

GHSC-PSM MALARIA LMIS ROADMAP THAILAND

Logistics Management Information Systems Roadmap

Thailand National Malaria Control Program

Prepared for the Global Health Supply Chain – Partnership for Supply Chain
Management (Washington DC)

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ACRONYMS AND ABBREVIATIONS

API – Application Programming Interface
 App – Application
 BI – Business Intelligence
 BIOPHICS - Center of Excellence for Biomedical and Public Health Informatics
 BOE – Bureau of Epidemiology
 BVBD – Bureau of Vector Borne Diseases
 COTS – Commercial Off-the-Shelf
 FOSS – Free & Open Source Software
 GHSC-PSM – Global Health Supply Chain Procurement and Supply Management
 GOT – Government of Thailand
 HCMIS – Health Commodity Management Information System
 HDC – Health Data Center
 HIS – Health Information System
 IR – Intermediate Response
 LMIS – Logistics Management Information System
 LogHealth - Healthcare Supply Chain Excellence Centre
 M&E – Monitoring and Evaluation
 MIS – Malaria Information System
 MMIS – Material Management Information System
 MOPH – Ministry of Public Health
 NMCP – National Malaria Control Program
 ODPC – Office of Disease Prevention and Control
 PHO – Provincial Health Office
 PMI – President’s Malaria Initiative
 SaaS – Software as a Service
 SCM – Supply Chain Management
 SOP – Standard Operating Procedure
 TOT – Training of Trainers
 USAID – United States Agency for International Development
 VBDC – Vector Borne Disease Control Center
 VBDU – Vector Borne Disease Unit
 VHV – Village Health Worker

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EXECUTIVE SUMMARY

Background

The Ministry of Public Health (MOPH) of Thailand has adopted a National Malaria Elimination Strategy (2017-2026) aiming to eliminate the malaria epidemic in country by 2024. The National Malaria Control Program (NMCP) was instituted to oversee the malaria response in Thailand. NMCP is currently implementing a rapid response approach (“1-3-7”) by closely monitoring and responding to malaria cases. Currently there is a surveillance system – Malaria Information System (MIS) – that allows Vector Borne Disease Control Centers (VBDC) to enter data that will sync to a dashboard (Malaria Online). However, there is no stock status information from health facilities for NMCP to efficiently respond and adapt to malaria incidence or outbreak. Mainstream public hospitals are decentralized and have disparate logistic management systems. Hospitals report malaria cases to The Bureau of Epidemiology (BOE), but are not required to report malaria commodity information to BOE or NMCP. The use of multiple electronic systems instead of one streamlined system has resulted in gaps in commodity data and duplication of data. The NMCP needs a comprehensive Logistics Management Information System (LMIS) to effectively implement the rapid response approach for achieving the goal of malaria elimination by 2024.

The Global Health Supply Chain Procurement and Supply Management (GHSC-PSM) commissioned an LMIS landscape analysis and stakeholder workshop to develop a roadmap for configuring a new LMIS to assist the MOPH to adaptively manage the malaria epidemic and evolving commodity needs. The LMIS Landscape Analysis identified the need for a mobile app to collect malaria stock information in the short-term and the need for this app to integrate with the MOPH HL7 interoperability layer in the long-term. The LMIS Landscape Analysis was developed as a separate document and is a companion to this Roadmap.

Methods

Information for the Roadmap was gathered through stakeholder interviews and an LMIS workshop. The objectives of the LMIS workshop were to:

- Validate understanding of current logistics management information systems
- Discuss potential future LMIS states and identify risks
- Develop specific LMIS use cases
- Prioritize future state LMIS features and functions

User Requirements

LMIS business, user and solution requirements were articulated by interviewees during the landscape analysis and the LMIS Workshop. The LMIS workshop identified LMIS functionality requirements for high level use cases for a procurement officer, monitoring and evaluation (M&E) officer and program manager. Examples of BVBD identified requirements include:

- Real time visibility of stock in vertical and general health facilities
- See programmatic data, trends, stock levels and indicator progress in the same system
- Drug request approval flow built into the LMIS
- Quantification tool built into the LMIS
- Ability to compare previous financial expenditures with current financial expenditures
- Notifications of stock levels, expiration dates and data entry errors
- Ability to track the procurement process – from request, to order, to delivery, to disbursement
- Direct data entry of bednet distribution with comparison against number of bednets procured
- Ability to export reports and change report content according to programmatic requirements

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LMIS Systems Analysis

Six LMIS software options were analyzed against the business requirements identified during the LMIS workshop, hardware required to implement and overall costs. The analysis considered free and open source software, commercial off the shelf software, and software as a service. The options included OpenLMIS, OpenBox, HCMIS, CommCare Supply, mSupply, Oracle SCM and SAP SCM.

Recommendations

It is recommended that BVBD adapt CommCare Supply as their LMIS, with an API to MIS/Malaria Online, due to its alignment to articulated business requirements, ability to be utilized in low resource settings and associated costs. CommCare Supply is a commercial off-the-shelf solution that allows for mobile data collection, integrates with CommCare and support interoperability through APIs. Compared to other lower cost options, CommCare Supply allows for offline and mobile data entry, has multi-language functionality and a user-friendly interface to create data entry forms. Existing mobile phone can be utilized for data entry, so less hardware needs to be purchased to implement. Additionally, the user friendly interface allows BVBD staff to more easily configure the software to country needs.

This solution is easily scalable (up and down) without substantial up-front costs –a feature that is particularly important in the context of malaria program absorption into general health services. As Thailand operationalizes the planned interoperability layer and key malaria data flows routinely from the health sites, reliance on the LMIS point of collection solution (i.e. CommCare Supply) will be diminished. Though we expect there will be a need for this system component well into the future, the scalability will help to minimize cost and maximize value.

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BACKGROUND

The purpose of the United States Agency for International Development (USAID) Global Health Supply Chain Procurement and Supply Management Program is to ensure uninterrupted supplies of health commodities in support of U.S. government-funded public health initiatives around the world. The program provides direct procurement and supply chain management support to the President's Emergency Plan for AIDS Relief, President's Malaria Initiative (PMI), and USAID's family planning and reproductive health program. In Thailand, the GHSC-PSM project supports PMI through two primary objectives:

- Assistance with logistics and tracking for malaria commodities purchased by partners
- Global and country collaboration to improve long-term availability of health commodities by strengthening supply chain management and reducing commodity gaps

The National Malaria Control Program in Thailand is one of the programs within the Bureau of Vector Borne Diseases (BVBD). NMCP oversees malaria clinics and manages supply of malaria commodities to these clinics and to the mainstream public hospital system. This program is referred to as the vertical program.

