Common Requirements for Logistics Management Information Systems

Produced with the Collaborative Requirements Development Methodology (CRDM)

September 30, 2010

MAIL
PO Box 900922
Seattle, WA 98109 USA

STREET
2201 Westlake Avenue, Suite 200
Seattle, WA 98121 USA

Tel: 206.285.3500
Fax: 206.285.6619
www.path.org

HMN

Public Health Informatics Institute

The Rockefeller Foundation

PATH

This work is licensed under the Creative Commons Attribution-ShareAlike 3.0 Unported License. To view a copy of this license, visit http://creativecommons.org/licenses/by-sa/3.0/ or send a letter to Creative Commons, 171 Second Street, Suite 300, San Francisco, California, 94105, USA. The content in this document may be freely used in accordance with this license provided the material is accompanied by the following attribution: "From the Collaborative Requirements Development Methodology and Common Requirements for Logistics Management Information Systems. Copyright © 2010 Program for Appropriate Technology in Health (PATH) and the Public Health Informatics Institute."

Suggested citation: PATH. *Common Requirements for Logistics Management Information Systems*. Seattle: PATH; 2010.

This project was supported through a grant from the Rockefeller Foundation.

Table of Contents

Preface 4
List of Abbreviations 5
Project Partners 7
Acknowledgments 9
Executive Summary 11
The Need 13
Towards a Global e-Health Architectural Framework 14
Health System Domain Reference Model 16
Supply Chain Domain Conceptual Model 17
A Vision for Logistics Management Information Systems 18
A Methodology for Determining and Documenting Requirements 19
Business Process Framework for LMIS 23
Business Processes of Logistics Management 25
User and Systems Requirements Supporting Business Processes 30
How to Apply Requirements at a Practical Level 42
Conclusions 43
References and Additional Resources 45
Appendix A: Glossary of Business Process and Systems Engineering Terms 48
Appendix B: Glossary of Supply Chain Terms 51
Appendix C: Task Flow Diagrams 56

Preface

This document is intended to bridge the language and discipline of global health with the language and discipline of software and system engineering. The focus of this work was on the creation of a methodology for producing descriptions, models, and figures that accurately represented the views and needs of global health professionals. This document describes this methodology and as such can be used by global health practitioners who are interested in applying it to inform software development related to health systems.

This document also presents a set of descriptions, models, and figures that were produced as a result of the methodology being applied in supply chain and more specifically in logistics management. These artifacts are intended to be useful in discussions between health professionals and suppliers of logistics management information systems. This document does not intend to be a definitive authority on the discipline of logistics management or to provide guidance on how to organize and manage the logistics function within a country. This work was informed by supply chain and logistics management experts. The References and Additional Resources section of this report presents some of the work of these experts in the health system domain of supply chain.

This document is designed to be both a road map and a tool. It serves as a road map for helping ministries of health (MOH) move toward the vision of an effective LMIS as expressed in this document. At the same time, it is a tool for structuring specific implementation projects, informing vendor requests for proposals (RFPs), self assessing existing LMIS capabilities, and providing a methodology that is repeatable in other health system domains. It does not provide the technical specifications for an information system that are often used for designing and writing software applications. MOHs are encouraged to customize or adapt this document to meet local needs. They can modify the business process sections by adding specific or unique requirements and deleting business processes not under their jurisdiction.

List of Abbreviations

CDC	Centers for Disease Control and Prevention
CDR	Central Data Repository
CHAI	Clinton Health Access Initiative
COTS	Commercial Off The Shelf
CSO	Central Supply Organizations
CRDM	Collaborative Requirements Development Methodology
CWG	Core Work Group
EDI	Electronic Data Exchange
ERP	Enterprise Resource Planning System
FEFO	First to Expire First Out
FIFO	First In First Out
GLN	Global Location Number
GRN	Goods Received Note
GTIN	Global Trade Identification Number
HIS	Health Information Systems
HMIS	Health Management Information Systems
HMN	Health Metrics Network
HR	Human Resources
ICT	Information and Communication Technology
ICW	Inter-Country Warehouse
IHP	International Health Partnership
ISO	International Organization for Standardization
IVR	Interactive Voice Response
JSI	John Snow Incorporated
KPI	Key Performance Indicator
LMIS	Logistics Management Information System
M&E	Monitoring and Evaluation
MIS	Management Information Systems
MOH	Ministry of Health
MOU	Memorandum Of Understanding
MSH	Management Sciences for Health
NGO	Nongovernmental Organization
PEPFAR	President's Emergency Plan for AIDS Relief
PHII	Public Health Informatics Institute
PFSCM	Partnership for Supply Chain Management
PMO	Program Management Office
RDC	Regional Distribution Center
RFID	Radio Frequence Identification
RFP	Request for Proposal
ROI	Return on Investment
SCM	Supply Chain Management
SCMS	Supply Chain Management System
SCOR	Supply Chain Operations Reference Model
SDLC	Software Development Life Cycle

SDP	Service Delivery Point
SKU	Stock Keeping Unit
SLA	Service Level Agreement
SME	Subject Matter Expert
SOP	Standard Operating Procedure
TCO	Total Cost of Ownership
UAT	User Acceptance Test
UNICEF	United Nations Children's Fund
UPC	Universal Product Code
USAID	US Agency for International Development
VAR	Vaccine Arrival Report
VSSM	Vaccination Supplies Stock Management
WMS	Warehouse Management System
WHO	World Health Organization
WHO/EMP	World Health Organization/Essential Medicines and Pharmaceutical Policy Unit
WHO/EPI	World Health Organization/Expanded Program on Immunization
WHO/HMN	World Health Organization/Health Metrics Network
WMS	Warehouse Management System
3PL	Third Party Logistics provider

Project Partners

With significant support from the World Health Organization (WHO), Health Metrics Network (HMN), and the Rockefeller Foundation, three organizations form the core of this project:

PATH

PATH creates sustainable, culturally relevant solutions that enable communities worldwide to break longstanding cycles of poor health. By collaborating with diverse public- and private-sector partners, we help provide appropriate health technologies and vital strategies that change the way people think and act. Our work improves global health and well-being.

Since its inception in 1977, PATH has excelled at developing, adapting, transferring, and advancing health technologies for use in resource-poor settings. We have also developed and implemented tools and techniques for introducing, using, monitoring, and evaluating such technologies. PATH's central goal is to make appropriate and affordable technologies available to developing countries in an economically and socially sustainable manner and ensure effective introduction and use in diverse settings including urban, rural, and remote areas. PATH has developed deep expertise in mapping health systems and collaborating with global and national health leaders to develop information and communication technology requirements for country and global applications. PATH is an active collaborating partner of WHO and the Health Metrics Network to assist countries with strengthening their health and health information systems.

Project Optimize

Project Optimize, a five-year, WHO-PATH collaboration funded by the Bill & Melinda Gates Foundation, has been given a unique mandate to think far into the future—to create a vaccine supply chain that is flexible and robust enough to handle an increasingly large and costly portfolio of vaccines, and ultimately, create synergies with the delivery of other health commodities. To put technological and scientific advances to work, by 2012 Optimize aims to help define specifications for health products and ensure they are designed for maximum efficiency and safety in the field. Optimize also aims to create innovative policies and logistics systems for the future. This will enable vaccines and other health products to be at the right place, at the right time, and in the right quantities, without compromising quality. Optimize will generate the tools and evidence that support implementing these choices. The project will also develop consensus amongst major partners and stakeholders around the global vision for health logistics. Optimize will thus build the momentum to carry the global vision forward, resulting in sustainable, long lasting impact.

Public Health Informatics Institute

The Public Health Informatics Institute (the Institute) is an independent, nonprofit organization dedicated to improving the performance of the public health system by advancing public health practitioners' ability to strategically manage and apply health information systems. The Institute

is a program of the Task Force for Global Health, established in 1984. The Institute translates best practices from the information technology industry into methods and tools that public health agencies can use in addressing their information challenges. The Institute works collaboratively with public health agencies to clarify the value of information solutions, define the work of public health through a practical application of business process analysis and requirements specification, and formulate realistic approaches to guiding and measuring performance improvement. The Institute's approach and methodologies help public health agencies understand their information needs and develop more effective information systems.

Acknowledgments

Core Work Group

Ali Arale, Kenya MOH

Diallo Aliou, Senegal MOH

Magali Babaley, WHO/EMP

James Cheyne, PATH Project Optimize

Modibo Dicko, WHO/EPI

Laity Gning, Senegal MOH

Mojtaba Haghgou, independent consultant

Dai Hozumi, PATH Health System Strengthening

Steve Kinzett, PATH Reproductive Health Supplies Coalition

John Lloyd, PATH Project Optimize

Olivier Ronveaux, WHO/EPI

Nguyen Van Cuong, Viet Nam MOH

Technical Contributors

Linda Allain, JSI

Richard Anderson, University of Washington

Ahmet Afsar, UNICEF

Sharon Boyle, World Vision International/Global Supply Chain

Tony Burton, WHO/EPI

Rochika Chaudrey, PFSCM

James Dailey, VillageReach

Kyle Duarte, MSH

Richard Gakuba, Rwanda MOH

Dhiraj Jain, PFSCM

Max Kabalisa, Supply Chain Management System (SCMS) Rwanda

Ramesh Krishnamurthy, WHO/HMN

Mark Landry, WHO Western Pacific Regional Office

Maeve Magner, Clinton Health Access Initiative

Henry Mwanyika, Ifakara Health Institute

Patrick Nganji, Rwanda Pharmacy Task Force

Nosa Orobaton, WHO/HMN

Liz Peloso, independent consultant

Chris Seebregts, Jembi

David Sinegal, independent consultant

Adriano Sommerlatte, JSI

Helen Tata, WHO/EMP

Steven Uggowitzer, WHO/HMN

Meade Walker, independent consultant

Allen Wilcox, VillageReach

Edward Wilson, JSI

Randy Wilson, MSH

Michel Zaffran, Project Optimize, PATH

Project Technical Team

Nicki Buchanan, Public Health Informatics Institute (PHII)

Kelley Chester, PHII

Jan Grevendonk, PATH

David Lubinski, Principal Investigator, PATH

Anita Renehan-White, PHII

Dave Ross, PHII

Kate Wilson, PATH

Executive Summary

The importance of functional health information systems in achieving improved health outcomes continues to grow, yet the reality in most developing countries is that the systems and health information technologies which support them are often poorly designed and unable to work together as a sustainable and scalable system. Donors and countries alike recognize the need to establish architecture and reusable tools for more systematically building global health information systems. This project was funded to address that need and had two main objectives; (1) develop a general methodology for determining and documenting health information system user requirements and (2) apply this methodology to produce requirements in supply chain as one of the core functional domains of a national health system.

PATH conducted a landscape analysis of the peer-reviewed and grey literature to identify examples, methods, and models for developing user requirements in global health applications. PATH also interviewed global health information system experts to discover any existing user requirements processes not covered in the literature that could be used to inform the development of common user requirements. The result of this landscape review showed that the work of the Public Health Informatics Institute represented the most mature methodology with ten years of US-based public health informatics experience in user-driven design. The PATH/Institute partnership lead to the adaptation of what is now called the collaborative requirements development methodology (CRDM). The *collaborative* aspect of CRDM was designed to span the needs of multiple vertical programs for the diverse countries of Kenya, Rwanda, Senegal, and Vietnam and a blend of global and national experts, users and stakeholders.

The results showed further that CRDM was effective in achieving the objective of generating user and system requirements that are understandable, adoptable and useful to stakeholders and managers for acquiring, enhancing, or developing a Logistics Management Information System (LMIS) for any health product. Furthermore, CRDM has begun to be replicated in individual countries for other projects where user-driven design is necessary. A key aspect of the effectiveness of CRDM is the use of nontechnical language that is familiar to users and subject matter experts. This enables greater clarity and accuracy when communicating the needs of users of information systems to software and system engineers as well as vendors of LMIS applications.

The output of the CRDM for the supply chain domain is a set of 12 business processes, 7 of which were prioritized as most likely to improve the performance of logistics management in countries. These 7 processes were made up of 59 discrete activities that formed the logical work flow to complete each process. A total of 208 specific user and system requirements were determined as necessary and documented. These requirements are now being used by countries to make informed decisions when acquiring commercial or open-source LMIS solutions, evaluating their existing capabilities, or enhancing existing implemented solutions. For technical agencies, the use of these requirements can be applied across diverse projects to encourage the

development of common, reusable LMIS solutions. Well-designed, robust, and proven global applications that are reusable can lead to lower total costs and reduce the time associated with implementing health information solutions. For donors, resources can be applied in more consistent, focused development efforts which increase the value of these investments with the intent of producing stronger, better-designed, reusable solutions. Finally, the CRDM can be replicated to produce common requirements for other health system domains. Together, they will deliver a health information system that countries can depend upon to strengthen their health systems in a sustainable and scalable manner.

The Need

The global health community recognizes that strong health systems are the foundation necessary to effectively deliver health services that produce better health outcomes. Strengthening health systems in developing countries requires improved decision-making capacity at all levels and building capacity in countries with the least resources requires strengthening the management of health systems as a whole.[1] Improved access to and use of health information is central to strengthening management and building health system capacity in low-resource countries.

The Health Metrics Network (HMN), a partnership hosted by the World Health Organization (WHO), was created to develop a framework for improving the availability and use of health information.[2] Since 2005, more than 100 countries have expressed interest in strengthening their health information systems (HIS) and are actively seeking guidance and solutions. HMN and its network of partners have called for a global strategy for developing national HIS. This strategy will include development of an architecture that countries, donors, and developers can use as a model in strengthening systems.[3]

From July 12 to August 8, 2008, the Rockefeller Foundation sponsored a conference series at its Bellagio Center titled "Making the eHealth Connection: Global Partnerships, Local Solutions." The conference convened more than 200 leaders representing health care, technology, finance, policy, and government to discuss how to leverage e-health to advance health services, particularly in low-resource settings. These leaders expressed a strong need for global guidance and standards for strengthening HIS and validated the urgent requirement for a model architecture to help achieve this goal. They perceived that such an architecture would directly contribute to saving time and money and to reducing the risk of failure when implementing HIS projects.[4]

In June of 2009, the Rockefeller Foundation awarded PATH a grant to begin development of a catalytic approach for strengthening HIS. The ongoing focus of this project is to create and apply a requirements development methodology that contributes to a model architecture. Because the availability of vaccines, pharmaceuticals, and medical supplies is so central to delivering

---

[1] Mills A, Rasheed F, Tollman S. Strengthening health systems. In: *Disease Control Priorities in Developing Countries*, 2nd ed., New York: Oxford University Press; 2006; 87–102. DOI: 10.1596/978-0-821-36179-5/Chapter-3. www.dcp2.org

[2] World Health Organization (WHO). *The Health Metrics Network Framework, 2nd ed.* January 2008. http://www.who.int/healthmetrics/en/

[3] Ibid.

