patient, vaccination history, laboratory data, and investigated result are recorded in the ME system.
- *Pillar three*, event-based surveillance system (EBS). It is a community-based surveillance network, which is composed of the reporting from Village Health Volunteers and sub-district health facilities, plus surveillance on high risk spots on the border, such as Myanmar temporary shelter and Mekong Basin Disease Surveillance. Division of Vaccine Preventable Diseases, a unit under the BoE, plays important roles in supervision, monitoring, and evaluation the community-based surveillance in reginal and provincial level.

All collected data are pooled and analyzed at central level by the BoE with support from provincial offices. The results are then used to inform/guide relevant departments' actions, including immunization programme and Surveillance Rapid Response Teams in case of outbreak.

[3] We identify three types of reasons: 1) vaccine programme failure, i.e. peoples should be vaccinated but not. 2) vaccine failure. 3) occur in someone for whom vaccination is not recommended.

Diagram 1. Thai VPD surveillance system overview



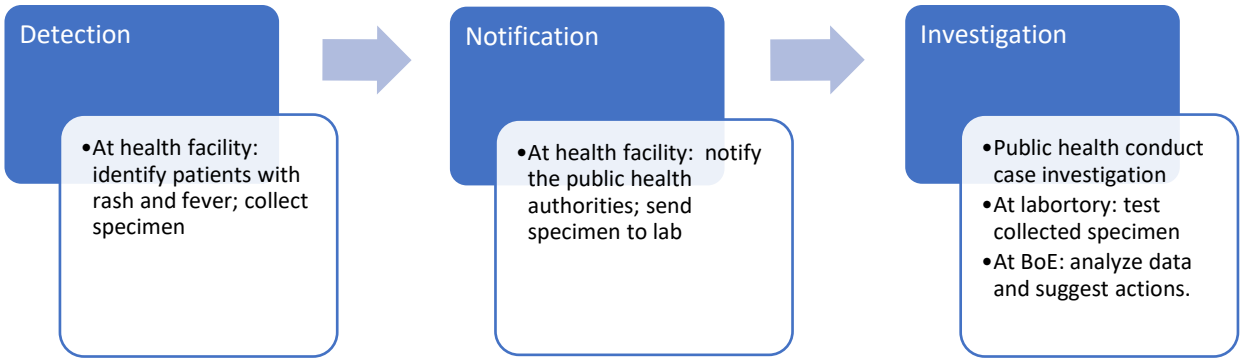
Note: BoE – Bureau of Epidemiology; EBS – Event-based Surveillance; EPI – Extended Programme on Immunization; HF – Health facility. MBDS – Mekong Basin Disease Surveillance; SRRTs – Surveillance Rapid Response Teams; VHV – Village Health Volunteers

* 5 VPDs are Diphtheria, pertussis, pneumococcal, Hib, meningococcus

2) Main activities relating to measles and rubella surveillance

Measles and rubella surveillance are run under the general VPD surveillance system. Diagram 2 illustrated the actions to be taken for measles and rubella surveillance.

Diagram 2. Measles and rubella case-based surveillance related activities



Detection at health facility can occur in both OPD and IPD ward, all patients with rash and fever must be collect specimen. Doctors and nurses immediately report cases to Epidemiology Unit under Department of Social Medicine, meanwhile, a staff working in Medical Record Room also reports the Epidemiology Unit when found ICD10 related to measles and rubella. Epidemiologists at health facility investigate individual case, send the specimen to Reginal Medical Sciences Center (RMSC), report in the ME system, and notify epidemiologists at provincial health office. The provincial health office notifies to reginal health office or Office of Disease Prevention and Control (ODPC) and also coordinate with the RMSC. Finally, laboratory data will be submitted into the ME system by RMSC.

In case of measles outbreak, the epidemiologists at level of region/province (depending on severity of outbreak) and at health facility will set a SRRT, which may include local government and authority (mayor, deputy governor village headman), in order to conduct individual case and outbreak investigation area by using the ME forms which need to collect specimens for Measles IgM test about 10-20 samples and randomly test genotype by throat/nasal swab at least 5 samples in the outbreak area. The provincial/reginal health office coordinates with the RMSC for sending and testing the specimens. Finally, laboratory data will be submitted into the ME system by RMSC. BoE annually analyze data and suggest actions.