The MOPH has developed its National Malaria Elimination Strategy 2017-2026 which aims at eliminating malaria by 2024. The strategy includes gradually integrating malaria services to the main stream public hospital system. The NMCP is implementing a rapid response approach ("1-3-7") by closely monitoring and responding to malaria cases. Currently there is a surveillance system – Malaria Information Systems – that allows Vector Borne Disease Control Centers to enter data that will sync to a dashboard (Malaria Online). However, there is no stock status information from health facilities for NMCP to efficiently respond to malaria incidences or outbreak. Stock status is collected on separate excel reports and shared on a quarterly or ad hoc basis. Furthermore, the mainstream public hospitals are decentralized. Hospitals adopted or developed their own electronic systems for hospital management which includes management of logistics information for medical products. They also procure malaria commodities using their own budgets. Hospitals report malaria cases BOE, but are not required to report malaria commodities' logistics information to BOE or NMCP. The use of multiple electronic systems instead of one streamlined system has resulted in gaps in commodity data and in other cases duplication of data.

GHSC-PSM commissioned an LMIS Landscape Analysis in Thailand in April and May of 2019. As a result of the landscape analysis, short- and long-term recommendations were introduced to address existing gaps in the LMIS. As there was no identified digital platform to easily collect, review and analyze stock data at facilities in Thailand, a short and long term LMIS solution was proposed.

Short-Term LMIS Recommendation

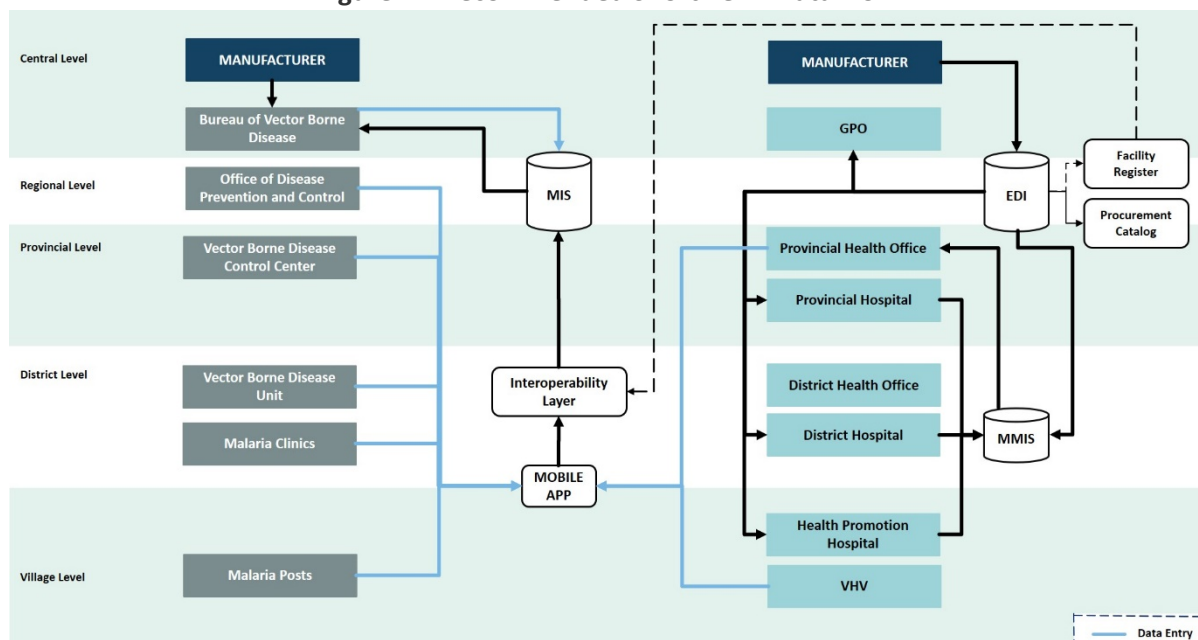
A commercial off the shelf (COTS) mobile application (app) can be adapted to fit Thailand's LMIS needs in the short term. **Figure 1** shows the recommended data flow in the short term, where a mobile app would replace paper-based data collection within the vertical program. The general health program hospitals continue to use their existing health information system (HIS). The inventory information will flow into the Material Management Information System (MMIS), being scaled by the Healthcare Supply Chain Excellence Centre at Mahidol University (LogHealth). The Provincial Health Office (PHO) will access the information and enter the data into the mobile app. Village Health Volunteers (VHV) can also directly enter bed net distribution information in the app. The mobile application interacts

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with an interoperability layer. This interoperability layer utilizes the metadata being developed by LogHealth and MOPH-IT. By using the standardized hospital codes, product codes, etc., BVBD can ensure that the data in the MIS can be cross-walked to data in the general health services. The interoperability layer then pushes data into the MIS, where BVBD is able to access the data and dashboards as is done currently.

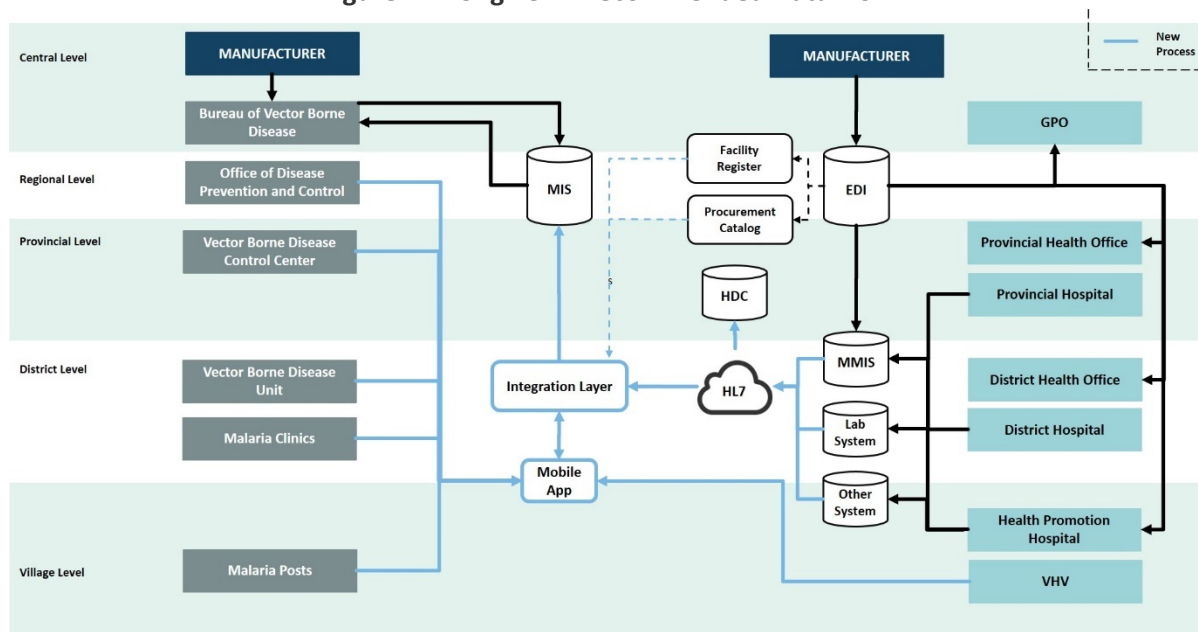
Figure 1 – Recommended Short Term Data Flow



Long-Term LMIS Recommendation

The long-term LMIS recommendation builds on the successful implementation of the short-term recommendation. **Figure 2** demonstrates the long-term vision for a nation-wide LMIS.