[4] eHealth, Health Systems Improvement and the Rockefeller Foundation page. Rockefeller Foundation website. Available at: http://www.rockefellerfoundation.org/uploads/files/f3235b45-704f-412e-8ba6-20d92c82ef75-ehealth.pdf

effective health services, the methodology has initially been applied in the domain of supply chain, and more specifically to logistics management.

Over the past 14 months in partnership with the Public Informatics Institute (Institute), the Collaborative Requirements Development Methodology (CRDM) was adapted and applied in the domain of supply chain. To illustrate the work within this domain, this report is divided into two sections. First, it presents the CRDM and describes how it was used to collect the common user and system requirements produced for logistics management information systems (LMIS). Following that description, the report provides guidance on how countries can use these common requirements to develop country-specific supply chain solutions.

Towards a Global e-Health Architectural Framework

The *architecture* represents a logical understanding of the context of the work performed in the health system—the problems, opportunities, work flow, business processes, activities, requirements, and the people that perform the work, or are users/producers of information. *Solutions* are the physical instances that are informed by the architecture, taking the form of information and communications technology that people will use to perform work, provide/gain access, and use information. The overall goal of the architecture work is to deliver effective, practical solutions that enable users in a country to do their work more effectively and efficiently in support of meeting the mission and objectives of the health system.

The foundation of an architecture is the requirements it is supposed to address. The Gartner Group goes further to emphasize the importance of active collaboration in the development of requirements as well as ongoing management of requirements throughout a project lifecycle.[5] The Open Group is another voice representing commercial firms and governments that has produced the Open Group Architecture Framework which is based on the primacy of requirements.[6] The importance of requirements in designing and developing health information systems is finally becoming commonplace, but its actual application still lags.[7] Thus the focus of this project was first and foremost on the methods to determine and document requirements through a collaborative approach that would result in common and generally relevant requirements.

[5] Light M. The First Key to Project Success Is Collaborative Requirements Definition and Management. *Gartner Research.* 2008; August 11: 1-9.

[6]The Open Group Architecture Framework (TOGAF). *TOGAF Version 9, Enterprise Edition.* February 2009. www.opengroup.org/. Accessed June 4, 2010.

[7] Schlotzer A and Madsen M. Health Information Systems: Requirements and Characteristics. In: E.J.S. Hovenga et al. (eds.) *Health Informatics*, IOS Press 2010, pp.156–166.

Figure 1. Framework for Global Common Architecture and Local Country-Specific Solutions

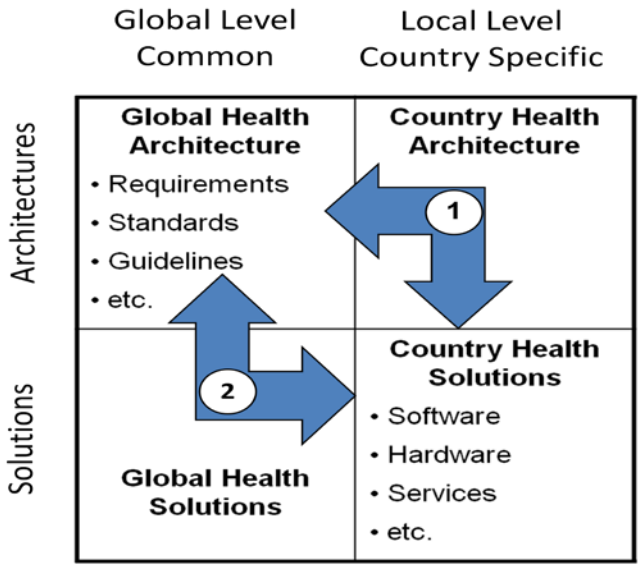


Figure 1 provides a framework for understanding the relationships between architecture and solutions and differentiating those things that are global, common, and reusable by many countries versus those that are local and specific to one country. Ultimately the value of information systems is realized only when solutions are deployed in a country as presented by the lower right hand cell in the grid. But two equally powerful paths are possible for this value to be realized. The first path is a bi-directional relationship or feedback loop (1) between "Global Architecture ↔ Local Architecture ↔ Local Solution." Existing and ongoing work in each box can inform others through broad sharing of outputs. Specific solutions are incredibly valuable to help inform architecture. Global and common requirements can inform specific national architectures and common solutions. Feedback loop (2) might be more likely to draw value from specific solutions, as there are numerous existing projects where direct, immediate, and invaluable deployment experience is available to be leveraged. HMN and others serve a key clearinghouse role for information, tools, and project outputs that support these feedback loops.

One major challenge countries face is the lack of resources, tools, and common, reusable building blocks available to plan and create their own country-specific enterprise architectures and solutions. This project focused on delivering two of these building blocks in the form of the CRDM process which is a tool that countries can use to collect user requirements and by developing the global common, reusable requirements for LMIS. The purpose of developing common architectural building blocks is to create, catalog, and distribute reusable components to provide countries, donors, and developers a starting point to reduce the cost and time of creating their own enterprise architectures, plans, and solutions.

Health System Domain Reference Model

Health systems across the world share many common characteristics. When working to strengthen national health information systems it is useful to have a conceptual model that represents the major functions of a health system that are called domains. A domain represents a set of processes and activities that naturally occur together or are enough alike that working with them as a set is efficient. Describing a set of interrelated domains is referred to as a domain reference model that is not intended to be prescriptive. Rather, it is intended to help those who are working on parts of the health information system to understand their work in relation to the other parts of the health system. In this way the domain reference model provides a useful way to focus and organize work and contribute deliverables that fit within a larger body of work.

The health domain reference model below (see Figure 2) represents a working model that was drafted in a technical consultation convened by WHO and HMN hosted by PATH in Seattle, Washington, on September 11 and 12, 2008, and is evolving through continued review and feedback among leaders and experts in health information systems. For the purposes of this project we are focused on supply chain and in particular, logistics, which is one of the ten domains in this evolving model. To help describe each of the domains in the reference model, two examples of functional processes are listed in the second column for each domain. Listed in the third column are likely users that perform work in the domain. Many well-described sectors of the global economy like manufacturing, retail, pharmaceuticals, and the financial sector have benefited from well-described domain reference models. One of the purposes of the domain reference model is to support communication and collaboration across projects that have the shared objective to produce architectures and solutions to be reused for the benefit of the broader community. An additional purpose of a domain reference model is to identify relationships between domains that should be considered when designing information systems. In the case of supply chain it is clear that many relationships exist with the other domains of the health system that will be significant to the people designing health information systems.

Figure 2. Evolving Health System Domain Reference Model

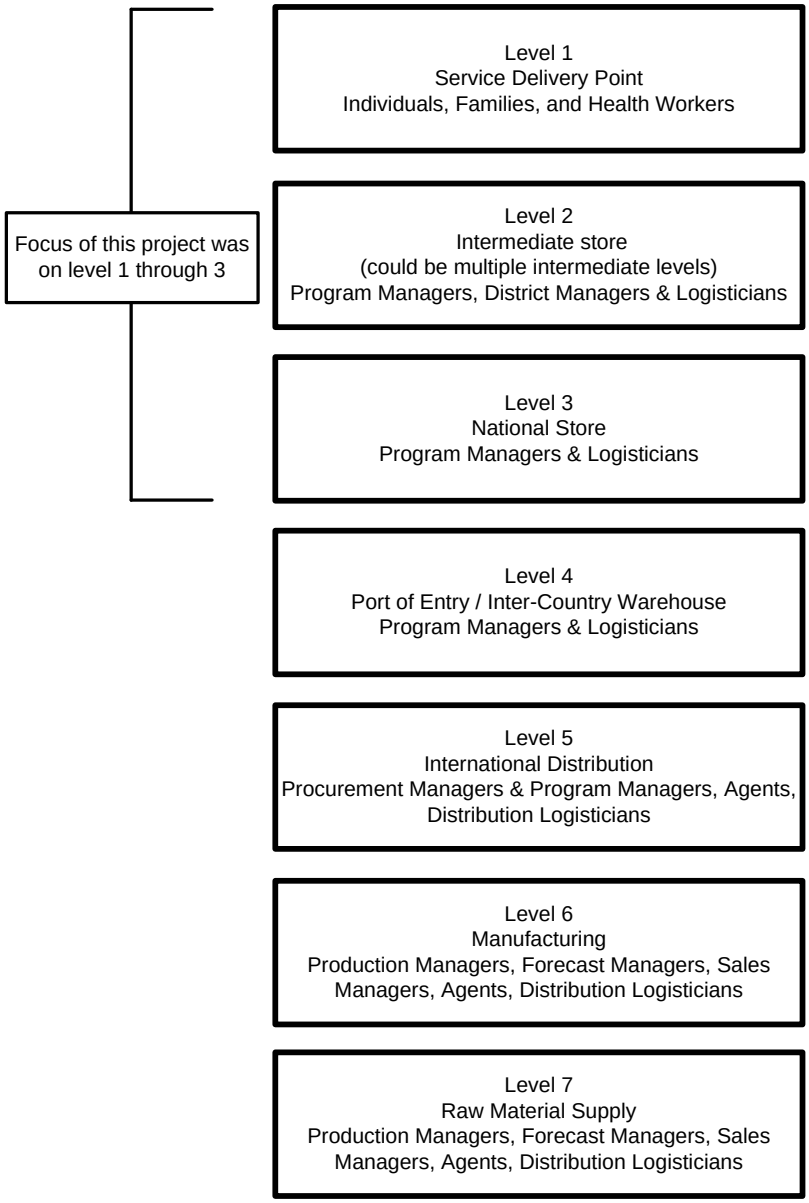
Functional Domain	Sample Processes	Typical Users
Community Services	Patient registration Patient case management	Health care worker Supervisor
Facility Services	Patient registration Birth registration	Health care worker Surveillance officer
Laboratory Services	Specimen Collection Result reporting	Health care worker Laboratory technician
Human Resources	Create new position Transfer employee	HR officer District manager

Functional Domain	Sample Processes	Typical Users
Supply Chain	Order medicines Store medicines	District manager Storekeeper
Finance and Insurance	Enroll members Verify coverage	Registration clerk Receptionist
Management & Planning	Produce M&E indicator reports Create annual operating plan	District manager National M&E manager
Environmental Services	Map water quality and access Map sanitation resources and access	District manager Surveillance officer
Knowledge & Information	Create care-delivery protocols Access research and protocols	Program manager District health officer
Infrastructure Management	Manage cold chain equipment Create facility construction plan	National EPI manager Program manager

Supply Chain Domain Conceptual Model

Supply chain is a well-defined domain as a result of extensive commercial and public-sector research and decades of practical experience. The following conceptual model in Figure 3 was introduced to enable this project to establish and maintain focus on areas of the supply chain where performance was most likely to be under the control of country leaders and managers. It was also important to focus on processes that had the highest immediate impact on improving the performance of logistics management with a more effective LMIS. Thus, as noted below, this project focused on the processes that connected the national level store to the service delivery point (SDP). It was clear that in some countries level 2 in the model below is made up of multiple, intermediate levels. The countries in the core work group (CWG) represented both scenarios, but regardless of how many intermediate levels there were, each intermediate level repeated the same processes and activities, although there may have been variations in degree of detail or resources.

Figure 3. Supply Chain Domain Conceptual Model



A Vision for Logistics Management Information Systems

Each of the domains in Figure 2 above displays a set of processes that together represent a critical building block of a health system. A key objective of this project is to validate that a common set of requirements can be extrapolated from country-specific examples which address the processes of supply chain and its needs across vaccines, pharmaceuticals and medical

supplies, necessary to any vertical health program in any country. Thus, the resulting vision for a common LMIS is intentionally broad enough to capture value across the entire health system:

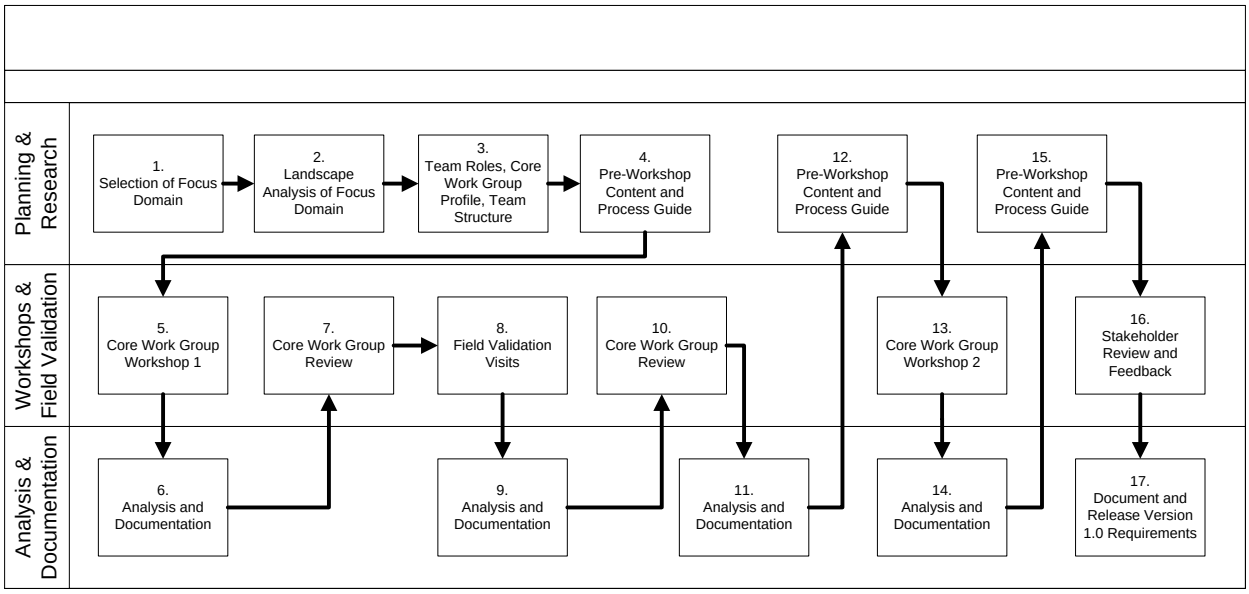
> *An effective logistics management information system (LMIS) should ensure that adequate quantity and quality of vaccines, essential medicines, and supplies are always available to meet patient demand. In order to do this, the LMIS must be able to support:*
>
> 1. *Capturing accurate routine administration, dispensing, and consumption data.*
> 2. *Real-time, end-to-end logistics management from point of origin to service delivery point.*
> 3. *Demand forecasting, capacity planning, and modeling based on consumption.*

A Methodology for Determining and Documenting Requirements

PATH completed a landscape review of experiences and methods used to inform the architecture and design of global health applications in early 2009. There was very little evidence of systematic approaches being taken for the design and development of global health applications. The notable exception is the work of the John Snow Incorporated/DELIVER project which introduced some of the core concepts of systematic software design that precede development of software applications.[8] The most promising and best-documented work that focused on a general and repeatable process for systematic design was the work of the Institute in development of the CRDM. The CRDM has been evolving through practice in public health institutions in the United States over nearly ten years. At the core of CRDM is the application of business process analysis and modeling in a richly collaborative manner with stakeholders, subject matter experts, and users. This project adapted the approach to accommodate and test the ability to create common requirements that would span multiple vertical health programs in multiple countries. The activities and flow of CRDM as adapted for this project is represented in Figure 4 below.