IV. Study Design

4.1. Type and scope of the study

This is a program costing study, characterized as a quantitative study with primary data collection on healthcare resource utilization and costs over a period of one year to conduct MR surveillance. The reference year for this study will be from October 2018 to September 2019. The main investigation tool aims at aiding public health officials to estimate the cost of MR surveillance systems at national, region/province, district, and health facility levels. However, for outbreak response, only the surveillance related activities are included in the cost estimation. Other outbreak responses, such as treatment or vaccination campaigns, are not considered as part of the surveillance activities in this study. While all costs incurred at the central level will be collected for all involved surveillance units, the data at sub-national and health facility levels will be collected only for a selected sample and extrapolated as needed.

The study takes the perspective of surveillance service providers, including only public sector, but does not include the cost for the target population that receive the services.

4.2. Sampling frame

1) Background information

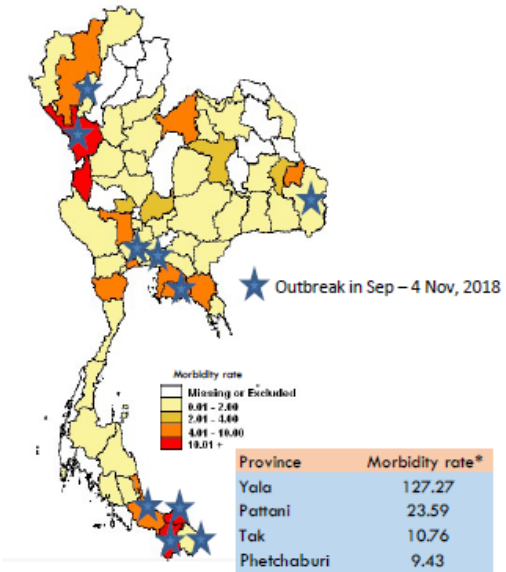
Thailand is divided into six geographical regions based on natural features, including landforms and drainage, as well as human cultural patterns – North Region, Northeast Region, Central Region, East Region, West Region, and South Region. Northern and western Thailand are a mountainous area connecting to Myanmar border. While Easternmost point and Southernmost are nearby Laos and Malaysia, respectively. Moreover, Thailand divided into 76 provinces and two special administrative areas, i.e. capital Bangkok and the city of Pattaya. Provinces are the primary local government units and are divided into districts and sub-districts, respectively. Thailand's national government organization is divided into three types: central government (ministries, bureaus and departments), provincial government (provinces and districts) and local government (Bangkok, Phatthaya city, provincial administrative organizations, etc.) According to public health administration, Ministry of Public Health has been generated regional health system to decentralize the administration into 13 regional health offices, managing its specific health problems and increasing quality of care.

Table 1. Regional Health Office in Thailand

Regional Health Office	Provinces
1	Chiang Mai, Mae Hong Son, Lampang, Lamphun, Ching Rai, Nan, Phayao, Phrae
2	Tak, Phitsanulok, Phetchabun, Sukhothai, Uttaradit
3	Kamphaeng Phet, Nakhon Sawan, Phichit, Uthai Thani, Chai Nat
4	Nonthaburi, Pathum Thani, Phra Nakhon Si Ayutthaya, Saraburi, Lopburi, Sing Buri, Ang Thong, Nakhon Nayok
5	Kanchanaburi, Nakhon Pathom, Ratchaburi, Suphan Buri, Prachuap Khiri Khan, Phetchaburi, Samut Songkhram, Samut Sakhon
6	Prachinburi, Sa Kaeo, Chanthaburi, Trat, Rayong, Chonburi, Samut Prakan, Chachoengsao
7	Kalasin, Khon Kaen, Maha Sarakham, Roi Et
8	Loei, Nong Khai, Nong Bua Lamphu, Udon Thani, Bueng Kan, Nakhon Phanom, Sakon Nakhon
9	Chaiyaphum, Nakhon Ratchasima, Buriram, Surin
10	Yasothon, Sisaket, Amnat Charoen, Mukdahan, Ubon Ratchathani
11	Chumphon, Surat Thani, Nakhon Si Thammarat, Ranong, Phang Nga, Phuket, Krabi
12	Phatthalung, Trang, Songkhla, Satun, Pattani, Yala, Narathiwat
13	Bangkok

Measles situation in Thailand shows several suspected cases and death in the Southern part (Yala, Pattani, Songkhla, and Narathiwat Provinces), and outbreaks were located nearby the borders. In 2018, there were 1,782 confirmed cases, which were 1,647 Thais (93 per cent), 103 Burmese (6 per cent), and 32 others (1 per cent).