Figure 2 – Long Term Recommended Data Flow



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The vertical program will use the mobile application at all levels for data entry. The data will be pushed through an integration layer and into the MIS for real time data analysis. Facilities in the general health services will enter data into their respective HIS. The HIS will push data into the HL7 integration layer and from there into the MIS integration layer and the Health Data Center (HDC). The MIS integration layer will include standardized codes and data cross-walks necessary to feed into the data hierarchy in the MIS. The data will be pushed into the MIS where it will be available for data analysis.

PURPOSE AND OBJECTIVES

The LMIS Roadmap is a companion document to the LMIS Landscape Analysis. This Roadmap frames recommendations of software that BVBD can configure as a national LMIS for malaria to capture data from the vertical program and general health services, including private sector providers. The purpose of this roadmap is to identify LMIS use cases, business and stakeholder requirements for an LMIS, evaluate available LMIS software, provide recommendations of which software to adapt and provide a workplan to adapt an LMIS.

METHODOLOGY

Information for this roadmap was gathered through stakeholder interviews, focus group discussions and a stakeholder LMIS workshop. Nineteen individuals participated in the LMIS Workshop, including individuals from the Bureau of Vector Borne Diseases (BVBD), Office of Disease Prevention and Control (ODPC), VBDC, PR-DDC, BIOPHICS, USAID, GHSC and USCF.

The objectives of the LMIS workshop were to:

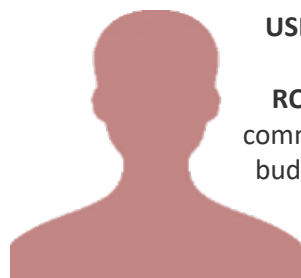
- Validate understanding of current logistics management information systems
- Discuss potential future LMIS states and identify risks
- Develop specific LMIS use cases
- Prioritize future state LMIS features and functions

The current LMIS state in Thailand was articulated in the Landscape Analysis. This document explores the use cases and user defined requirements as articulated during the LMIS workshop and through interviews.

SUMMARY OF USER DEFINED REQUIREMENTS

Example Use Cases

There are many different individuals who will use the LMIS. During the workshop, three example high-level uses cases were identified and are described in this section.



USE CASE: PROCUREMENT OFFICER

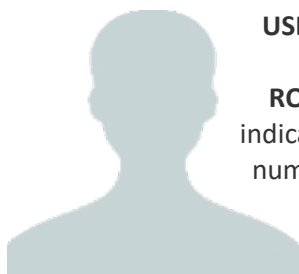
ROLE: The Procurement Officer quantifies and forecasts malaria drugs and commodities. S/he ensures stock is purchased and delivered according to plan and budget and oversees the distribution of commodities. The BVBD Procurement Officer manages stock and approves additional request for commodities by confirming case load numbers from MIS and based on budget.

LMIS REQUIREMENTS:

- Real time visibility of stock in vertical and general health facilities
- Approval flow for additional drugs built into the LMIS

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- Quantification tool built into the LMIS
- Ability to compare previous financial expenditures with current financial expenditures, and approved budget against allocated and original budgets
- Notification when stock levels are low
- Ability to track the procurement process – from request, to order, to delivery to disbursement

**USE CASE: M&E OFFICER**

ROLE: The M&E Officer is responsible for developing M&E frameworks, tracking indicators and reporting. Specifically, the M&E Officer tracks indicators such as number of stock outs, number of LLINs and number of LLIHNS distributed. S/he reviews data that is submitted and checks for data quality issues.

LMIS REQUIREMENTS:

- Real time visibility of stock in vertical and general health facilities
- Automated flags for data entry errors
- Track drug expiration dates to allow for drug rotation or re-allocation
- Direct data entry of LLIN/LLIHN distribution with comparison
- Ability to export reports and change report contents according to programmatic requirements

**USE CASE: PROGRAM MANAGER**

ROLE: The Program Manager oversees components of the National Malaria Control Program. S/he uses data from the MIS and HDC on a weekly basis to see trends in malaria program data. The data is used for decision making, policy development, budget planning, workforce planning and monitoring and evaluation of the program.

LMIS REQUIREMENTS:

- Real time visibility of stock in vertical and general health facilities in a digital format
- Ability to compare previous expenditures with current expenditures, and approved budget against allocated and original budgets
- Notification when stock levels are low
- See programmatic data, trends, stock levels and indicator progress in the same system

User Defined Requirements

Table 1 contains business, user and solution requirements articulated by interviewees during the landscape analysis and the LMIS Workshop. Business requirements are high level and articulate how the solution will help the project achieve its objectives and strategic goals. User requirements identify the needs of specific groups of users. Solution requirements describe details needed to build the solution and the steps needed to achieve the business requirements. There are two types of solution requirements: functional and non-functional. Functional requirements describe functions or capabilities of the solution while non-functional requirements articulate the behavior of the solution.

Table 1: LMIS Business Requirements Identified to Date

Requirement	Requirement Type	User(s)
Real time visibility of stock in all facilities (vertical and general health)	Business	Malaria Unit, Management, Facilities

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Real time visibility of stock expiration dates in all facilities	Business	Malaria Unit, Management, Facilities
Ability to adapt indicators to meet reporting requirements	Functional	M&E, Management
Produce required reports	Functional	M&E, Management
Report on budget allocation	Functional	M&E, Management
Dashboard should show progress of performance targets	Functional	M&E, Management
Automate quantification of medicine	User	Malaria Unit, Management, Strategies & Planning Unit
Automate allocation based on quantification	User	Malaria Unit, Management, Facilities
Ability to track procurement process status from order through distribution	User	Malaria Unit, Management, Facilities
Approval flow built into the system for drug requests	Functional	Malaria Unit, Management, Facilities
Ability to see status in the approval flow	Functional	Malaria Unit, Management, Facilities
Utilize barcodes to track medicines	Functional	Malaria Unit, Management
Ability to assign someone an action and follow up (e.g., alerted for low stock and a staff member is assigned to request additional commodities)	Functional	Management
Approval flow built into the system to approve allocation plan	Functional	Malaria Unit, Management, Facilities
Interoperability with HDC	Functional	Malaria Unit, Management
Interoperability with other existing systems	Functional	Management
View approved budget online against allocated and original budget	User	Malaria Unit, Management, Strategies & Planning Unit
Compare previous expenditures with current expenditures	User	Malaria Unit, Management, Strategies & Planning Unit
Real time visibility of budget allocation	Functional	Malaria Unit, Management, Strategies & Planning Unit
Compare stock levels against allocation and case numbers	User	Malaria Unit, Management, Strategies & Planning Unit
Alert when remaining budget falls below a pre-determined threshold	User	Malaria Unit, Management
Alert for data entry errors	User	M&E, Management
Alert when stock is low and needs to be requested	Functional	Malaria Unit, Management, Facilities
Alert for malaria outbreaks	Functional	Malaria Unit, Management
Configuration of user privileges	Functional	Management
Different access levels in the system: central level can see amount of remaining stock while local level can see binary result about stock availability	Non-functional	Management
The system should be lightweight and adaptable	Non-Functional	Management

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The solution should be scalable enough to reach many users	Non-Functional	Management
Support offline data entry	Non-Functional	Facilities

LMIS SOLUTION LANDSCAPE

There is no available digital platform to easily collect, review, and analyze stock data in the vertical or general health system program that can be adapted within Thailand. BVBD staff utilize the MIS and access Malaria Online for data visualizations and expressed interest in continuing to use MIS and Malaria Online for data visualization and analysis. This section explores LMIS solution options that can interface with the MIS. There are generally three types of software that can be used: free and open-source software (FOSS), COTS, and software as a service (SaaS). **Table 2** shows the differences between the types of software.