[8] Owens Jr., R. C., Islam A., Whitehouse M. (2006). *Guidelines for Implemening Computerized Logistics Management Information Systems (LMIS) second edition*. Arlington: John Snow, Inc./DELIVER. Pages 9-21.

Figure 4. CRDM Activities



Moreover, the figure above outlines discrete activities and their logical flow over the course of this project. As illustrated at the left side of the figure, the CRDM is composed of three main sets of activities: planning and research, workshops and field validation, and analysis and documentation.

Planning and Research

The set of activities explained in Figure 4 focused on developing a draft business process framework for the domain based on existing research and proven practice. In the case of supply chain there was a rich repository of well-documented practices and process definitions as represented in the References and Additional Resources section of this report. The core technical team developed the draft business process framework in September and October of 2009. Key to the CRDM process was the core work group which was intentionally small and composed of a blend of global and local experts, users, and stakeholders. The profile of participants was developed and individuals were invited to participate. The final activity of this stage was the preparation for the core work group meetings; this activity included finalizing meeting structures, selecting the correct facilitation techniques, and developing the agendas and participant materials.

Workshops and Field Validation

The draft business process framework for supply chain logistics developed in the planning and research phase was tested and refined through the workshop and field validation phase. The draft framework was evaluated by the core work group members during a five-day workshop. Through a facilitated process, work group members analyzed the draft framework and refined it based on their knowledge of common supply chain practices for vaccines. Next, the core work group prioritized those business processes (i.e., 1 – 6a) that were of highest priority in having the most immediate impact for achieving the LMIS vision. Then, through a series of plenary, small groups, the core work group elaborated the priority business processes, activities, and requirements. During this activity the business analysts captured and began rough documentation of the content produced by the core work group and produced a refined version of the draft business process framework for validation at the country level. In this project four countries were identified for field validation. In each country, the team visited an urban and rural setting to observe the existing business processes and activity flow for goods as they moved from the central store to each subsequent service delivery point until final delivery to a patient. The field team was composed of four people including a business analyst, supply chain expert and two technical staff who conducted one-on-one interviews and employed direct observation to refine the process mapping at each service delivery level.

The results of the field validation were analyzed and the requirements refined and then presented at the second core work group meeting. The business process models were further refined based on facilitated, plenary, and small group activities. This meeting also afforded three of the four countries the opportunity to present their reactions to the field validation and their impressions of how the outputs would be useful or could be modified to be more useful. The second core work group workshop was held at WHO in Geneva for two days to refine the requirements and explore the way participating countries have already used the requirements or plan to use them in the future. This workshop was followed by a two-day consultation with a broader group of global supply chain stakeholders (i.e., WHO/EMP, WHO/HMN, UNICEF, PFSCM, Clinton Foundation, Rwanda MOH) who joined the core work group to review the overall business process framework and the individual process models to determine their usefulness for countries outside of the core work group. In facilitated, plenary sessions, stakeholders were presented the outputs of the project and provided an opportunity to present their organizational points of view of the value and application of the requirements in their work.

Analysis and Documentation

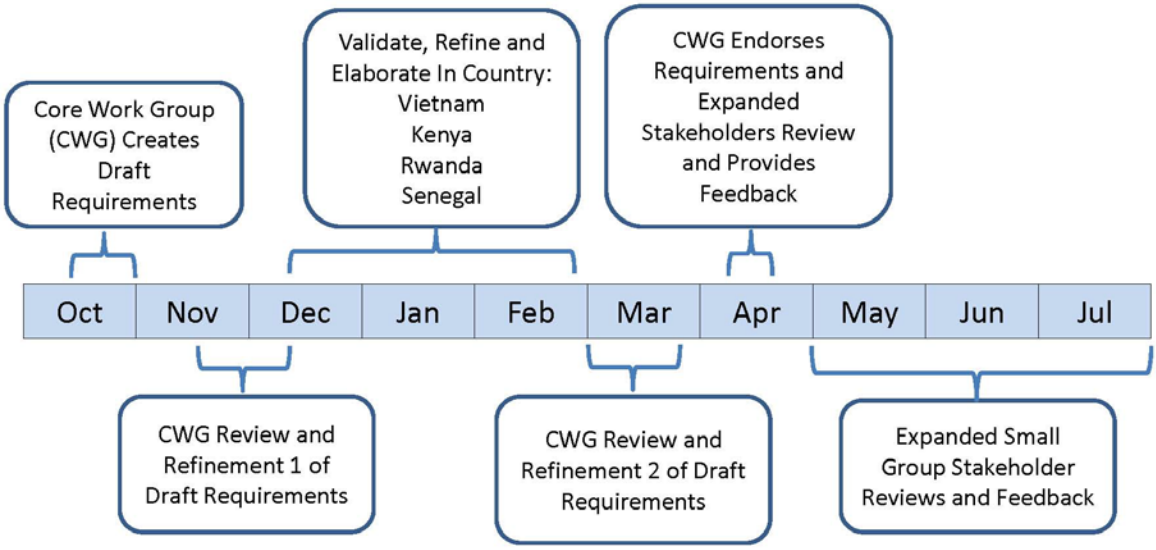
One of the keys to the effectiveness of the CRDM is having the ability to support the contributions from subject matter experts, users, and stakeholders with careful analysis of the individual business processes. A key member of the core CRDM is the business and system analyst who performs this role. This person plays an active role in research-phase collecting and also in reviewing previous efforts to determine and document processes, activities, and requirements. The analyst also plays a support role in the second set of activities above during

the workshops and field validation. This support role is to capture, analyze, and clarify the contributions from the active participants. In the analysis and documentation set of activities, the analyst plays a lead role. He or she assists in translating the outputs of the collaborative processes above into words and activity models that accurately represent the processes, activities, and user and system requirements.

A major focus of this project was to place careful attention on the functional view of user and system requirements and to explicitly avoid computer jargon and discussions of actual software and hardware solutions. In this way, this entire project focused on the "What" and "Why" descriptions of LMIS, not on the "How" or physical information technologies that may be used to implement the requirements. As a result, the analyst played a key role in using nontechnical language to represent the functional view of the system. The CRDM paid very close attention to ensuring that subject matter experts, stakeholders, and users were able to understand the terms and process models. It was the goal of the analyst to use terms contributed by participants that would also have explicit meaning to software and system engineers.

The major work of CRDM was completed between October 2009 and April 2010 with an extended phase of broader stakeholder feedback completed between April and July 2010. Figure 5 illustrates the entire timeline for CRDM as applied in this project.

Figure 5. LMIS Project Timeline, October 2009—July 2010



Business Process Framework for LMIS

This section briefly introduces the business process framework for LMIS which includes 12 business processes. The purpose of the framework is to provide sufficient detail to describe the domain as completely as possible but at a high level, as a tool to broadly communicate what is included in the domain. This section goes on to briefly describe the objective and outcome for each of the 12 business processes. Not all 12 identified business processes relevant to LMIS are described in detail, however. The CWG determined that some processes within the framework were more relevant to improving performance and moving towards the vision of a strong logistics management system. The table in Figure 6 below shows the 12 processes with the first set of 7 business processes prioritized for in-depth analysis and development of user and system requirements for this project. The order of the processes is simply a listing that was useful to the core work group and is not intended to represent the logical order in which they are performed in practice.

Figure 6. Table of Business Processes Contained in the Framework for LMIS

No.	Process	Definition Completed Pages 26-30	Requirements Completed Pages 31-42
1	Requisition	✓	✓
2	Receiving	✓	✓
3	Storage	✓	✓
4	Dispatch	✓	✓
5	Transport	✓	✓
6	Dispense-General	✓	✓
6a	Dispense-Administer Vaccine	✓	✓
7	Forecasting	✓	
8	Capacity Planning	✓	
9	Distribution Planning	✓	
10	Contracts & Grants Management	✓	
11	Procurement	✓	

There were many topics and issues that were raised in the application of CRDM to the supply chain. There were three specific issues that generated a great deal of interest and feedback from core work group members as well as stakeholders and reviewers. These three topics are (1) dispensing as an LMIS business process, (2) data management and analysis as an LMIS business process and, (3) the impact of *push* and *pull* strategies on logistics requirements. Based on the depth of these discussions it is important to provide the reader of this report some background to help with the understanding of why certain decisions were made.

The Rationale for Including the Dispensing Business Process in LMIS

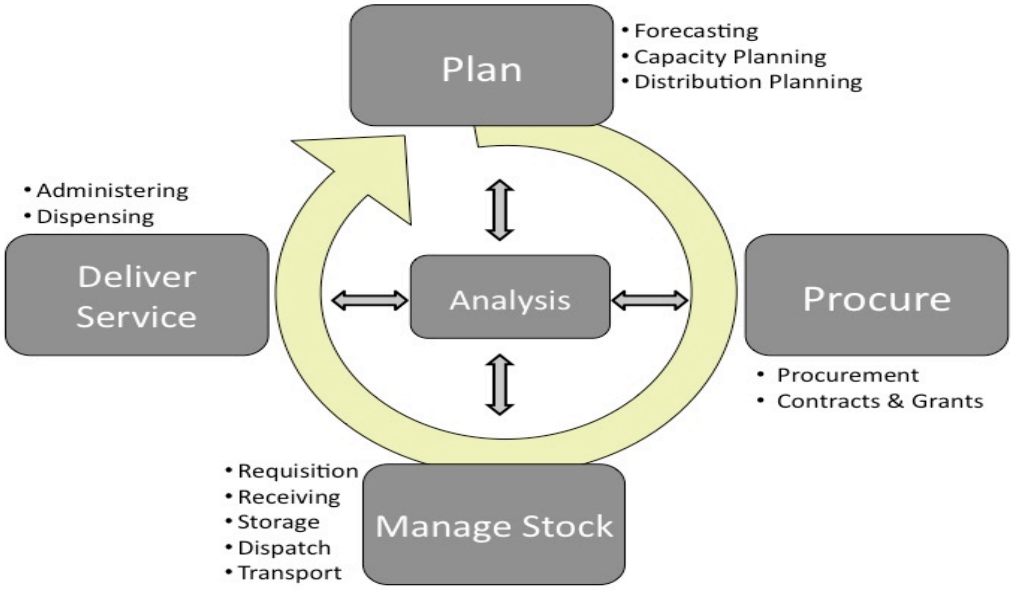
This project focused on supply chain as a discrete health system domain and specifically on logistics management as a set of in-country processes that most immediately affect availability of adequate inventory of health products. It is not possible to determine the core logistics requirements without understanding the relationship between logistics management and the generic dispensing process. Business process number 6 is a generic process for dispensing any health product and is intended only to identify those activities where logistics-sensitive data are created or needed to support the process. It is deliberately high level on those activities and sub-processes that call for further elaboration by experts, stakeholders, and users of health care services delivery.

It is expected that future application of the CRDM will elaborate user and system requirements for information systems that support the delivery of health care services. When this occurs, those health services processes will have the same need to show their relationships with logistics systems as well as other health domain systems like laboratory and national health insurance. The CWG for this project took one step towards a more elaborate version of the generic dispensing process for the administration of routine childhood vaccinations. There is tremendous demand to improve vaccine logistics in the immediate term, and it was the goal of this project to ensure vaccine logistics were thoroughly addressed. Business process number 6A is Dispense-Administer Vaccine variation and captures the next level of specific detail for vaccine-related products. This illustrates the extensibility of the business process framework for LMIS to allow for further development of more specific requirements for a particular health intervention. Experience in applying these requirements will help determine if this is necessary or if the further elaboration of specific health programs should be done in the context of the health care services delivery process with LMIS linkages determined and documented as appropriate.

The Rationale for Not Including Data Management and Analysis as a Business Process in LMIS

The CWG emphasized the critical and central role that data management and analysis played in the ability to strengthen logistics management and how it was integral to each business process. In some cases, a business process was dependent on data being available to perform an activity and in other cases a particular activity was a producer of data for other activities. This resulted in the development of the view of the business process framework model in Figure 7. While data management and analysis was not determined to be a discrete process, it was placed in the center of the framework. An effective LMIS would enable the creation, use, and analysis of data as a core function.