Figure 2. Thailand reported measles cases from Jan to Nov 2018



Province	Morbidity rate*
Yala	127.27
Pattani	23.59
Tak	10.76
Phetchaburi	9.43
Samut Sakhon	7.93
Rayong	7.34
Chonburi	7.16
Chiang Mai	6.91
Suphan Buri	6.50
Loei	5.19

province	Setting	No. of suspected case/death	First-Last case onset
Yala	Community wide in 8 districts	1073/10	4 Jul – 1 Nov 2018
Pattani	Community wide in 11 districts	408/4	4 Aug -3 Nov 2018
Songkhla	Community wide in 3 districts	127	4 Sep - 1 Nov 2018
Narathiwat	Community wide in 2 districts	16	25 Aug -29 Oct 2018
Rayong	Factory workers	31	6 Jul - 6 Oct 2018
Samutprakarn	Juvenile detention center	10	20 Aug-1 Sep 2018
Bangkok	Military	15	29 Sep -1 Oct 2018
Tak	Factory workers	13	10 Sep - 16 Oct2018
Lumphun	Factory workers	14	4 – 29 Oct 2018

Data source: http://www.boe.moph.go.th/files/meeting/srrt2018/3.pdf

The costing exercise will cover four levels of activities: center, province, district, and health facility. The sampling is done by cost centers. A cost center is a unit to which the activity costs can be allocated. The targeted categories of cost centers are listed in Table 1.

2) Sampling strategy

The stratified purposive sampling will be used to select sample units. The main considerations for sampling is the burden of measles outbreak and non-outbreak area.

Step 1. At central level: to include all units involved in the MR surveillance.

List of survey units: BoE – for MR surveillance, Division of Vaccine Preventable Diseases – unit managing EBS, Department of Medical Sciences (DMS) – National Laboratories doing MR testing, SRRT at national level to response for the measles outbreak, and WHO IPD unit.

Step 2. At provincial levels: to include all units involved in the MR surveillance. Four provinces will be selected to be study sites. Two provinces will be selected from the area that have high burden of measles outbreak, while the other two will be selected from the area that have low burden of measles outbreak.

List of survey units – at regions: ODPC, SRRT at regional level to response for measles outbreak, all regional laboratories that conducting MR tests.

List of survey units – at provinces: Provincial public offices, SRRT at provincial level, provincial hospitals

Step 3. At district level: in each province, select the districts of which the area represents the outbreak situation of the province.

List of units – district public office, district hospitals and a randomly chosen SRRT.

Step 4. At sub-district level:

- to purposively select one community hospital/health facility inside of the selected district,
- to select one community for VHVs information.

According to this strategy, the sample size will be 41

Table 2. Total and sample sizes of surveillance units by the category of cost centers

	Actors working on VPD surveillance	Total number of units	Sample number
Central	BoE – VPD surveillance unit (including the units managing the R506 and AFP and ME reporting systems)	1	1
	Division of Vaccine Preventable Diseases, BoE	1	1
	DMS	1	1
	SRRT at the national level to response for the outbreak	1	1
	WHO IPD unit	1	1
Provincial	Provincial health office (which cover VPD surveillance)	77	4
	Provincial Hospital	77	4
	SRRT at the provincial level to response for the outbreak	77	4
District	District health office (which cover VPD surveillance)	878	4
	District Hospital	878	4
	SRRTs for case investigations		4
	Local government/ authority		4
Sub-district and community	Sub-district level health facilities	9763	4
	Community level VHVs		4
Total			**41**

4.3. Cost classifications

1) Total vs incremental costs

The study tends to estimate both total cost for MR surveillance system and the incremental cost for improving the surveillance with the target of meeting MR elimination by 2020. Total cost considers the cost of all resources employed, where an incremental approach focuses only on the difference, the added cost, between a start-off point and the endpoint, led by the specific objective in question.

2) Economic vs financial costs

This study addresses both the economic and financial costs for the MR surveillance system. Economic costs measure the opportunity cost of all resources used to conduct surveillance activities at all levels, i.e. central, district and health facility levels. Financial cost measures the financial outlays in a given period for surveillance activities.

3) Capital vs recurrent costs

The study analyses the total costs of the current MR surveillance system/surveillance platform. This includes both the capital and recurrent costs. Capital cost means the values of assets of which the useful life lasts more than one year. Recurrent cost means the values of the goods and services that will be consumed within one year (Box 1).

Box 1. Illustration of main data that are needed for the surveillance costing study

Recurrent costs: human resource, communication, transportation, sample shipment, laboratory operational cost (such as test kits, equipment maintenance), office functioning cost (overhead, office supplies, information system maintenance and operation costs, etc.), case investigation costs, capacity building and training costs, data dissemination costs etc.