Table 2 – Characteristics of Software Types

Software Type	License Fees	Hosting and Support	Software Upgrades	Business Intelligence (BI)
Free and Open-Source Software	<ul style="list-style-type: none"> • No cost 	<ul style="list-style-type: none"> • No hosting or technical support • Requires local hosting 	<ul style="list-style-type: none"> • No 	<ul style="list-style-type: none"> • None; will need to link with other BI software
Commercial Off-The-Shelf Software	<ul style="list-style-type: none"> • Annual license cost for bulk users 	<ul style="list-style-type: none"> • Various levels of support available • Local hosting or fee for cloud-based hosting 	<ul style="list-style-type: none"> • Periodic updates and bug fixes 	<ul style="list-style-type: none"> • None; will need to link with other BI software
Software as a Service	<ul style="list-style-type: none"> • Annual fee per user 	<ul style="list-style-type: none"> • Includes support • Includes cloud hosting 	<ul style="list-style-type: none"> • Includes upgrades 	<ul style="list-style-type: none"> • BI included

Solution Options

This section compares various LMIS options across the three types of software, including OpenLMIS, OpenBoxes, CommCare Supply, Health Commodity Management Information System (HCMIS), Oracle and SAP.

OpenLMIS

OpenLMIS is a web-enable electronic LMIS solution that facilitates the procurement process in low-resource settings. It is an example of a FOSS that automates the LMIS. It supports interoperability through Application Programming Interfaces (APIs) which allow implementers to send and receive data between HIS visualization software, mobile data collection platforms, and warehouse EPR systems.

OpenBoxes

OpenBoxes is a FOSS supply chain management system designed to manage stock and track stock movement at healthcare facilities.

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CommCare Supply

CommCare Supply is a COTS solution for logistics management with mobile data collection. It integrates with CommCare and supports interoperability through APIs. An annual fee for support is required for up to 1,000 users.

Health Commodity Management Information System

The Health Commodity Management Information System is a locally developed LMIS in Ethiopia. This is an example of an open source custom software solution.

mSupply

mSupply is a pharmaceutical supply chain management system, focusing on pharmaceutical warehouses, stores and hospital dispensaries. It is a COTS solution that is also open source and was designed to be used in developing countries.

Oracle Supply Chain Management (SCM)

Oracle SCM is a cloud-based SaaS that provides commodity lifecycle management, supply chain planning, inventory management and order management. The Oracle SCM Cloud has five modules that can be selected as a complete package or a la carte: Warehouse Management, Transportation Management, Procurement, Planning Central and Product Hub.

SAP Supply Chain Management

SAP SCM is an on-premise or cloud-based SaaS solution that incorporates predictive analytics and artificial intelligence for supply chain planning. SAP SCM shows visibility into stock levels and assists users in planning, sourcing, delivering commodities and managing supplier relationships.

Solution Analysis

It is important to ensure that a solution will meet the business need and country context, as well as what hardware is required to implement the solution. **Table 3** shows the technology requirements and costs of the selected solutions. **Table 4** identifies what key features are available across each solution.

Technology Requirements

It is important to understand the hardware that needs to be in place to utilize each solution and the costs associated with the required hardware. **Table 3** describes the technology requirements of each solution, including the operating system, browsers, mobile platforms, development tools, APIs and databases utilized. FOSS solutions require more hardware to be available in country or to be purchased than COTS or software as a service. It is important to note that OpenLMIS and HCMIS do not allow for mobile data entry while CommCare does not allow for computer data entry. Oracle SCM and SAP SCM allow for both computer and mobile data entry.

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Table 3 – Technology Requirements of Solutions

Technology Requirements	OpenLMIS	OpenBoxes	CommCare Supply	HCMS	mSupply	Oracle SCM	SAP SCM
Operating System for Server	<ul style="list-style-type: none"> • Linux • Microsoft 	<ul style="list-style-type: none"> • Linux 	<ul style="list-style-type: none"> • CommCare HQ Server Cloud 	<ul style="list-style-type: none"> • Microsoft 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Oracle SCM Cloud 	<ul style="list-style-type: none"> • SAP SCM Cloud
Operating System for End User	<ul style="list-style-type: none"> • Windows XP or later 	<ul style="list-style-type: none"> • Windows XP • Mac 	<ul style="list-style-type: none"> • Windows XP or later 	<ul style="list-style-type: none"> • Windows XP or later 	<ul style="list-style-type: none"> • Android • Windows XP or later 	<ul style="list-style-type: none"> • Windows XP • Mac • Android • IOS 	<ul style="list-style-type: none"> • Windows XP • Mac • Android • IOS
Browsers	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox 	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox • Internet Explorer 	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox • Internet Explorer v10 or higher 	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox 	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox 	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox • Internet Explorer v10 or higher 	<ul style="list-style-type: none"> • Google Chrome • Mozilla Firefox • Internet Explorer v10 or higher
Mobile Platform	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Android • SMS 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Android 	<ul style="list-style-type: none"> • Android • IOS 	<ul style="list-style-type: none"> • Android • IOS
Development Tools	<ul style="list-style-type: none"> • PHP • Zend Framework • Javascript • JQuery • Fusion Chart 	<ul style="list-style-type: none"> • Git • tomcat 	<ul style="list-style-type: none"> • CommCare HQ 	<ul style="list-style-type: none"> • Visual Studio 2010+ DevExpress 	<ul style="list-style-type: none"> • Javascript • React 	<ul style="list-style-type: none"> • Oracle SCM 	<ul style="list-style-type: none"> • SAP SCM
APIs	<ul style="list-style-type: none"> • DHIS2 • CommCare Supply • OpenSRP ERP 	<ul style="list-style-type: none"> • Custom 	<ul style="list-style-type: none"> • OpenLMIS • DHIS2 	<ul style="list-style-type: none"> • DHIS2 	<ul style="list-style-type: none"> • Custom 	<ul style="list-style-type: none"> • Custom 	<ul style="list-style-type: none"> • Custom
Database	<ul style="list-style-type: none"> • MySQL 	<ul style="list-style-type: none"> • MySQL 	<ul style="list-style-type: none"> • CommCare HQ 	<ul style="list-style-type: none"> • SQL Server Express 	<ul style="list-style-type: none"> • mSupply cloud 	<ul style="list-style-type: none"> • Oracle SCM Cloud 	<ul style="list-style-type: none"> • SAP SCM Cloud

Business Requirements

Table 4 compares the functionality of each solution against the business solutions identified during the LMIS Workshop and stakeholder interviews. Each solution addresses the business requirements to different degrees. It is important to note that only three of the six solutions meet the requirements to allow for mobile data entry.