Figure 7. Business Process Framework for LMIS



The Impact of Push Versus Pull Systems on Requirements

Today most logistics systems are based on a push system in which the personnel who issue the supplies at the procurement unit or warehouse determine what drug quantities are to be issued to lower levels. Many countries are seeking to move to a pull system in which the personnel who receive supplies at each peripheral facility determine the drug quantities to be requisitioned from higher levels. It is likely that the transition from push to pull will include a phase where the logistics system will be a hybrid or a combination of both push and pull, where the interface between the push-based stages and the pull-based stages is known as the push–pull boundary. An example of this might look like the following: inventory levels of individual products are determined by forecasting general demand, but final fulfillment from higher levels to lower levels is in response to specific SDP orders or requisitions based on consumption.

The CRDM objective was to develop requirements that were relevant whether the country was using a push system, a pull system, or a hybrid of the two. An individual requirement will be prioritized or modified depending on the specific context for that country. If there was a bias in the wording of a requirement, it was to lean towards a pull-based system, as this is what the CWG and country validations strongly indicated as a future state they were interested in pursuing. Just as the CWG wanted the requirements to have durable value, we also wanted them to be pointed forward towards an LMIS that would meet the requirements of a pull system.

Business Processes of Logistics Management

This section briefly describes 12 business processes and associated objectives relevant to the operation of a national logistics management system. Business process 7 is actually an

elaboration of business process 6 which we have labeled as business process 6a to indicate there could be multiple elaborations of business process 6 for additional health care service interventions. We used a "book-end" approach to each process with one end being a clear statement of its objective followed by a measurable outcome that could be used to determine when the process is performed successfully. A short narrative follows to provide additional context for the process. The business process is made up of activities that are necessary to successfully complete the process. These business process descriptions, detailed below, serve as the basis for elaboration of the activities and the associated requirements in the business process requirements section that follows in the next section of this report.

Business Processes for LMIS

1. ### Requisition Business Process

   Objective: Ensure timely ordering of the right vaccine/drug/supply in the right quantity.

   Measurable outcomes: Stock levels are routinely maintained within the minimum and maximum thresholds and stock-out situations are reduced.

   This business process provides the mechanism for calculating and ordering goods for stores at intermediate and service delivery points. The process may be performed with a push or pull system. Different rules and guidelines for estimating the need for stock are used to create the requisition. Transmitted requisitions are submitted to the appropriate store and then go through a validation and approval process.

2. ### Receiving Business Process

   Objective: Receive verified quantity and quality of goods into store and determine need for remedial action when necessary.

   Measurable outcomes: Goods are accepted or rejected. Those goods that are accepted are placed into stock, and those that are rejected are stored for disposition. Records are updated with appropriate information.

   The receiving business process describes the process at all levels of the system within a country. The activities of receiving are often performed by different individuals or functional roles based on the level at which receiving is taking place, i.e., national, intermediate, or service delivery. The manner in which arriving goods will be handled will depend on the requirements of cold storage and security. Portions of the receiving process may be outsourced, such as port and customs clearance.

3. ### Storage Business Process

   Objective: Maintain chain of custody and appropriate environmental conditions for stock and inventory.

Measurable outcomes: There is an absence of waste/damage to 1%. Stock records are accurate, and detailed and inventory measures such as stock turnover and under stock situations are alerted appropriately. There is an adherence to environmental and security conditions and regulations. There is an ability to respond to requests in a timely manner.

Stock should be stored according to the manufacturer's requirements, i.e., controlled temperature and/or humidity. Chain of custody implies the monitoring of the flow of stock items within the logistics system. Monitoring both stock environment and stock movement facilitate line of sight as well as proper storage which prolongs the life of the goods. Existing warehouse management systems may provide all or part of these activities as well as linkages into the LMIS.

4. Dispatch Business Process

Objective: Identify and prepare accurate quantities of items packed correctly from store needed for transport by lower level.

Measurable outcomes: Accurate quantities of the correct items in the correct storage conditions are ready for transport.

The dispatch process is triggered by a requisition. Individual requisitions can be received from intermediate stores or service delivery locations when a "pull" system has been implemented or in the case of a "push" system can be regularly scheduled based on a previously completed distribution plan or standing orders. Allocation of stock for a requisition can depend on stock status within the store, competing needs of other stores, consumption patterns, or budgetary status. Once an order is ready to be dispatched, the transportation process is triggered.

5. Transport Business Process

Objective: Manage the movement of supplies between locations.

Measurable outcomes: Goods are delivered where they are needed in good condition and on time.

Transportation is triggered by the dispatch business process. Transportation of deliveries can be on a fixed schedule or on demand. Orders are often grouped into trips in order to efficiently and effectively utilize transportation resources. Environmental considerations per type of goods to be delivered are critical when determining transportation mode and type. The receiving business process is triggered either by notification of goods in transit or upon arrival at the receiving location.

6. Dispense Business Process: Generic

Objective: Dispense effective treatment in the correct quantity and quality to the correct client with appropriate information for proper use.

Measurable outcomes: Program goals are achieved. There is a reduction of morbidity for individuals receiving appropriate treatment.

The dispense business process is a high-level and generic process designed to cover the full spectrum of health-related products including vaccines, pharmaceuticals, and medical supplies. Certain products, such as vaccines, may have additional relevant process details and can therefore be elaborated in a separate business process task flow. Dispensing goods begins with a client encounter and a determination of which type(s) of treatment and/or goods are needed by the individual. If the treatment(s) are available and in the correct quantity and quality, they will be dispensed to the individual and the client record will be updated with appropriate information. This business process can trigger a scheduling process to inform the client of their next visit.

6a. Dispense Business Process: Administer Vaccine

Objective: Safely administer appropriate vaccine to target individuals as per schedule.

Measurable outcomes: Effective vaccination coverage is achieved. There is a reduction in the morbidity and/or mortality of vaccine-preventable disease. Adverse events following immunization due to errors are reduced. Appropriate levels of client satisfaction are achieved.

The administer business process is a more detailed elaboration of the generic dispense business process specifically for routine childhood vaccinations. The activities account for several sub-processes that take place as a result of vaccine administration such as micro-planning, treatment for adverse events, and waste disposal. Service delivery locations can include scheduled immunization sessions at health clinics, outreach to outlying areas or single visits to a health clinic. The encounter includes checks to determine which vaccinations are needed according to a schedule and a check of the client's contraindications to reduce the chance of an adverse event. Throughout the process, records can be updated with current client information and information concerning vaccines received. The administer process can trigger a scheduling process to inform the client of their next scheduled immunization.

7. Forecasting Business Process

Objective: Provide accurate estimation of goods and material needs for a specified time period.

Measurable outcomes: Appropriate stock available at all levels based on appropriate estimation methods. Reduced wastage due to oversupply. Reduced missed treatment opportunities because of a lack of available stock.

Accurate forecasting of stock needs can aid the procurement process for ordering adequate stock and securing appropriate cold chain capacity throughout the health system. Forecasting can occur at multiple levels of the system and use different methods of estimation. The most common estimation methods include target population estimation, previous consumption estimation, and estimation based on size of planned immunization sessions.

8. Capacity Planning Business Process

Objective: Plan for sufficient storage capacity for appropriate equipment and adequate supply of goods and materials based on recommended storage conditions.

Measurable outcomes: Adequate capacity for storage is available for goods and materials based on forecasted needs.

The capacity planning business process is triggered by the forecasting of needs for an appropriate period of time. Determining the storage capacity will have a significant impact on the procurement process. Based on the duration at which goods can be stored and their physical volume, the amount of space needed to store the goods can be estimated.

9. Distribution Planning Business Process

Objective: Plan for efficient and effective storage and movement of goods and materials.

Measurable outcomes: Reduced wastage due to inadequate storage conditions.

The distribution planning business process determines where goods, equipment, and materials should be stored and how they should be distributed. Resupply intervals and transportation issues are determined based on the location of stores and forecasted demand for goods. Distribution planning will also determine if the receiving store will order supply or passively receive goods, i.e., a push vs. pull system.

10. Contracts and Grants Management Business Process

Objective: To ensure a continuous supply of high-quality goods at the lowest possible price.

Measurable outcomes: Appropriate quantities of supplies that meet technical and quality requirements are available for purchase.

The contracts and grants process specifies the technical requirements of the goods required and the terms and conditions of the contract and/or grant. Critical details of the technical requirements include specification of the goods or drugs, required quality standards, packaging, price and payment terms, and dates of shipment.

11. Procurement Business Process

Objective: Procure the right goods in the right quantities at the lowest possible price while ensuring recognized standards of quality.

Measurable outcomes: Reduced stock shortages and stock-outs and achievement of the lowest total cost at each level of the health system based on purchasing schedule, quantities ordered, and safety stock levels.

Procurement is the process of acquiring supplies from private or public suppliers through purchases from manufacturers, distributors, bilateral aid programs, or other agencies. Procurement can occur under several different models including annual purchasing, perpetual purchasing, or scheduled purchasing. These models can be used in combination at different levels of the health system.

User and Systems Requirements Supporting Business Processes

This section details functional user and system requirements for business processes 1, 2, 3, 4, 5, 6, and 6a as described above. Functional user requirements are the statements that describe what an information system needs to do to support the tasks or activities that make up the business process. These requirements are things that a user will see and use and answer the question, "What needs to happen to support the user to complete a work activity?" For the seven business processes for which requirements were developed, there are a total of 59 activities and a total of 149 functional requirements. These requirements, detailed below, are organized under each business process and associated with each of the 59 activities they support. Not all listed activities within the business process have associated requirements. By showing activities that do not have associated requirements, we capture the complete logical flow of work which will be useful in the subsequent step when translating functional requirements into technical specifications. Creating these technical specifications will then be the work of software engineers, not part of the CRDM. Each of the business processes are illustrated in a task flow model showing the logical work flow in Appendix C.

This section also includes general system requirements which are not associated with a specific activity or business process but rather are requirements that impact the entire system. General system requirements differ from functional user requirements in another important aspect. These requirements most often are not visible to the end user but are essential for the system to be able to perform and support the functionality a user does see and use. These 59 requirements, detailed below, are organized into six categories. These requirements and categories were not derived in

one specific exercise with CRDM but instead were derived by the core technical team as a result of data collected throughout the entire CRDM project. In some cases these requirements were informed by contributions from the technical advisors and stakeholder reviewers.

Figure 8 provides a legend for the numbering schema. The numbering schema was created specifically for this project and is intended as a reference example that could inform a shared and standard model for a repository of requirements for multiple health system domains.

Figure 8. Numbering Schema for User and System Requirements

Functional and User Requirements	
Reference #	Description
1	Business Process
1.1	Activity
1.1.1.	Requirement
1.1.1.1	Alternative or More Specific Requirement
General System Requirements	
Reference #	Description
99.1	Category
99.1.1	Requirement

Functional User Requirements

1. Requisition Business Process

1.1 Estimate Need

1.1.1 Estimate stock needs according to defined rules

1.1.1.1 Based on past consumption data

1.1.1.2 Based on minimum quantity threshold

1.1.1.3 Based on patient records/registry data

1.1.1.4 Based on aggregating requisitions by intermediate levels

1.1.1.5 Based on target populations

1.1.2 Enable flexible order point based on user-defined criteria

1.1.3 Display past consumption data

1.2 Determine Current/Projected Quantities Available

1.2.1 Display current available and usable on-hand quantity of each stock item

1.2.2 Display open order in transit inbound

1.2.3 Display open outbound orders and projected usage

1.2.4 Display current stock levels at all relevant levels

1.2.5 Display expiry dates for on-hand stock

1.3 Decision Point–Commodities Required?

1.4 Issue Requisition

1.4.1 Generate requisition based on need

1.4.2 Display lead time for order fulfillment

1.4.3 Validate order by the originator

1.4.4 Display item cost at time requisition is generated

1.4.5 Calculate order cost at time requisition is generated

1.4.6 Display minimum quantity order increments

1.5 Transmit Requisition

1.5.1 Print the requisition

1.5.2 Submit requisition

1.5.3 Monitor/inquire/maintain order status, approval status, and shipping status

1.6 Validate Requisition

1.6.1 Provide approval/rejection mechanism at appropriate levels

1.6.2 Modify the requisition, if needed

1.6.3 Record requisition approval date

2. Receiving Business Process

2.1 Notification of Arrival

2.1.1 Accept notification of arrival of shipment

2.1.2 Record shipment information prior to arrival

2.2 Decision Point–Order Correct?

2.3 Corrective Action[9]

2.3.1 Flag shipment as incorrect if difference exists between notified quantities and order quantities

[9] This activity is a subprocess which actually represents much more detail and activities that are not elaborated above.