Capital costs: building cost, vehicle purchase, equipment purchase including lab and IT equipment, and other assets.

4) MR specific vs shared costs

MR surveillance specific costs include the value of inputs and activities undertaken specially for MR surveillance. In other words, their utilization is 100% for the MR surveillance. Shared costs include the value of inputs that are not specific to MR surveillance and which are also used for other disease surveillance activities. In other words, their utilization for MR surveillance is less than 100%.

To summarize, the main criteria to distinguish specific cost from shared cost is whether the input or the activity is 100% used for MR surveillance purpose. For example, for a training program, if it is only for measles surveillance update, it is a measles specific activity; if it is for all VPD surveillance but includes MR surveillance component, it is a shared cost for MR surveillance.

5) Indivisibility of certain resources

MR surveillance is not an independent system. In Thailand, it is integrated into the general diseases surveillance system. As consequence, most of the resources/inputs requested by MR surveillance activities are shared with other surveillance activities.

A standard methodology for costing MR surveillance system would be to identify all the resources needed by MR surveillance and extract the share of resource usage that is indeed due to MR surveillance. However, some resources are not divisible. Cost only part of those resources does not provide the real financial needs for building MR surveillance system. A surveillance officer, for instance, might spend only 10% of his/her time for MR surveillance. However, to open a surveillance officer position, the government needs to pay a full-time job rather than just 10% of that position. A vehicle even if it is used only 20% of its time for MR surveillance purpose, costs the public health office the full price for that vehicle, rather than just 20% of its price.

To take the indivisibility of resources into account, we will record both the full cost of such resources and their share used for MR surveillance purpose. When calculating the total cost of MR surveillance, the indivisibility of resources should be considered and reflected in the final cost estimation.

4.4. Cost estimation methods

1) Objective 1. Estimate the total economic and financial costs for the current MR surveillance system

A. Direct MR surveillance activity costs

MR surveillance should include the following activities:

- Case detection, notification and reporting
- Investigation of MR cases
- Specimen collection and shipment
- Quality assurance of laboratory procedures
- Data management and analysis (both epidemiologic and laboratory data).
- Active case research (part of monitory and supervision activities)
- Contact tracing

The costing exercise uses the ingredient approach to estimate the value of resources. Input here means the resources that are used to implement activities. The ingredient approach uses the formula 1 (Diagram 3):

$$Cost\ of\ Input_i = Quantity\ of\ input_i\ used\ for\ MR\ surv. \times unit\ price\ of\ the\ input_i \quad (1)$$

i is a specific input. I is the total number of inputs needed. The cost of surveillance activities for MR surveillance is the value of all inputs for that purpose (Formula 2).

$$Direct\ MR\ surveillance\ activity\ cost = \sum_I^i cost\ of\ input_i \quad (2)$$

If the input is divisible, the MR specific usage will be extracted by weighting the total cost with the share of the resource usage for MR surveillance purpose. If the input is indivisible, its quantity will be counted by integer unit, even if it is used partially for MR surveillance. But the share of resource usage for MR surveillance purpose will also be recorded for analysis purpose.

B. MR surveillance related programme activities costs

To improve the effectiveness and efficiency of the MR surveillance system, there are also resource needs to conduct programmatic activities. The main MR surveillance related programmatic activities include: training, monitoring and supervision, and coordination. These activities often take the form of an event. The MR surveillance related programmatic activity cost is calculated in formula (3)

$$MR\ surv.related\ programmatic\ cost = \sum Even\ cost \times Event\ frequency\ over\ 1\ year \quad (3)$$