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Table 4 – Business Requirements Addressed by Solution

Business Requirements	OpenLMIS	OpenBoxes	CommCare Supply	HCMIS	mSupply	Oracle SCM	SAP SCM
Offline Access	✓	✗	✓	✓	✓	✓	✓
Real Time Data	✓	–	✓	–	✓	✓	✓
Inventory Management	✓	✓	✓	✓	✓	✓	✓
Expiry Tracking	–	✓	✓	✓	✓	✓	✓
Dashboard	✓	✓	✓	✓	✓	✓	✓
Purchase Order Workflow	✓	–	✓	✓	✓	✓	✓
Approval Workflow	✓	–	✓	✗	–	✓	✓
User Configuration	✓	✓	✓	✓	✓	✓	✓
GIS Web Mapping	✓	–	✓	–	–	✓	✓
Proof of delivery at warehouses	✓	–	✓	✓	✓	✓	✓
Proof of delivery at facilities	–	–	✓	–	✓	✓	✓
Forecasting	✓	–	–	–	✓	✓	✓
Barcode Scanner	✗	✗	✓	✗	✓	✓	✓
Data error alerts	✗	–	✓	–	–	✓	✓
Warning alerts	✗	–	✓	✓	–	✓	✓
Assign actions and follow-up to actions	✗	✗	✗	✗	✗	–	–
Track Financial Data	✗	✗	✗	✗	✗	✓	✓
Mobile Application	✗	✗	✓	✗	–	✓	✓
Multi-Language Functionality	✓	✓	✓	–	–	✗	✗

 Functionality Exists
  Configuration Needed
  Functionality does not exist

Cost Requirements

Deploying a digital solution requires funding for license fees, hosting, customization, configuration, training, maintenance and user support. The costs provided are illustrative and based on the information provided on company websites and through consultations. The total cost will depend on the level of customization required, the number of users and the amount of training. The costs in **Table 5** are based on total estimated costs for three years for 500 users.

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Licensing Fees

Usually, FOSS solutions do not charge any licensing fees, COTS solutions charge an annual fee and SaaS solutions charge a per user fee. OpenLMIS and HCMIS do not charge any licensing fees. OpenBoxes has a no fee option, a \$250 monthly fee for basic support, and up to \$6,000 monthly fee for full support and customization. CommCare Supply charges a fee of \$12,000 annually for up to 500 users whereas mSupply charges a one-time fee of \$12,000. Oracle SCM and SAP SCM charge between \$200-\$900 per user monthly, depending on which module is used.

Hosting

For FOSS solutions, no hosting services are provided. BVBD has access to the DDC-IT servers and Government of Thailand (GOT) cloud that can be utilized for hosting. Most solutions provide cloud hosting in the licensing fees and mSupply charges a separate fee for cloud hosting.

Customization

If the solution does not meet all of the business requirement, the solution will need to be customized. Additionally, the solution may need to integrate with other existing databases. An in-house developer can do the customization, or a developer can be hired. The full support version of OpenBoxes provide customization in their fee and CommCare Supply provides some customization support. mSupply charges a rate of \$111 per hour for customization. As mSupply is relatively new, it is anticipated that additional customization will be required. SAP SCM and Oracle SCM allow for minimal customization. For external customization, a rate of \$150 per hour is used for the cost estimate. It is anticipated that the amount of customization will decrease each year.

Configuration

Configuration includes the costs to install, configure and test the solution. This also includes the cost to provide data back-up. The data back-up responsibility already falls to BVBD-IT and would add additional hours as the amount of data being housed will increase. The other responsibilities can also be accomplished by BVBD-IT and DDC-IT without the need for external support. The full version of OpenBoxes, Oracle SCM and SAP SCM provide configuration support. For this costing exercise, a rate of \$150 per hour is used for external resources.

Training

Training costs include the cost to develop training materials (e.g., documentation, training videos, SOPs, etc.) and train staff to use the software. It is recommended that BVBD consider utilizing a training of trainers (ToT) approach for training. BVBD and BVBD-IT can conduct the initial training with provincial staff. And the designated trainers can then train people in the regions and communities. For external training, costs are estimated at \$1,200 per day for the trainer, excluding travel and per diem costs of both the trainer and the attendees. mSupply has a lower per day training fee, but also excludes per diem and travel costs. Training costs will likely be on-going as training materials may need to be updated as software is updated and new staff are onboarded.

Data Migration

Current stock data is kept in individual Excel sheets. If BVBD would like to upload past data into the new solution, there will be a cost for data migration to export, reformat, clean and test the data before uploading to the new solution. BVBD-IT or external resources can complete the data migration. Costs are estimated at \$1250 per week.

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Maintenance

Once the solution is deployed and implemented, there will be costs associated with maintaining the solution. For SaaS solutions, some of the costs are already included in the licensing fees (e.g., bug fixes). For FOSS, the full cost of maintenance will be with BVBD-IT and BVBD.

Table 5 – Cost Estimates by Solution for 500 Users

	OpenLMIS	OpenBoxes	CommCare Supply	HC MIS	mSupply	Oracle SCM	SAP SCM
Licensing Fees							
Notes	No cost	Monthly cost for Basic Service is \$250 and \$6,000 for custom	Annual cost is \$12,000 for 500 users	No cost	There is one upfront licensing fee of \$12,000	Monthly cost is \$50 per month per staff for 1,000+ employees	Monthly cost is \$199 per user for the Enterprise version
Year 1	• \$0	• \$3,000 - \$72,000	• \$12,000	• \$0	• \$12,000	• \$600,000	• \$1,200,000
Year 2	• \$0	• \$3,000 - \$72,000	• \$12,000	• \$0	• \$0	• \$600,000	• \$1,200,000
Year 3	• \$0	• \$3,000 - \$72,000	• \$12,000	• \$0	• \$0	• \$600,000	• \$1,200,000
Hosting							
Notes	Not included	Cloud Hosting	Cloud Hosting	Not included	Cloud Hosting	Cloud Hosting	Cloud Hosting
Year 1	• \$3,000	• \$0	• \$0	• \$3,000	• \$2,400	• \$0	• \$0
Year 2	• \$3,000	• \$0	• \$0	• \$3,000	• \$2,400	• \$0	• \$0
Year 3	• \$3,000	• \$0	• \$0	• \$3,000	• \$2,400	• \$0	• \$0
Customization							
Notes	Weekly cost is \$6,000	Basic Service Cost	Weekly cost is \$6,000	Weekly cost is \$6,000	Weekly cost is \$4,500	Included in package	Included in package
Year 1	• \$30,000	• \$45,000	• \$24,000	• \$75,000	• \$27,000	• \$0	• \$0
Year 2	• \$20,000	• \$30,000	• \$12,000	• \$30,000	• \$18,000	• \$0	• \$0
Year 3	• \$10,000	• \$10,000	• \$6,000	• \$15,000	• \$9,000	• \$0	• \$0
Configuration							
Notes	Estimated at \$150/hour	Included in custom version with some staff support costs	Estimated at \$150/hour	Estimated at \$150/hour	Estimated at \$111/hour	Included, with some staff support costs	Included, with some staff support costs
Year 1	• \$45,000	• \$12,000 - \$45,000	• \$30,000	• \$60,000	• \$25,000	• \$12,000	• \$12,000
Year 2	• \$30,000	• \$6,000 - \$30,000	• \$15,000	• \$45,000	• \$15,000	• \$6,000	• \$6,000
Year 3	• \$15,000	• \$6,000 - \$30,000	• \$6,000	• \$25,000	• \$10,000	• \$6,000	• \$6,000
Training							
Notes	Some training materials	Some training materials	Some training materials	No training materials	Few training materials	Some materials are	Some materials are