2.3.2 Notify appropriate parties of discrepancies

2.3.3 Initiate backorder as appropriate

2.3.4 Reject order, if necessary

2.4 Prepare Storage Space

2.4.1 Display the storage requirements based on quantity shipped gross volume

2.4.2 Display amount of storage space available by type

2.4.3 Flag if insufficient storage space by type

2.5 Arrive at Warehouse

2.5.1 Provide details of the shipment to store manager

2.6 Inspect Shipment

2.6.1 Record shipment information

2.6.2 Link shipment information to purchase order and arrival notification

2.6.3 Flag discrepancies compared to the shipment received

2.6.4 Record damage, discrepancy, batch mismatch, indicator, and variation information for individual line items

2.6.5 Record notes concerning discrepancies and variations in goods received

2.7 Decision Point – Damage/Discrepancy?

2.8 Corrective Action (subprocess, see footnote 9)

2.8.1 Report damages and discrepancies to appropriate individuals

2.8.2 Reject order, if necessary

2.9 Record Receipt

2.9.1 Create receiving report

2.9.2 Record authorization of receipt by appropriate individuals

2.9.3 Receive goods without a requisition/purchase order reference

2.10 Place into Stock

2.10.1 Display storage requirements for items

2.10.2 Propose space/positions for each stock item

2.10.3 Print pallet/shelf tag specifying status of goods, if appropriate

2.10.4 Create/update bin card per item

2.11 Release to Stock

2.11.1 Update stock records with quantity received per lot, expiry date, VVM record, etc.

3. Storage Business Process

3.1 Move Stock to Allocated Position

3.2 Monitor Stock Environment

3.2.1 Display storage requirements

3.2.2 Record temperature

3.2.3 Record VVM status

3.2.4 Record frozen conditions status

3.2.5 Set threshold conditions per product, as appropriate

3.2.6 Alert conditions outside threshold

3.3 Monitor Stock Movement and Expiry

3.3.1 Track lots and expiry dates

3.3.2 Generate physical inventory count sheets

3.3.3 Assign location based on product condition

3.3.4 Define pending expiry

3.3.5 Display and transmit alerts and notifications for pending expiries

3.3.6 Display and transmit alerts and notifications for stock outs, overstock, understock

3.3.7 Define multiple inventory storage locations (Aisle, Bin, Slot, etc.)

3.3.8 Record warehouse-to-warehouse transfers

3.3.9 Flag items as hazardous, as appropriate

3.4 Update Records

3.4.1 Update stock record, as needed

3.4.2 Record stock adjustments

4. Dispatch Business Process

4.1 Process Incoming Requisition

4.1.1 Receive a stock requisition and/or act on a dispatch plan

4.1.2 Validate the requisition/dispatch plan

4.1.3 Route the requisition to the appropriate warehouse/store

4.1.4 Group requisitions into trips

4.1.5 Verify that requestor is authorized, if appropriate

4.1.6 Verify credit worthiness of requestor, if appropriate

4.1.7 Enable backorder for unfulfilled items

4.1.8 Link equivalent items, as needed

4.2 Allocate Stock

4.2.1 Display requisition history

4.2.2 Display current usable stock on hand for requisitioned items by batch

4.2.3 Recommend appropriate batch to pick from stock

4.2.4 Set parameters for allocation, as appropriate

4.3 Create Pick List

4.3.1 Display current location(s) for requisitioned items

4.3.2 Create pick List sorted by stock location

4.3.3 Display stock expiry date

4.3.4 Record VVM status

4.4 Pick From Stock Location

4.4.1 Update bin card

4.4.2 Record stock adjustments if pick List includes damaged/lost/missing stocks

4.4.3 Modify pick-list, as appropriate

4.5 Update Bin Card

4.6 Pack Order

4.6.1 Display handling instructions

4.6.2 Display availability of appropriate packing and transportation materials and monitoring devices

4.6.3 Provide instructions for packaging goods, e.g., vaccines syringes, safety boxes, diluents

4.6.4 Group orders by location and trip to facilitate delivery

4.7 Document for Delivery

4.7.1 Create shipping documents to include invoice and goods received note (GRN)

4.8 Record Dispatch

4.8.1 Record stock issues/update quantity on hand

4.8.2 Create transport order

5. Transport Business Process

5.1 Determine Payload, Volume, and Dimensions

5.1.1 Estimate weight and dimensions of packaging

5.1.2 Modify dimensions and weight of packaging

5.2 Select Transportation Mode and Type

5.2.1 Display available transport modes and type

5.2.2 Determine temperature control requirements

5.3 Notification of Dispatch

5.3.1 Include in notification order detail, tracking number, vehicle, driver

5.4 Transport Order

5.4.1 Receive transport order

5.4.2 Schedule transport resources

5.4.3 Display delivery instructions

5.4.4 Track location and update ETA

5.5 Deliver

5.5.1 Record transport history

5.6 Obtain Arrival Report

5.6.1 Print arrival report

5.7 Update Dispatch Records

5.7.1 Update dispatch record

5.7.2 Update stock records

6. Dispense Business Process (Generic)

6.1 Encounter

6.1.1 Retrieve client record

6.1.2 Record registration and screening information

6.1.3 Display vaccination history of the client

6.1.4 Display dispensing/service received history of the client

6.2 Consult and Diagnose (subprocess, see footnote 9)

- 6.2.1 Show availability of current and future quantity of product
- 6.2.2 Display relevant cost of product
- 6.2.3 Record consultation comments
- 6.2.4 Advise options available
- 6.2.5 Record client selected method
- 6.2.6 Transmit client chosen method dispensary/dispenser
- 6.2.7 Provide information on potential contraindications

6.3 Decision Point – Treatment Available?

6.4 Referral (subprocess, see footnote 9)

- 6.4.1 Capture reason for treatment not available, e.g., stock-outs

6.5 Dispense (subprocess, see footnote 9)

- 6.5.1 Receive prescription/order
- 6.5.2 Dispense/administer the device/products
- 6.5.3 Capture reason for non delivery of service, e.g., refusal, temporary/permanent contraindication, stock-out, etc.

6.6 Update Record

- 6.6.1 Record information on stock register
- 6.6.2 Update client record
- 6.6.3 Alert potential device/product shortages
- 6.6.4 Record lot information on stock register and/or client record
- 6.6.5 Record administered or dispensed device/product information

6.7 Inform Next Visit

- 6.7.1 Record appointment
- 6.7.2 Schedule and record follow-up appointment

6a. Dispense Business Process (Administer Vaccine Alternative)

6a.1 Micro Planning (subprocess, see footnote 9)

- 6a.1.1 Identify target population for the period
- 6a.1.2 Create a list of the expected target population for the period
- 6a.1.3 Capture new births and target populations

6a.1.4 Support session planning

6a.1.5 Recommend date, time, and place

6a.1.6 Communicate to target population

6a.2 Encounter

6a.2.1 Retrieve client record

6a.3 Decision Point – Vaccination Status Complete?

6a.4 Create/Update Record

6a.4.1 Create/update client record

6a.4.2 Record/create a unique identifier for each client

6a.5 Check Contraindications

6a.5.1 Display past contraindication information for the client

6a.5.2 Enter contraindication information

6a.5.3 Flag which vaccinations are contraindicated for the client

6a.6 Determine Required Dose(s)

6a6.1 Display the vaccination history of the client

6a.6.2 Display all doses needed for the client by antigen at the time of visit

6a.7 Decision Point – Vaccine Available?

6a.8 Record Appointment for Next Visit

6a.8.1 Record need for antigen that is not available

6a.8.2 Trigger the scheduling process for the client

6a.9 Prepare Vaccine

6a.10 Administer

6a.11 Dispose of Waste (subprocess, see footnote 9)

6a.12 Update Record

6a.12.1 Record lot information

6a.12.2 Record administered vaccine information

6a.12.3 Schedule and record follow-up for client

6a.13 Monitor Client

6a.14 Decision Point – Adverse Reaction?

6a.15 Treat as Appropriate (subprocess, see footnote 9)

6a.15.1 Record adverse event

6a.16 Inform Next Visit

6a.16.1 Display next appointment

6a.16.2 Print client appointment reminder

General System Requirements

There are a number of general requirements that are not business process specific but are important from the perspective of overall system functioning. These requirements describe system capabilities that are necessary to support an LMIS. The numbering schema jumps from the business process order of 1, 2, etc. to 99 to clearly separate them from the functional user requirements that precede them. This list of requirements is not meant to be exhaustive but reflects what was captured in this project. It is highly likely and in fact desirable for a robust list of general system requirements to be developed that are applicable to other systems that a country might deploy like electronic medical record management systems or human resource management systems.

99.1 General Characteristics

99.1.1 Be described in terms of the total cost of ownership including all upfront and recurring costs

99.1.2 Be described in terms of all necessary hardware, software, and networking components for implementation over the life of the LMIS

99.1.3 Provide a stable and highly available environment

99.1.4 Use industry standard user interface practices and apply them in a consistent manner throughout the system

99.1.5 Provide access to on-line help

99.1.6 Allow printing of forms, tables, data fields, screen shots

99.1.7 Provide access to technical support for the application functions and technical system performance and management

99.2 Management

99.2.1 Maintain transaction log history

99.2.2 Enable configuration by role of rights to enter data

99.2.3 Enable item master updating by local system administrators

99.2.4 Enable system administration by local staff

99.2.5 Document the software development life cycle (SDLC) including bug and issue tracking and resolution

99.2.6 Provide software updates and schedule of future releases and lists of new, changed, and dropped features

99.2.7 Provide a unique version number for each revision

99.2.8 Enable the system to detect incompatible versions of software running on different components

99.2.9 Enable customization to any national and subnational administrative structure or number of levels

99.2.10 Provide means to add additional languages, currencies, and calendars

99.3 Operations

99.3.1 Enable earlier versions of a record to be recoverable

99.3.2 Back up data so that it is recoverable in the event of a system or hardware failure

99.3.3 Support synchronous and asynchronous updates

99.3.4 Accommodate loss of connectivity to components

99.3.5 Be deadlock free, described as a situation where two or more competing actions are each waiting for the other to finish, and thus neither ever does

99.3.6 Enable access to the central system from all levels of the health system

99.3.7 Provide real-time response to transactions submitted by connected devices up to the configured national volume level

99.3.8 Enable deployment in an environment subject to power loss

99.3.9 Enable deployment in an environment subject to loss of connectivity

99.3.10 Allow for client devices with low bandwidth or irregular connectivity

99.4 Security

99.4.1 Support definitions of unlimited roles and assigned levels of access, viewing, entry, editing, and auditing

99.4.2 Require each user to authenticate by role before gaining access to system

99.4.3 Provide flexible password control to align to national policy and standard operating procedure

99.4.4 Protect system servers with an internet firewall

99.4.5 Be secured against viruses and malware

99.4.6 Be kept up to date on security updates

99.4.7 Provide a report of a current source code audit against security threats

99.4.8 Provide encrypted communication between components

99.5 Technical Design

99.5.1 Exchange data with other approved systems

99.5.2 Enable a task to be canceled and rolled back to previous state

99.5.3 Generate unique record number(s) i.e., for requisitions

99.5.4 Allow for conversion of different currencies to a standard currency at the prevailing exchange rate

99.5.5 Provide access from internet-enabled devices

99.5.6 Support a range of data entry devices and form factors

99.5.7 Enable electronic data interchange (EDI)

99.5.8 Display item master appropriate for each corresponding administrative level

99.5.9 Carefully describe and document the terms of the software development life cycle

99.5.10 Have the ability to access the system at all levels/stores

99.5.11 Accept data from multiple input methods including paper, online web forms, PC asynchronously, PC synchronously, interactive voice response, bar code, RFID

99.5.12 Log transactions at time of data entry

99.5.13 Provide asynchronous and synchronous data synchronization

99.5.14 Provide a search interface

99.5.15 Enable flexible search criteria for accessing transactions by any data element including item number, requisition, vendor, date, location, status, etc.

99.5.16 Support real time data entry validation and feedback to prevent data entry errors from being recorded

99.5.17 Provide appropriate calculations at time of data entry

99.5.18 Provide atomic updating of a record. Atomicity prevents updates to the database occurring only partially, which can cause greater problems than rejecting the whole series outright.

99.5.19 Enable a task to be interrupted and resumed

99.6 Reporting

99.6.1 Provide an interface to a third-party report-generation tool

99.6.2 Generate stock status for individual items at any and/or all levels for any time period

99.6.3 Generate stock consumption report at any and/or all levels for any time period

99.6.4 Generate coverage reports for any product or combination of products

99.6.5 Generate requisition activity reports for any open, modified, and cancelled requisitions for any level, location, and time period

How to Apply Requirements at a Practical Level

This document is designed to be both a road map and a tool. It serves as a road map for helping ministries of health (MOH) move toward the vision of an effective LMIS as expressed in this document. At the same time, it is a tool for structuring specific implementation projects, informing vendor requests for proposals (RFPs), self assessing existing LMIS capabilities, and providing a methodology that is repeatable in other health system domains. It does not provide the technical specifications for an information system that are often used for designing and writing software applications. MOHs are encouraged to customize or adapt this document to meet local needs. They can modify the business process sections by adding specific or unique requirements and deleting business processes not under their jurisdiction.

Other health system domains that involve operational processes normally supported by separate information systems, such as human resources, finance and general accounting, or laboratory are not included in these requirements. The requirements have been organized to provide a general and functional description for the reader of an LMIS from a “macro view” to a “micro view view.” Country- or project-specific requirements and technical specifications need to be determined and documented within the context of a specific country-based LMIS project. These common requirements provide a starting point to support this work. In some cases, open source development projects and commercial off-the-shelf (COTS) suppliers will develop such technical specifications with the intent of producing a general product for the market. This approach often allows for country- or project-specific adaptations or customizations to meet specific needs.

There are four specific examples of where the application of the requirements and the CRDM can add value to countries, donors, technical agencies, and software developers:

1. Prepare a request for proposal

For project teams that have identified the need to implement an information system to support logistical processes, the LMIS documentation provides both a framework that will allow the proper scoping of the project and a checklist that can be used when drafting terms of reference or an RFP. First, it will allow the team to “zoom in” on what they want to do (functional scope). It will also allow the team to ask essential questions, for example: “Will the solution support advanced storage capabilities as one would expect from a warehouse management system, or

will it focus more on demand estimation and distribution planning?" Once the scope is clear, essential questions are: "What are the requirements that will be relevant at the various levels of the organization?" "Are there any requirements that are essential to address while others would be nice to have but not essential?" The list of requirements provides a good head start in this prioritization process.

2. Evaluate alternative solutions

Sometimes managers will be in a position where they have many alternatives and need to choose a system that best matches the complex and diverse organizational needs. This is often a tricky process in which different parts of the organization may prefer different solutions. Not every software package will be equally strong across all requirements. The list of requirements may in this case be used to score different systems against a list of weighted and prioritized requirements based on country or team preferences, making the discussion more transparent and structured.

3. Conduct landscape analysis

Even a seemingly narrow field like LMIS may actually cover many different kinds of systems. Some logistics systems are in actuality more focused on warehouse management functions, while others could be characterized as supply chain planning, or enterprise resource planning (ERP) systems. Nongovernmental organizations (NGOs), technical agencies, and donors can use these requirements to conduct further analysis of currently available LMIS systems (including commercial, publicly funded, and open source), and the requirements will provide an objective comparison to help with the mapping of system capabilities and the completeness of solutions evaluated.