C. Total MR surveillance costs (Diagram 3)

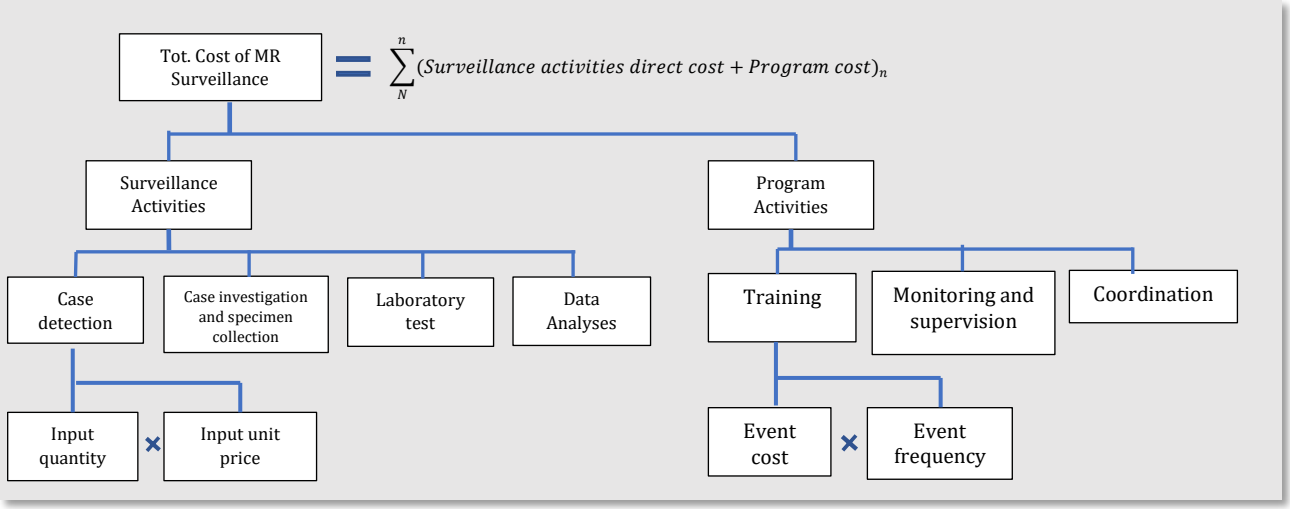
For a specific cost center *n*, the total MR surveillance cost is the sum of the direct MR surveillance activities costs plus MR surveillance related programme activities costs for that cost center. (Formula 4)

$$MR\ Surveillance\ cost\ for\ cost\ center_n = (total\ direct\ MR\ surveillance\ activity\ cost + total\ MR\ surv.related\ programme\ cost)_n \quad (4)$$

The total Thai MR surveillance system cost is the sum of MR surveillance costs for all cost centers involved in the MR surveillance system in the country. Suppose that the total number of cost centers in the country is N. The total MR surveillance activity cost would be as following:

$$Tot.Cost\ of\ MR\ surveillnce = \sum_N^n (Surveillance\ activities\ direct\ cost + Program\ cost)_n \quad (5)$$

Diagram 3. Costing structure



Source: by the author

Table 2 listed the resource needs for each activity. When a resource is shared among several functions/activities, a distribution key will be estimated/calculated based on the share of that resource used for MR surveillance activities.

From the point of view of the cost centers, they might participate in the different parts of surveillance activities (Table 3). Based on Table 2 and 3, the activities and corresponding resource components will be attributed to each cost center.

Table 3. Resources needed by surveillance activity

Recurrent costs / Activities	personnel	Travel	Vehicle maintenance	Office supplies	Office rental	IT maintenance	Building overhead	Specimen shipment	Lab supplies/test kits	Lab equipment maintenance
Case detection, notification and reporting	X			X	X	X				
Case investigation	X	X	X	X	X					
Specimen collection and handling	X			X	X			X	X	
Laboratory test	X			X	X	X	X	X	X	X
Data management and analysis	X			X	X	X	X			
Communication	X			X	X					
Active case search	X	X	X	X	X	X				

Capital costs / Activities	Vehicle purchase	Lab equipment purchase	
Case detection, notification and reporting			
Case investigation	X		
Specimen collection and handling	X		
Laboratory procedures		X	
Data management and analysis			
Communication			
Active case search			

Table 4. VPD surveillance activities conducted by each cost center

	Central			Region	Provincial		District			Sub-district & community	
	BoE	Nat. Lab.	EBS	Regional health office and regional lab	Pub Health Off	Provincial Hosp.	Pub. Health off	District Hosp.	SRRT	Health facilities	Community level VHV
Case detection, notification, and reporting					X	X	X	X	X		
Case investigation	X	-	X	X	X	X	X	X	X	X	-
Specimen collection and handling	X	-	-	X	X	X	X	X	X	X	
Laboratory tests		X		X							
Data management and analysis	X			X	X	X	X	X			
Supervision and monitoring	X										

2) Objective 2. Estimate the incremental economic and financial costs for improving MR surveillance system to meet MR elimination goal.

The Thai government has committed to meet the measles elimination goal by 2020. The country has maintained a high MCV1 coverage since 2000, varying between 94% and 99%. However, the measles outbreak in 2018-2019 reveals several concerns about the country's measles elimination programme. 1) Regardless of high MCV1 coverage, the vaccination gaps continue to exist across the country. 2) Few data are available to identify the impact of the frequent migration on the borders.