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	OpenLMIS	OpenBoxes	CommCare Supply	HC MIS	mSupply	Oracle SCM	SAP SCM
	already available. Daily cost is \$1200	already available. Daily cost is \$1200	already available. Daily cost is \$1200	available. Estimated at \$150/hour	available. Daily training is \$888	provided, but steep learning curve. Daily cost is \$1200.	provided, but steep learning curve. Daily cost is \$1200.
Year 1	• \$30,000	• \$30,000	• \$30,000	• \$45,000	• \$25,000	• \$36,000	• \$36,000
Year 2	• \$20,000	• \$20,000	• \$20,000	• \$30,000	• \$20,000	• \$25,000	• \$25,000
Year 3	• \$10,000	• \$10,000	• \$10,000	• \$15,000	• \$10,000	• \$15,000	• \$15,000
Data Migration							
Notes	This is optional	This is optional	This is optional	This is optional	This is optional	This is optional	This is optional
Year 1	• \$5,000	• \$5,000	• \$5,000	• \$5,000	• \$5,000	• \$5,000	• \$5,000
Year 2	• \$0	• \$0	• \$0	• \$0	• \$0	• \$0	• \$0
Year 3	• \$0	• \$0	• \$0	• \$0	• \$0	• \$0	• \$0
Maintenance							
Notes	All support provided by BVBD.	Some support included in custom version.	Some support provided.	All support provided by BVBD	Full support provided.	Bug fixes and help desk available. Annual maintenance fee charged	Bug fixes and help desk available. Annual maintenance fee charged
Year 1	• \$75,000	• \$30,000 - \$60,000	• \$40,000	• \$100,000	• \$84,000	• \$30,000	• \$60,000
Year 2	• \$50,000	• \$30,000 - \$50,000	• \$30,000	• \$75,000	• \$84,000	• \$30,000	• \$60,000
Year 3	• \$50,000	• \$30,000 - \$50,000	• \$30,000	• \$75,000	• \$84,000	• \$30,000	• \$60,000
Total							
Year 1	• \$188,000	• \$149,000 - \$183,000	• \$141,000	• \$288,000	• \$130,400	• \$683,000	• \$1,313,000
Year 2	• \$123,000	• \$128,000 - \$133,000	• \$89,000	• \$183,000	• \$157,400	• \$661,000	• \$1,291,000
Year 3	• \$88,000	• \$103,000 - \$118,000	• \$64,000	• \$133,000	• \$115,400	• \$651,000	• \$1,281,000
Total:	• \$399,000	• \$395,000 - \$419,000	• \$294,000	• \$604,000	• \$403,200	• \$1,995,000	• \$3,885,000

LMIS SOLUTION ANALYSIS

Table 6 highlights the pros, cons and recommendations for each solution.

Table 6 – Solution Analysis

Solution	Pros	Cons	Recommendations
OpenLMIS	<ul style="list-style-type: none"> No licensing fees Proven in low-resource settings Offline data entry capabilities 	<ul style="list-style-type: none"> No mobile data entry No expiry tracking No maintenance support No work flow and approval flow capabilities 	OpenLMIS does not have mobile data entry capabilities, meaning additional hardware would need to be purchased to support this approach.

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Solution	Pros	Cons	Recommendations
	<ul style="list-style-type: none"> Some training materials are already developed Community support for software development 	<ul style="list-style-type: none"> High level of effort (LOE) for configuration and maintenance Higher cost Hosting hardware needed 	<p>Additionally, there is a high LOE for configuration and maintenance as all development and maintenance will be the responsibility of BVBD-IT. It is not recommended to move forward with OpenLMIS.</p>
OpenBoxes	<ul style="list-style-type: none"> No licensing fees Intuitive user interface Support available with licensing Some training materials already produced 	<ul style="list-style-type: none"> No mobile data entry No offline data entry No work flow and approval flow capabilities High LOE for configuration Medium LOE for maintenance Hosting hardware needed 	<p>OpenBoxes does not have mobile data entry capabilities, meaning additional hardware would need to be purchased to support this approach. Compared to OpenLMIS, the cost is low in that for \$450,000, OpenBoxes will support configuration and implementation, minor bug fixes, etc. However, because of the inability for offline data entry and mobile data entry, it is not recommended to move forward with OpenBoxes.</p>
CommCare Supply	<ul style="list-style-type: none"> Mobile data entry Offline data entry Adaptable in low-resource settings Easy UI to create data entry forms Can work on SMS and smartphone Hits majority of business requirements Lower cost No additional hardware needed 	<ul style="list-style-type: none"> Medium LOE for configuration and maintenance No forecasting capabilities without API No data entry on computers No approval flows 	<p>CommCare Supply has the lowest cost while meeting the majority of business requirements. Additionally, existing mobile phones can be utilized for data entry, so less hardware needs to be purchased to implement. And SMS allows data entry without internet. It is recommended that BVBD explore CommCare Supply as the LMIS solution.</p>
HCMIS	<ul style="list-style-type: none"> Adaptable in low-resource settings Can be adapted to other sectors Can sync with outside vendor through API 	<ul style="list-style-type: none"> No mobile data entry LOE for configuration and maintenance is high System does not have as many community members to provide support High costs associated with high configuration and maintenance LOE 	<p>HCMIS has not been widely adapted and has little support for customization and configuration. As such, the cost is highest to move forward with this solution, even though the features do not align well to the business requirements. It is not recommended to move forward with HCMIS.</p>
mSupply	<ul style="list-style-type: none"> Adaptable in low-resource settings Can sync with APIs 	<ul style="list-style-type: none"> Most data entry is done on tablets instead of phones, with the mobile 	<p>mSupply has not been widely adapted or used in malaria SCM. The tool</p>

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Solution	Pros	Cons	Recommendations
	<ul style="list-style-type: none"> Addresses most of the business requirements Has a scanning feature Easy UI to create data entry forms Mobile data entry May have crowd source funding available to build out system Forecasting capabilities 	<ul style="list-style-type: none"> applications still being built out No Thai language capabilities, but can be added As this is a newer tool, more customization will be needed to meet requirements No approval workflows 	meets many of the business requirements, but will require additional configuration and customization since the tool is still in early development. As additional customization may take longer to deploy the tool, it is not recommended to move forward with mSupply.
Oracle SCM	<ul style="list-style-type: none"> Offers most functionality within the business requirements Training materials provided Provides full support for customization and implementation No additional hardware needed 	<ul style="list-style-type: none"> No Thai language capabilities Modular approach means that GOT would need to purchase multiple modules for full functionality High cost associated with functionality that is not needed in the context High user costs Less ability for BVBD-IT to adapt the solution to country needs 	While Oracle SCM addresses the majority of business requirements, there is no capability for Thai in the system. As this is a larger enterprise tool, the costs are also higher. Given that multiple modules would need to be purchased and configured, the cost can become higher than estimated in this document. It is not recommended to move forward with Oracle SCM given that the additional functionality provided will not be utilized.
SAP SCM	<ul style="list-style-type: none"> Strong AI and forecasting capabilities Meets majority of business requirements Provides full support for customization and implementation Training materials available Low configuration and maintenance LOE No additional hardware needed 	<ul style="list-style-type: none"> No Thai language capabilities Higher cost associated with lower maintenance LOE Capability exceeds what is needed for BVBD, causing the software to be more expensive 	While SAP SCM hits the majority of business requirements, there is no capability for Thai in the system. Additionally, this provides more functionality than is needed, driving up costs. BVBD would not have as much flexibility in adapting the solution to their needs as customization is included in the cost.