4. Apply CRDM in country projects

CRDM is a generic process and can be used to identify, discuss, reach agreement on, and document any business process and its related requirements systematically. The main LMIS processes and requirements were already mapped in this document in a way that should be as generic as possible, but even then there may be value to be had in the analytical and consensus-building aspect of the exercise itself at a country or project level. Furthermore, not all requirements may be equally important or even relevant in every context, so as a minimum, national or local users of this methodology should validate the content of processes and requirements in their specific context.

Conclusions

Health systems that perform well deliver better health outcomes, and health information systems are increasingly seen as a critical enabler to enhancing performance. This project had two objectives: contribute to the development of a global eHealth architecture by developing a methodology for determining and documenting requirements and then apply the methodology in

supply chain. This document described the methodology called the CRDM and contains the requirements that were produced through the application of it.

The CRDM was effective in generating requirements that spanned multiple vertical programs and multiple countries. It demonstrated that while programs and countries are indeed different in many ways, when carefully examining the work of handling pharmaceuticals, vaccines, and medical supplies, there is a great deal more common and shared process than unique. This is a critical insight, as this sets the stage for health information systems to be informed by common requirements. Common requirements can help strengthen health information systems to:

1. Enable countries to save time and money and reduce the risk of software development projects by reusing common requirements vetted by others.
2. Enable developers of solutions to create software that is useful across programs and countries.
3. Enable donors to focus resources on health information system development projects that can be used across projects, countries, and programs.

CRDM was designed as a general, adaptable, and repeatable methodology that can be applied to other health system domains at the global level and country level. At the country level, applying CRDM can be completed in far less time since travel and participant scheduling is dramatically simpler. One of the key benefits of CRDM is the ability for diverse participants and points of view to be brought together and consensus to be achieved. This is as beneficial at the country level for harmonizing diverse donors and programs across the health system as it is to establish common reusable requirements at the global level.

Next steps for this body of work fall into four areas:

1. Develop country-specific solutions. These common requirements can be adapted and extended to create solutions in a specific country using local solution developers.
2. Develop global reusable solutions. These common requirements can also be adapted and extended to create global solutions that can be offered to countries as a reusable building block as either COTS or open source products.
3. Refine and improve CRDM as mainstream global health informatics methodology. This body of work provides a first version of a methodology and documentation standard. As with any first version of a tool or approach, there are likely to be many ways it can be refined, adapted, and improved. There is a need for a global repository of methods and their artifacts that can be available as public goods for countries, solution developers, and donors to be reused in future projects.
4. Apply CRDM to a minimum set of health system domains. Strengthening the performance of logistics systems is necessary but not sufficient to strengthen the health system. Developing requirements in primary care services, facility-based services,

laboratory services, human resources, or national health insurance would provide a strong core foundation upon which countries could build their national health information systems. A CRDM *requirements factory* type of approach could be applied to rapidly, consistently, and efficiently determine and document requirements to support a core health information system platform.

References and Additional Resources

Ambler SW. *Agile Modeling: Effective Practices for eXtreme Programming and the Unified Process.* New York, NY: John Wiley & Sons, Inc.; 2002.

Bate R. *Rolling Back Malaria: Rhetoric and Reality in the Fight Against a Deadly Killer*. Washington, DC: American Enterprise Institute for Public Policy Research; 2008.

Center for Global Development. *A risky business: Saving money and improving global health through better demand forecasts, The report of the Center for Global Development*, Global Health Forecasting Working Group; Washington DC: Center for Global Development; 2007.

Constantine B, Ruwadi BD, Wine J. Management practices that drive supply chain success. *The McKinsey Quarterly.*2009;1–4.

Foster S, Laing R, Melgaard B, Zaffran M. Ensuring supplies of appropriate drugs and vaccines. In: Jamison DT, Bremen JG, Measham AR, et al., eds. *Disease Control Priorities in Developing Countries, second edition*. New York: Oxford University Press; 2006: 1323–1327.

Gottesdiener E. *Requirements by Collaboration.* Boston, MA: Addison-Wesley; 2002.

Health Metrics Network. *Framework and Standards for Country Health Information Systems, second edition*. Geneva: World Health Organization; 2008.

Huff-Rousselle M, Raja S. *Ghana: Estimating the Cost of Logistics in the Ministry of Health Supply System*. Arlington, VA: Family Planning Logistics Management (FPLM)/John Snow, Inc., for the US Agency for International Development; 2002.

Karim AM, Bieze B, Chimna J. *Measuring family planning logistics system performance in developing countries: Working paper*. Arlington: US Agency for International Development/DELIVER; 2008.

Lai F, Li D, Wnag Q, Zhao X. The information technology capability of third-party logistics providers: A resource-based view and empirical evidence from China. *Journal of Supply Chain Management.* 2008;44(3):22–38.

Larman C. *Agile & Iterative Development: A Manager's Guide*. Boston, MA: Addison-Wesley. 2008.

Larman C. *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development*. Third Edition. Upper Saddle River, NJ: Prentice Hall PTR. 2005.

Li L. *Supply Chain Management: Concepts, Techniques and Practices Enhancing the Value Through Collaboration*. Singapore: World Scientific Publishing Co.; 2007.

Light, Matt. The first key to project success is collaborative requirements definition and management. *Gartner Research.* 2008; August 11:1–9.

Management Sciences for Health Inc. *Managing Drug Supply: The Selection, Procurement, Distribution, and Use of Pharamaceuticals, second edtion, revised and expanded*. West Hartford: Kumarian Press, Inc.;1997.

Mechael P, Sloninsky D. *Towards the Development of an mHealth Strategy: A Literature Review*. New York, NY: The Earth Institute, Columbia University; August 2008. Available at: http://mobileactive.org/files/file_uploads/WHOHealthReviewUpdatedAug222008_TEXT.pdf. Accessed June 4, 2010.

Mills A, Rasheed F, Tollman S. Strengthening health systems. In: Jamison DT, Bremen JG, Measham AR, et al., eds. *Disease Control Priorities in Developing Countries, second edition.* New York: Oxford University Press; 2006: 87–102.

Nelson DP, Adams IC. *A Guide to Improving Drug Management in Decentralized Health Systems: The Monitoring-Training-Planning Guide for Program Implementation*. Arlington, VA: Management Sciences for Health, Inc.; 2000.

Owens Jr. R C, Islam A, Whitehouse M. *Guidelines for Implemening Computerized Logistics Management Information Systems (LMIS), second edition*. Arlington: John Snow, Inc./DELIVER; 2006.

Owens Jr. RC, Warner T. *Concepts of Logistics System Design*. Arlington, VA: John Snow, Inc./DELIVER; 2003.

Raja S, Mohammad N. *National HIV/AIDS Programs: A Handbook on Supply Chain Management for HIV/AIDS Medical Commodities*. Washington DC: The World Bank; 2005.

Schlotzer A and Madsen M. Health Information Systems: Requirements and Characteristics. In: Hovenga EJS, et al. eds. *Health Informatics.* IOS Press 2010, pp.156–166.

The Open Group Architecture Framework (TOGAF). *TOGAF Version 9, Enterprise Edition.* February 2009. www.opengroup.org/. Accessed June 4, 2010.

US Agency for International Development. *Immunization Essentials: A Practical Field Guide*. Washington DC: US Agency for International Development; 2003.

US Agency for International Development. *The Logistics Handbook: A Practical Guide for Supply Chain Managers in Family Planning and Health Programs.* Arlington, VA: US Agency for International Development/DELIVER; 2007.

US Agency for International Development. *Cold Chain and Logistics Management: An Essential Part of Safe and Effective Vaccination Programs*. Washington DC: US Agency for International Development; 2008.

US Agency for International Development. *Guidelines for Managing the Laboratory Supply Chain: Version 2*. Arlington: US Agency for International Development/DELIVER; 2008b.

World Health Organization. *The Common Assessment Tool for Immunization Services*. Geneva: World Health Organization; 2002.

World Health Organization. *Procurement of Vaccines for Public-Sector Programmes*. Geneva: World Health Organization; 2003.

World Health Organization. *Developing Health Management Information Systems: A Practical Guide for Developing Countries*. Geneva: World Health Organization; 2004.

World Health Organization. *The Health Metrics Network Framework, 2nd ed.* January 2008. http://www.who.int/healthmetrics/en/. Accessed May 26, 2010.

World Health Organization. Annex 9: Guide to good storage practices for pharmaceuticals. In: *WHO Expert Committee on Specifications for Pharmaceutical Preparations*. Geneva: World Health Organization; 2004. Available at: http://whqlibdoc.who.int/trs/WHO_TRS_908.pdf#page=135. Accessed June 17, 2010.

Appendix A: Glossary of Business Process and Systems Engineering Terms

Activity. A generic term for the work that is performed in the business process. The types of activities are tasks and subprocesses.

Artifact. The general term for any work product including text documents, diagrams, models, database schema, web graphics, software code, and so on.

Automating. Attempting to reduce an existing manual job to a set of computer programs that can replace the existing manual effort with a minimum of human effort or understanding.

Best practice. A technique or methodology that, through experience and research, has shown to reliably lead to a desired result.

Business practice. Habitual or customary actions or acts in which an organization engages. Also used in the plural to describe a set of business operations that are routinely followed.

Business process. A set of related work tasks or activities designed to produce a specific desired programmatic (business) result. The process can involve multiple parties internal or external to the organization and frequently cuts across organization boundaries.

Business process analysis. The effort to understand an organization and its purpose while identifying the activities, participants, and information flows that enable the organization to do its work. The output of the business process analysis phase is a model of the business processes consisting of a set of diagrams and textual descriptions to be used for design or redesign of business processes.

Business process redesign. The effort to improve the performance of an organization's business processes and increase customer satisfaction. Business process redesign seeks to restructure tasks and workflow to be more effective and more efficient.

Business rules. A set of statements that define or constrain some aspect of the business process. Business rules are intended to assert business structure or to control or influence the behavior of the health agency (business).

Context. Organizational groupings or entities involved in the business process and how they relate to one another to achieve the goals and objectives of the process.

Critical task. An action or set of actions that adds an identifiable value to a given business process objective.

Customer. Groups or individuals who have a business relationship with the organization—those who receive and use or are directly affected by the services of the organization. Customers include direct recipients of treatment and services and are sometimes referred to as clients or patients.

Entity. A person or a group of people who performs one or more tasks involved in a process. The entities are the participants in the process. Entities are represented in context diagrams.

Framework. A defined support structure in which other components can be organized and developed. A logical structure for classifying and organizing complex information. A system of rules, ideas, or principles that provides a unified view of the needs and functionality of a particular service.

Goal. The major health goal that the business process supports. The goal is the end state to be achieved by the work of the health agency and should be defined in terms of the benefits provided to the community/population or individual/client.

Information system. A tool that supports work.

Input(s). Information received by the business process from external sources. Inputs are not generated within the process.

Logical design. Logical design describes textually and graphically how an information system must be structured to support the requirements. Logical design is the final step in the process prior to physical design, and the products provide guidelines from which the programmer can work.

Objective. A concrete statement describing what the business process seeks to achieve. The objective should be specific to the process such that one can evaluate the process or reengineer the process and understand how the process is performing towards achieving the specific objective. A well-worded objective will be SMART (Specific, Measurable, Attainable/Achievable, Realistic and Time-bound).

Operation. A task series that completes a transaction.

Outcome. The resulting transaction of a business process that indicates the objective has been met. Producing or delivering the outcome satisfies the stakeholder of the first event that triggered the business process. Often, measures can be associated with the outcome (e.g., how much, how often, decrease in incidents, etc.). An outcome can be, but is not necessarily, an output of the process.

Output(s). Information transferred out from a process. The information may have been the resulting transformation of an input, or it may have been information created within the business process.

Result. A task output that may be used in one of three ways: (a) as an input to the next sequential step, (b) as an input to a downstream step within a task series; or (c) as the achievement of an organizational objective.

Requirements. The specific things the information system must do to make the process efficient and achieve its purpose.

Requirements definition. The purpose of a requirements definition is to refine our understanding of the workflow and then to define database outputs needed to support that work. The requirements definition serves to specifically define the functionality to be supported. In addition, the physical constraints are examined and the specific project scope determined. The requirements definition answers the question, "How would an information system support the performance of activity X?"

Requirements development methodology. A logical, step-wise approach to think through the tasks that are performed to meet the specific public health objectives (analyze business processes), rethink the tasks to increase effectiveness and efficiency (redesign business processes), and describe what the information system must do to support those tasks (define system requirements).

Stakeholder. A person, group, or business unit that has a share or an interest in a particular activity or set of activities.

Subprocess. A process that is included within another business process.

Task. A definable piece of "work" that can be done at one time; i.e., what happens between the "in-box" and the "out-box" on someone's desk. A business process is made up of a series of work tasks. The term task is often interchangeable with activity.

Task flow diagram. Graphical description of tasks showing inputs, processes, and results for each step that makes up a task. Often interchangeable with activity model or activity diagram.

Transaction. Information exchanges between entities. May also be the exchange of goods (e.g., a vaccine or payment) or services (e.g., an inspection) between two entities. Transactions are represented by arrows in context diagrams.

Trigger. Event, action, or state that initiates the first course of action in a business process. A trigger may also be an input, but not necessarily so.

Unified modeling language. A visual language for specifying, constructing, and documenting the artifacts of systems.

Use case. A description of system behavior in terms of sequences of actions. A use case should yield an observable result of value to an actor. A use case can be described in a wide spectrum of detail from very brief to very extensive, technical, and detailed. It may also contain a set of alternate flows of events related to producing the "observable result of value."

Appendix B: Glossary of Supply Chain Terms

Establishing a common domain-specific vocabulary for use in determining and documenting user and system requirements is an essential part of the process. This glossary should be developed in the research phase of the CRDM and then validated throughout the process. Any compilation of terms should intentionally be informed by previous efforts. In this case many of the terms below have been drawn from the extensive supply chain work of John Snow Incorporated (JSI), Management Sciences for Health (MSH), United States Agency for International Development (USAID) and GS1 as noted in the references and additional resources section of this report

Adjustments. Changes recorded when quantities of a product are issued to or received from other facilities at the same level of the pipeline. Also, sometimes used to explain administrative corrections—e.g., a physical stock count that is different from quantity listed on stock-keeping records.