All the above concerns point to the needs of improving the MR surveillance system. The incremental cost measures the value of additional resources needed to conduct the additional activities to align the current MR surveillance system performance to the global recommendation. The performance gap will be quantified by comparing the key surveillance indicators between the country data and the global recommendations. These indicators are:

Surveillance attribute	**Indicator**	**Target**
Timeliness and Completeness of investigation	Percentage of all suspected measles and rubella cases that have had an adequate investigation initiated within 48 hours of notification	≥ 80%
Sensitivity	Reporting rate of discarded non-measles non-rubella cases at the national level	≥ 2/100,000 population per 12 months
Case Investigation	Percentage of confirmed cases for which source of transmission is classified as endemic, import or import-related.	≥ 80%
Representativeness	Percentage of subnational administrative units (at the province level or its administrative equivalent) reporting at least 2 discarded non-measles non-rubella cases per 100,000 population per year	≥ 80%
Specimen collection and testing adequacy	Percentage of suspected cases with adequate specimens for detecting acute measles or rubella infection collected and tested in a proficient laboratory	≥ 80%
Viral detection	Percentage of laboratory-confirmed outbreaks with samples adequate for detecting measles virus collected and tested in an accredited laboratory	≥ 80%
Timeliness of specimen transport	Percentage of specimens received at the laboratory within 5 days of collection	≥ 80%
Timeliness of reporting laboratory results	Percentage of IgM results reported to national public health authorities by the laboratory within 4 days of specimen receipt	≥ 80%

To achieve the above-mentioned improvement, the following additional activities will be costed:

- Active surveillance is strengthened in the potentially high-risk and low MCV coverage zones,
- Case investigations are completed quickly and are complete
- Changing from the specific case definition to the more sensitive case definition of fever/rash to understand the cost implications for Thailand, a country with many febrile rash illnesses.
- Specimens are collected, transported, and tested in a timely manner
- Viral samples are taken on selected patients

Information on the inputs and activities costs are collected in the previous section to estimate the total MR surveillance cost. The same unit cost information will be used to project the incremental cost for additional activities. The incremental cost estimation will be based on scenario building exercises, where we put assumptions on the targeted improvement to be realized and the strategies to achieve them. The cost method will follow the similar structure as illustrated in Diagram 3.

V. Data Management and Analysis

5.1. Data collection tool

The data collection will be supported by a tailored questionnaire. The methods for data collection can be face-to-face interview, telephone interview, mail survey or online survey, where the project leader will decide the method depending on the situation in Thailand. The cost calculation will be based on an MS Excel sheet.

5.2. Data collection process

The project leading economist will develop the survey questionnaire for each level of facilities/administrative units. The data will be collected by HITAP staffs, who are trained about the questionnaire beforehand, with the supervision and quality control from the leading economist. The total data collection is expected to be conducted between December 2020 – April 2021. The data collection team will send the collected data to the leading economist on a daily base until the completion of the total data collection.

5.3. Data analysis

An extrapolation strategy will be developed with the country team based on the selected sample. The detail of this part will come up later with the data collection tool.

VI. Potential data sources

- Existing documents, such as MR surveillance Standard Operational Procedures (SOPs), VPD surveillance reviews, cMYPs, disease surveillance budget and expenditure records and other program records
- Interviews at central level with key stakeholders, such as the finance manager in the Ministry of Health, MR focal point at Bureau of Epidemiology, EPI manager, surveillance focal points at tertiary hospitals, National Reference Laboratory and National Institute of Health, key actors in the communicable disease/surveillance and immunization programme person in charge of budget allocation in the Ministry of Finance and department of international cooperation, main external health partners
- Interviews with surveillance focal points at regional level
- Survey of a selected sample of health facilities and surveillance sites

VII. Duration of the Project

The whole project will cover the period from July 2020 to June 2021.

Table 5. Gantt Chart

Activities	Month											
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Developing proposal												
Stakeholder consultation meeting												
Developing data collection tools												
Submitting ethical approval submission												

Activities	Month											
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Conducting field work												
Analyzing data												
Stakeholder consultation meeting												
Writing report												

VIII. Expected Outputs of the Study

The study will deliver the below outputs:

1) Final report on the cost evaluation of Thailand current MR surveillance system and incremental cost for future improvement
2) A workshop for the dissemination of preliminary results

The final report will be presented to the stakeholders and a manuscript will be submitted for publication.