Solution Recommendation

It is recommended that BVBD consider adapting CommCare Supply, with an API to MIS/Malaria Online, as the NMCP LMIS due to its alignment to the business requirements, ability to be utilized in low resource settings, multi-language capabilities and associated costs.

MONITORING FRAMEWORK FOR SYSTEM PERFORMANCE

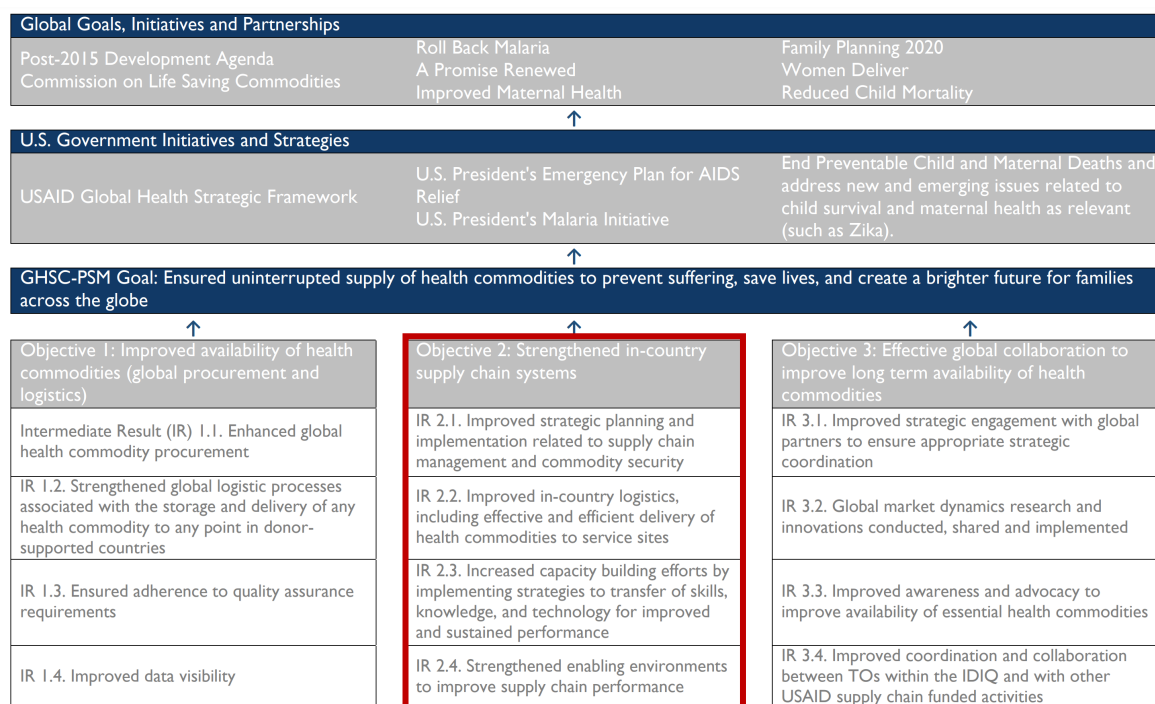
Monitoring and evaluation should be an integral part of an LMIS. Throughout the development and testing of the LMIS, it will be important to gather user feedback to improve the design of the LMIS.

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Once the LMIS is deployed nationally, monitoring will be critical to measure performance of the solution and increase accountability. Evaluation will identify strengths, weaknesses and best practices, allowing for continual improvement of the LMIS to meet user needs. Key M&E activities are included in the workplan.

The GHSC-PSM program has an approved M&E plan, as shown in **Figure 3**. *Objective 2: Strengthened in-country supply chain systems* aligns with the adaptation of an LMIS in Thailand.

Figure 3 – GHSC-PSM Monitoring and Evaluation Plan¹



Among the four intermediate results (IR) that feeds into Objective 2, *IR 2.2 – Improved in-country logistics*, including effective and efficient delivery of health commodities to service sites – contains indicators that track LMIS performance. Table 5 shows which indicators align to each IR. Those highlighted in red are indicators that track LMIS performance specifically.

Table 5 – Objective 2 Intermediate Results and Indicators

Objective 2: Strengthened in-country supply chain systems	
Intermediate Result	Indicators
IR 2.1 Improved strategic planning and implementation related to supply chain management and commodity security	B5. Percentage of required annual forecasts conducted B6. Percentage of required supply plans submitted to GHSC-PSM B7. Percentage of total spent or budgeted on procurement of commodities for public sector services, by funding source B10. Percentage of GHSC-PSM supported countries that have a functional logistics coordination mechanism in place B11. Percentage of leadership positions in supply chain management that are held by women B12. Mean absolute percent consumption forecast error

¹ USAID IDIQ [Project Monitoring and Evaluation Plan](#), 2018

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IR 2.2 Improved in-country logistics, including effective and efficient delivery of health commodities to services sites	B1. Stockout rate at service delivery points B2. Stocked according to plan at storage sites B3. Service delivery point reporting rate to LMIS B4. Average rating of in-country data confidence B12. Mean absolute percent consumption forecast error C10. Percentage of GHSC-PSM procured or supported molecular instruments that remained functional
IR 2.3 Increased capacity building efforts by implementing strategies to transfer of skills, knowledge, and technology for improved and sustained performance	B8. Percentage of initially GHSC-PSM supported supply chain functions carried out by national authorities without external technical assistance C2. Number of people trained C10. Percentage of GHSC-PSM procured or supported molecular instruments that remained functional
IR 2.4 Strengthened enabling environments to improve supply chain performance	B7. Percentage of total spent or budgeted on procurement of commodities for public sector services, by funding source B8. Percentage of initially GHSC-PSM supported supply chain functions carried out by national authorities without external technical assistance V9. Supply chain technical staff turnover rate B10. Percentage of GHSC-PSM supported countries that have a functional logistics coordination mechanism in place

Additional indicators can be considered for tracking the system performance of an LMIS, such as:

- **Order fill rate:** This indicator is a percentage of the amount of stock received versus the stock ordered
- **Percentage of orders placed that are filled correctly:** This indicator measures the percent of orders placed correctly.
- **Accuracy of logistics data for inventory management:** This indicator measures the discrepancy between the stock count in the LMIS and physical stock counts at the facility, helping to identify if the LMIS is capturing all stock counts.
- **Consumption forecasts versus actual consumption:** This indicator will compare the actual consumption of commodities versus the forecasted amount, indicating if the quantification component of the solution is accurately forecasting commodity needs in each area.
- **Percentage of stock wasted due to expiration:** This indicator will look at the percentage of stock that had to be thrown away due to expiration, indicating if the LMIS is helping to improve inventory management.