Aggregate summary report. A summary report that combines data from different facilities at the same level or may combine data from different levels.

Bin card. A stock-keeping record that keeps information about a single lot of a single product.

Clients. People who receive supplies. Used interchangeably with customers, patients, and users.

Commodities. Used interchangeably with stock, goods, products, supplies, and other terms to refer to all the items that flow through a logistics system.

Consumption records. Records kept on products consumed. See also daily activity register.

Customers. People who receive supplies. Used interchangeably with users and clients.

Daily activity register. Record that gives the quantity of each product dispensed to a user by user name or user number and by date. Used only at service delivery points, such as clinics, hospitals, or community-based distributors. See also consumption records.

Demographic data. Information on populations, such as the number of a target population to be served. Usually collected through surveys and censuses.

Dispensed-to-user data. Information on the quantity of products actually given to customers. Sometimes referred to simply as dispensed or consumption data.

Distribution system capacity forecast. Forecast that measures the volume of the pipeline (i.e., storage facilities and transportation resources) to determine the volume of supplies that can be moved and stored in the system.

Effectiveness. The extent to which an intervention achieves its intended effect in a real work setting.

Emergency order point. The level of stock that triggers an emergency order, regardless of the timing within the review period. It is always lower than the minimum stock level.

Essential data items. These include stock on hand, stock on order, consumption, and losses and adjustments.

Feedback report. A report that (a) informs lower levels about their performance, in some cases providing additional information about reporting from other facilities; and (b) informs managers at higher levels about how the system is functioning.

Forecasting. Management function that estimates the quantities of products a program will dispense to users for a specific period of time in the future.

Global location number. The globally unique GS1 Identification Key for Locations. The GLN can be used to identify physical locations and legal entities where there is a need to retrieve predefined information to improve the efficiency of communication with the supply chain.

Global trade item number®. The globally unique GS1 System identification number for products and services. A Global Trade Item Number may be 8, 12, 13, or 14 digits in length, represented as GTIN-8, GTIN-12, GTIN-13, and GTIN-14, respectively.

Goods. Used interchangeably with stock, commodities, supplies, products, and other terms to refer to all the items that flow through a logistics system.

Goods received note. A document produced when goods are received from a higher level in the supply chain. It will usually accompany goods to any inspection and is used to check against invoices or requisitions before accepting the shipment or approving payment. Often represented by the acronym GRN. See vaccine arrival report as a form of a GRN that is used for vaccine orders.

GS1®. GS1, based in Brussels, Belgium, is composed of global GS1 member organizations and manages the GS1 System and Global Standards Management Process. GS1 assists with establishing country offices to support the adoption and use of standards for trade management as in the case of Vietnam. www.gs1vn.org.vn.

Integrated system. A logistics system that supplies and manages products for more than one program. Also see vertical system.

International organization for standardization (ISO). Worldwide federation of national standards bodies promoting the development of standardization whose work results in the publication of international standards.

Inventory control card. An individual stock-keeping card that keeps information about all lots of a product.

Issue voucher. Transaction record that lists the items and quantities of products issued to a service delivery point.

Lead time. The time between when new stock is ordered and when it is received and available for use. Lead time varies depending on the system; speed of deliveries; availability and reliability of transport; and, sometimes, weather.

Logistics. Refers to the specific functions that need to be carried out by each of the supply chain partners such as selecting products, forecasting demand, procuring/ordering, warehousing/storing, managing inventory, transporting from one level to the next until the commodities reach the client.

Logistics data forecast. Forecast based on dispensed-to-user data from the service delivery level. When these data are unavailable, issues data from the lowest possible level can be substituted.

Logistics management. The part of the supply chain that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption.

Losses. The quantity of stock removed from the pipeline for any reason other than consumption by clients (e.g., losses, expiration, and damage). See also shrinkage.

Maximum stock level/maximum quantity. The level of stock above which inventory levels should not rise under normal conditions.

Minimum stock level/minimum quantity. The level of stock at which actions to replenish inventory should occur under normal circumstances.

Packing slip. Transaction record sent with products that lists the names and quantities of each product shipped. Usually paired with a receiving record. See also goods received note and vaccine arrival report

Physical inventory. The process of counting by hand the total number of units of each commodity in a store or health facility at any given time.

Pipeline. The entire chain of storage facilities and transportation links through which supplies move from manufacturer to consumer, including port facilities, the central warehouse, regional warehouses, district warehouses, all service delivery points, and transport vehicles.

Products. Used interchangeably with stock, commodities, goods, supplies, and other terms to refer to all the items that flow through a logistics system.

Pull system. Refers to a drug distribution system in which the personnel who receive supplies at each peripheral facility determine the drug quantities to be requisitioned from higher levels.

Push system. Refers to a drug distribution system in which the personnel who issue the supplies at the procurement unit or warehouse determine what drug quantities are to be issued to lower levels.

Radio frequence identification (RFID). A data carrier technology that transmits information via signals in the radio frequency portion of the electromagnetic spectrum. An RFID system consists of an antenna and a transceiver which read the radio frequency and transfer the information to a processing device, and a transponder or tag, which is an integrated circuit containing the radio frequency circuitry and information to be transmitted.

Rate of consumption. The average quantity of stock dispensed to users during a particular time period.

Requisition. Transaction record used in a pull distribution system that lists the items and quantities requested by a facility.

Safety stock. The buffer, cushion, or reserve stock kept on hand to protect against stock-outs caused by delayed deliveries or markedly increased demand.

Service delivery point. Any facility or community level that serves clients directly and where health workers receive supplies. Service delivery points are frequently clinics and hospitals but may be more remote health posts and individual community health workers who deliver services in villages and patient homes.

Shelf life. The length of time a product may be stored without affecting its usability, safety, purity, or potency.

Shrinkage. Refers to losses in stock due to theft.

Stock. Used interchangeably with commodities, goods, products, supplies, and other terms to refer to all the items that flow through a logistics system.

Stock card. A generic name for either an inventory control card or a bin card.

Stock on hand. The quantity of usable stock in inventory at a particular point in time. (Items that are unusable are not considered part of stock on hand. They are considered losses to the system.)

Stock-keeping records. Records kept on products in storage. Also see transaction records and consumption records.

Stores ledger. A stock-keeping record that keeps information about all lots of a product. Often referred to as a Stock Ledger.

Supplies. Used interchangeably with stock, commodities, goods, products, and other terms in this handbook to refer to all the items that flow through a logistics system.

Supply chain. Describes the links and interrelationships among the many organizations, people, resources, and procedures involved in getting commodities to customers. A typical supply chain would include partners from manufacturing, transportation, warehousing and service delivery.

Supply chain management. The delivery of customer and economic value through integrated management of the flow of physical goods and associated information, from raw materials sourcing to delivery of finished products to consumers.

Supply chain operations reference model. The supply chain operations reference model (SCOR) is a process reference model that has been developed and endorsed by the Supply-Chain Council as the cross-industry standard diagnostic tool for supply-chain management. SCOR enables users to address, improve, and communicate supply-chain management practices within and between all interested parties.[10]

Tick sheet. Consumption record that records the quantity of each product dispensed to users without recording the day or client.

Transaction records. Records kept on products being moved from one facility to another. Also see stock-keeping records and consumption records.

Universal product code (UPC). A generic term that refers to the GTIN-12, Coupon-12, RCN-12, or VMN-12 encoded in a UPC-A or UPC-E barcode symbol.

Vaccination supplies stock management. Vaccination supplies stock management (VSSM) is an open source, Microsoft Access-based computer application. VSSM focuses on vaccine stock management and also accommodates management of other categories of supplies such as cold chain and injection equipment, pharmaceuticals, and any other supplies. It allows different formulation of bundling injection equipment with different vaccines and for different settings.

Vaccine arrival report. The vaccine arrival report has been devised as a means to monitor international shipments of vaccines to ensure that shipping guidelines are followed and to ensure that vaccine quality is maintained by encouraging increased ownership of the procurement process by all parties involved.

Vertical system. A logistics system that supplies and manages products for only one program. Also see integrated system.

[10] http://www.supply-chain.org/

Appendix C: Task Flow Diagrams

A task flow diagram is a graphical model that illustrates the activities of a business process as well as who performs those activities, known as the functional role. The task flow provides a "story" for the business process being diagrammed and can help inform the writing of use cases as another method for documenting user requirements. Another important function of the task flow diagram is to serve as a focal point for achieving clairity and agreement among core work group members and stakeholders. They also serve the critical role in bridging to more technical representations of work flow and data flow. This next level of technical elaboration created by software and system engineers often involves UML (Unified Modeling Language), technical use cases, and data entity diagrams.[11]

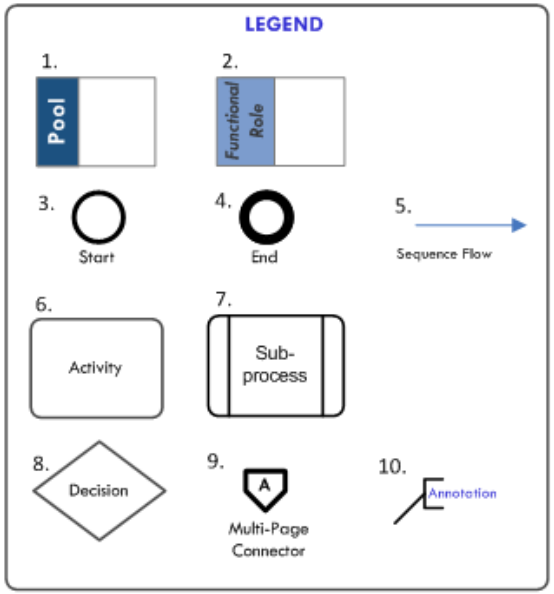
[11]Larman C. *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development. Third Edition*. Upper Saddle River, NJ: Prentice Hall PTR/ Upper Saddle River, NJ: Prentice Hall PTR. 2005.

Diagram Descriptions

Task Flow Diagrams

A task flow diagram is a graphical model that illustrates the activities of a business process, as well as who performs those activities, known as functional groups. The task flow provides a "story" for the business process being diagramed. The components of the task flow diagram are defined as listed below:

1. ***Pools***—a group, department, organization or unit that contains multiple functional swim lanes (functional groups).
2. ***Swim Lanes***—a functional individual or group. These are entities that perform or are accountable for designated activities in the process.
3. ***Start Event***—a process mapping shape used to define the "start" of the process.
4. ***End Event***—a process mapping shape used to define the "end" of the process.
5. ***Sequence Flow***—shows the logical flow and direction of information and activities.
6. ***Activity***—an action performed by the functional individual or group.
7. ***Subprocess***—a shape used as a call out to another process.
8. ***Decision***—a required conclusion needed in the process. These are typically approvals or resolutions.
9. ***Multi-Page Connector***—links to the next page when a process is too large to fit on one page.
10. ***Annotation***—a text description to add clarity or context to any point of the process.

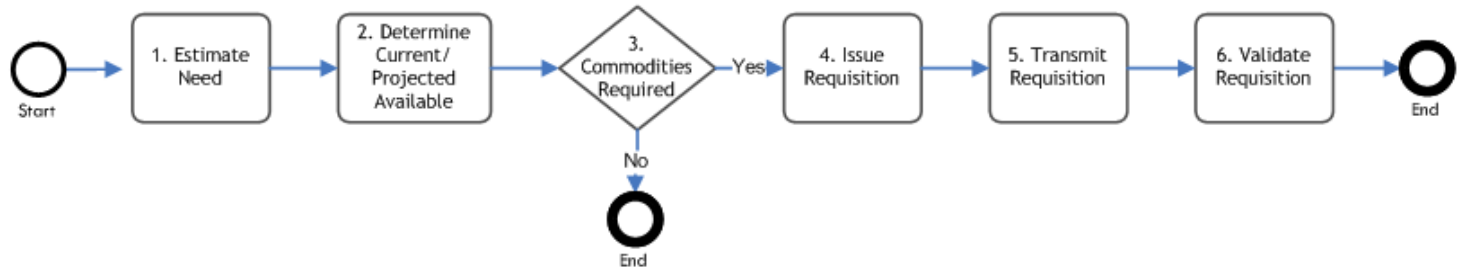


No. 1 Requisition Business Process

Logistics Management Information System (LMIS)

Page 1 of 1

Store / Program Manager



Activity Details/ Narrative

General Process Notes

Objective: Ensure timely ordering of the right vaccine/drug/supply in the right quantity.

- The store may operate under a push or pull system.
- The requisition business process should facilitate inventory control and provide a tracing mechanism for goods.

1. Estimate Need

- Consult order history and current outstanding orders to estimate need.
- Determine average consumption of goods.
- Calculate required quantities based on guidelines and rules.

2. Determine Current/Projected Available

- Determine quantity of goods currently available in the store.
- Compute quantity to requisition based on estimated need and current available stock.

3. Commodities Required

- Are additional commodities required to meet estimated need?

4. Issue Requisition

- Create requisition based on estimated needs.
- Consider minimum safety levels.
- Consider lead time for stock receipt.

5. Transmit Requisition

- Submit the requisition to the appropriate store for fulfillment.