LMIS ROADMAP

The Roadmap Action Plan in **Table 6** is broken down to three specific phases: Preparatory Phase, Platform Establishment and Scale Phase and Interoperability Phase.

Preparatory Phase

The main purpose of the preparatory phase is to create an enabling environment for the development of an LMIS and to ensure key requirements are addressed. Key activities during this phase include:

1. Identify and document malaria-specific metadata
2. Select a solution to adapt as an LMIS – further review LMIS solutions and existing infrastructure to select an LMIS solution

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3. Further develop business requirements for the LMIS – hold a user center design workshop to gather more solution requirements, especially around dashboards and data elements
4. Update data architecture in MIS to include commodity data – review and assess the functionality of the existing architecture, update as needed and add commodity data tables into the hierarchy
5. Provide Tableau training – identify trainings available to BVBD-IT staff in Tableau and provide opportunities to attend

Platform Establishment and Scale Phase

The main purpose of the platform establishment and scale phase is to design, test, train on and roll-out a national scale LMIS. Key activities during this phase include:

1. Design and configure software – based on business requirements, design and configure the LMIS
2. Develop training curriculum – develop training material in various media formats to complement the deployment of the system
3. System testing – identify test provinces and conduct user acceptance testing to get user feedback on the solution. Make updates to the system based on user feedback.
4. Develop a training plan and conduct training – to prepare system users for the roll out of the solution, provide a training (or training of trainers) to ensure end users and supervisors know how to use the system in both the vertical program and general health services
5. Roll-out LMIS nationwide – Deploy the system throughout the country. Continue to gather feedback and update the system as needed

Interoperability Phase

During the interoperability phase, BVBD will continue to develop relationships with MOPH-IT and LogHealth to ensure system alignment, advocate for the inclusion of malaria data in general health service databases and continue to monitor and maintain the LMIS. Key activities during this phase include:

1. Develop interoperability between LMIS and HL7 – coordinate with MOPH-IT to create an interoperability layer between LMIS and HL7
2. Advocate for inclusion of malaria data in general health service databases – communicate regularly with MOPH-IT and LogHealth to advocate for the inclusion of malaria data and indicators in the
3. Provider quality monitoring and maintenance support – monitor and evaluate the performance of the LMIS, provide user support and maintain the LMIS

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Table 6 – LMIS Three Year Roadmap

Task	FY19	FY20				FY21				FY22			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
PREPARATORY PHASE													
1. Identify and document malaria-specific metadata													
Develop Malaria Terminology List													
Develop Data Dictionary													
Develop Pharmaceutical Codes													
Confirm meta data for master facility registry and compare to LogHealth metadata													
Confirm coding for patient ID with LogHealth methodology													
Meet with LogHealth and MOPH-IT to understand the metadata they use													
Share developed documents with LogHealth and MOPH-IT													
2. Select a solution to adapt to an LMIS													
Review LMIS options													
Complete a full cost analysis on options													
Confirm interoperability with MIS													
Determine available infrastructure and additional resources that may be needed													
Contact company for a demo													
Select a solution													
3. Further define business requirements													
Review business requirements to date													
Hold a user-centered design workshop, inviting participants from all levels and with different roles													

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Task	FY19	FY20				FY21				FY22			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Develop dashboard requirements													
Based on dashboard requirements, identify data elements to be included													
Update business requirements documentation													
4. Update data architecture in MIS to include commodity data													
Review existing MIS data architecture and linking tables													
Assess if data architecture needs to be updated for better data analysis													
Update data architecture if needed													
Develop data tables for commodity data													
Add data tables, linking tables and indicator equations to the data architecture													
Meet with DDC-IT about requirements for migrating MIS from BVBD-IT server to the DDC-IT server													
Switch hosting to DDC-IT server													
5. Provide Tableau training													
Identify available Tableau trainings													
Identified BVBD-IT staff attend Tableau training													
6. Restructure process for MIS maintenance													
Review current process for updating the MIS													
Develop prioritization rubric that aligns with strategic vision for MIS													
Restructure the process to include design sprints													
Create template or standard way to submit requirements and communicate changes to staff													

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Task	FY19	FY20				FY21				FY22			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
PLATFORM ESTABLISHMENT AND SCALE PHASE													
1. Design and Configure Software													
Identify programmer to develop mobile app interface													
Meet with company to identify design process and requirements													
Create mock-ups of system and dashboards													
Develop dashboards													
Develop the mobile app													
Develop API to interoperate with MIS													
2. Develop LMIS training curriculum													
Desk review of any existing training materials													
Identify the media formats for the materials													
Develop the training content													
Receive user feedback on the content													
Update based on user feedback													
Continue to update as LMIS is updated													
3. System testing													
Identify which provinces to test in													
Coordinate key stakeholders in test provinces													
Train test provinces on LMIS													
Deploy LMIS in test provinces													
Hold user acceptance testing feedback session													
Update LMIS according to feedback													
4. Develop a training plan and conduct training													
Develop training plan, including PSO staff													
Identify staff to conduct the training													

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Task	FY19	FY20				FY21				FY22			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Identify trainers to train in each district													
Identify location and schedule training in each district													
Conduct training of trainers in each district													
Trainers conduct training throughout their district													
Distribute training materials													
Identify contact person to provide user support													
Provide user support													
5. Roll out LMIS nationwide													
Deploy LMIS to all provinces													
Develop and conduct survey to gather user feedback													
Maintain issues log to address feedback													
Coordinate with LMIS company to ensure smooth transition													
Hold feedback session with trainers and key stakeholders													
Request feedback on data analysis and dashboards after quarterly reporting cycle													
INTEROPERABILITY PHASE													
1. Develop interoperability between LMIS and HL7													
Meet with MOPH-IT on workplan for HL7 integration													
Establish working group or set meetings to update on progress of LMIS and HL7													
Identify business requirements for interoperability													
Update LMIS with business requirements													
Work with LMIS software to develop interoperability with HL7													

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Task	FY19	FY20				FY21				FY22			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Conduct refresher training and updated data visualization training													
Gather feedback on HL7 data													
Review data for duplications and deduplicate as needed													
2. Advocate for inclusion of malaria data in general health service databases													
Establish regular meetings with LogHealth and MOPH-IT on data standardization													
Identify documents needed to include malaria in the EDI, MMIS and HL7													
Develop and provide documents to MOPH-IT and LogHealth													
3. Provide quality monitoring and maintenance support													
Establish system performance baselines													
Conduct data quality checks													
Monitor indicator progress													
Conduct user feedback surveys													
Hold lessons learned session													
Evaluate LMIS performance													
Continue to update LMIS based on user needs and system requirements													