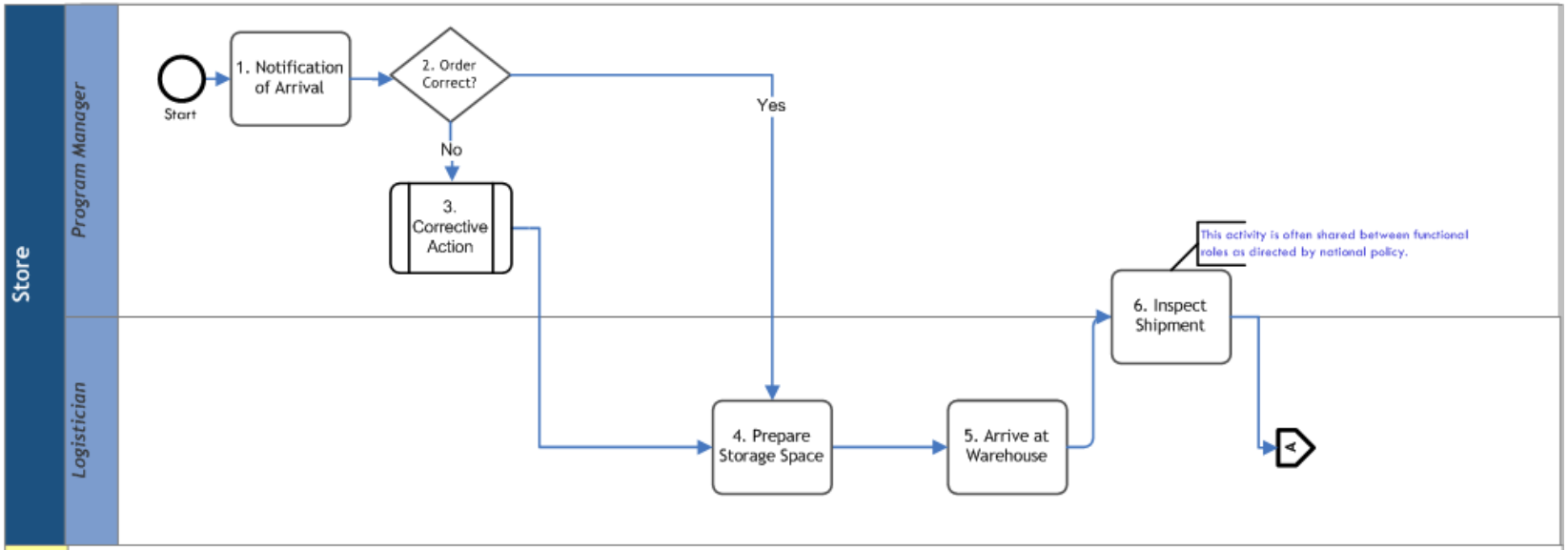
6. Validate Requisition

- This step in the process allows for an approval mechanism at higher levels and the ability to edit the quantities requested and/ or approve the requisition as is.

No. 2 Receiving Business Process

Logistics Management Information System (LMIS)

Page 1 of 2



Activity Details/ Narrative

General Process Notes

Objective: Receive verified quantity and quality of goods into store and determine need for remedial action when necessary.

- Portions of this business process may be outsourced.
- If the goods are arriving at the warehouse from the port (shipped from outside the country) they should have been through a separate process of port clearance/customs.
- Goods arriving at the warehouse will be handled in different manners according to the requirements of cold chain, security, etc.
- This business process should describe the receiving process at all levels of the system.
- The activities in this business process may be performed by different individuals or functional roles based on the level at which the process is occurring (national, regional, district, etc.).

1. Notification of Arrival

- Program managers or logisticians are notified of a shipment's pending arrival. This notification should happen prior to the physical arrival.
- The notification could be in several forms: telephone, fax, email, etc.
- The delivery may be scheduled or may not.
- Verify what is being received compared to what was requested.

2. Order Correct?

- Is what is being received what was requested and/or expected?
- This activity provides the first verification of quantity of goods ordered versus goods shipped.
- An order can be accepted even if the order is not correct. This is generally a decision made by a program manager.
- In many cases, the shipment is already in transit and will arrive at the warehouse.

3. Corrective Action

- The shipment can be flagged for rejection and stored for disposition upon arrival at the warehouse.
- The order can be accepted as is.
- The shipper is notified of the incorrect shipment and additional corrective action can be taken.

4. Prepare Storage Space

- Identify and estimate adequate space needed for storage of the expected shipment.
- Verification of appropriate storage, i.e., cold chain, security.
- This activity allows the store maximum time to find appropriate space for the shipment.
- This activity can become a trigger to the storage business process.

5. Arrive at Warehouse

- The goods should arrive with documentation from shipper. These documents are typically found within one of the boxes received.
- Goods can either be quarantined or stored in cold storage at this point in the process prior to inspection.
- Containers are checked against shipping documents for any apparent damage and or missing shipping cases.

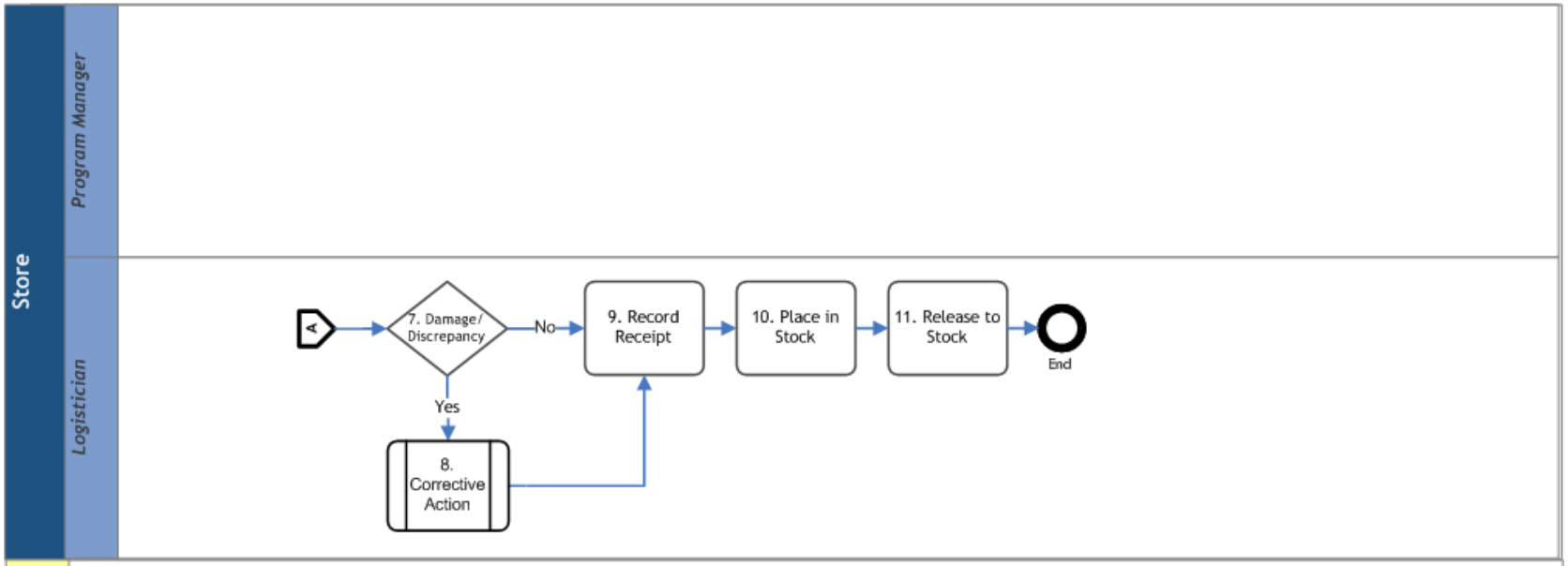
6. Inspect Shipment

- Quality Check—The shipment is inspected based on predefined criteria including: goods specifications, correct quantities received, usable or damaged goods.
- Administrative Check—Is what was ordered what was received.
- This is almost always a shared activity requiring two or three signatures upon inspection.

No. 2 Receiving Business Process

Logistics Management Information System (LMIS)

Page 2 of 2



Activity Details / Narrative

7. Damage/Discrepancy

- Damaged items or discrepancies are noted on the receiving report/invoice/shipping documents.

8. Corrective Action

- This is a subprocess that contains multiple activities with only a few of the major activities elaborated below.
- Shipper is notified if there are damaged goods or a discrepancy in the quantity or type of goods received and additional corrective action can be taken.
- Prepare separate space for damaged stock.
- Dispose of damaged or hazardous stock.
- This activity may trigger the requisition business process or a procurement process.

9. Record Receipt

- For vaccines, this is called the vaccine arrival report (VAR). UNICEF introduced the VAR to ensure the safety and quality of vaccines.
- There is one VAR per type of vaccine.
- Return copy of VAR to sender.

10. Place into Stock

- After goods are checked and approved, they are formally released to stock and moved into storage in the appropriate area (cold chain).
- This activity is a trigger for the storage business process.

11. Release to Stock

- The activity that physically releases the items into the warehouse or storage.

No. 3 Storage Business Process

Logistics Management Information System (LMIS)

Page 1 of 1

Store / Logistician

Activity Details / Narrative

General Process Notes

Objective: Maintain chain of custody and appropriate environmental conditions for stock and inventory.

- An existing warehouse management system may provide all or part of these activities as well as linkages into the LMIS.

1. Move Stock to Allocated Position

- Stock should be stored according to manufacturer's directions, i.e., uncontrolled or controlled temperature and humidity.
- Controlled substances must be stored in a secure location.
- Like stock should be stored at the same location.
- Incoming stock should be stored according to stock control method. First in first out (FIFO) or first expiry first out (FEFO)
- New stock should be examined for expiry date and promoted for earlier use if the date is earlier than existing stock.

2. Monitor Stock Environment

- Vaccines and essential medical supplies should be located in the store in an area with the appropriate combination of temperature and security.
- Cold storage must be kept at a precisely controlled temperature and should be monitored on a continuous basis.

3. Monitor Stock Movement & Expiry

- Chain of custody implies the monitoring of the flow of stock items within the logistics system.
- Record all stock movement in and out of storage areas.
- Monitor stock for expired goods.

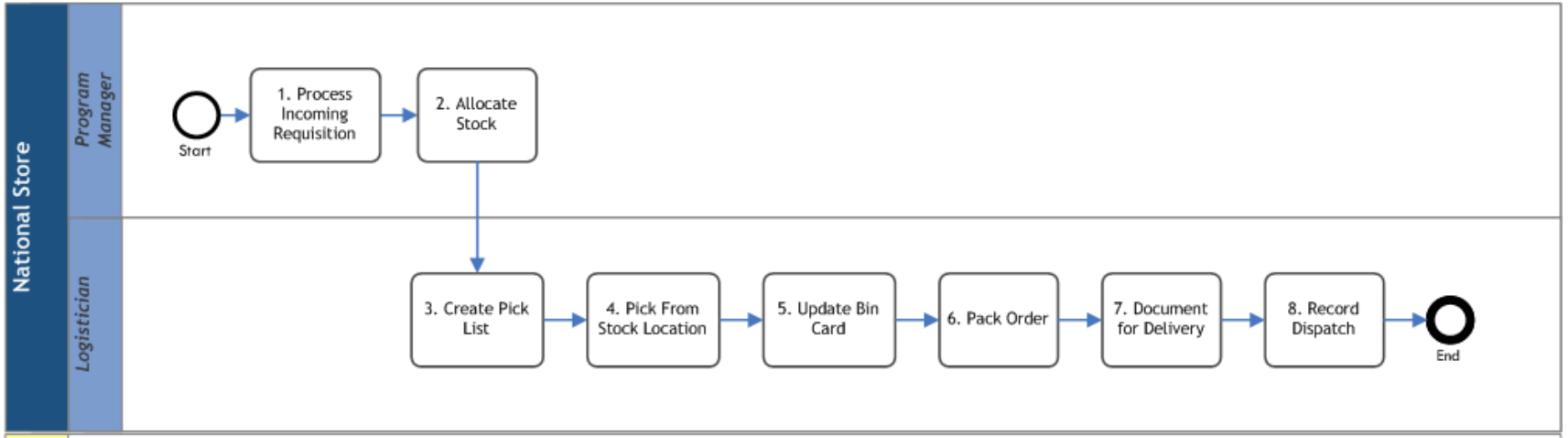
4. Update Records

- Update stock record and bin/location cards with stock information, i.e., quantity on hand, exact location of stock, expiry date, lot number, etc.

No. 4 Dispatch Business Process

Logistics Management Information System (LMIS)

Page 1 of 1



Activity Details / Narrative

General Process Notes

Objective: Identify and prepare accurate quantities of items packed correctly from store needed for transport by lower level.

1. Process Incoming Requisition

- Requisitions are received from intermediate store and/or service delivery locations.
- Standing orders are also a type of requisition, in this case the order is automatically generated.

2. Allocate Stock

- The program manager determines whether to allocate the quantities requested.
- Allocation may depend on current stock status in the warehouse, competing needs, facility consumption patterns, or budgetary status.
- If allocating stock from a cold store, must determine if proper cold boxes available for transport prior to picking.

3. Create Pick List

- Allocated quantities form the order pick list.
- The pick list should contain items to be allocated and the warehouse location of the stock.

4. Pick From Stock Location

- Stock is picked based on the inventory control method (FIFO, FEFO).

5. Update Bin Card

- Update bin card with new quantity on hand after stock is picked for order.

6. Pack Order

- Order is transported to the assembly area.
- Items are arranged in requisition order.
- Order is packed with appropriate measures taken for cold storage if necessary.

7. Document for Delivery

- The receiving location is identified for the order.
- This activity will trigger the transport business process.
- Appropriate government vouchers/forms should be sent with the shipment during transport (permission to carry goods).

8. Record Dispatch

- The assembled order is checked against the requisition for accurate quantities and condition of stock.
- Stock issued is recorded on the stock record and/or bin or location record.

No. 5 Transport Business Process

Logistics Management Information System (LMIS)

Page 1 of 1

National/Intermediate Store Service Delivery

Transportation

Activity Details / Narrative

General Process Notes

Objective: Manage the movement of supplies between locations.

- Deliveries can be on a fixed schedule or as needed.
- This process is triggered from the dispatch business process.

1. Determine Payload, Volume, and Dimensions

- Estimate need based on defined business rules.
- The order lists the number and type of packages to be delivered.
- The transport order may include several documents including shipping/handling information, dispatch note/record, warehouse issue form, permission to carry goods form, copy of requisition, etc.

2. Select Transportation Mode and Type

- Document special handling instructions, i.e., cold storage for goods to be delivered.
- Determine available transport modes/types based on goods to be delivered.
- Load the vehicle/consign.

3. Notification of Dispatch

- Provide advanced notification to receiving store/service delivery location of delivery.

4. Transport Goods

- The order is transported to the receiving store/service delivery location.

5. Deliver

- The order arrives at the receiving facility and this activity is the trigger for the Receiving Business Process.

6. Obtain Arrival Report

- The delivery record is signed by the receiving facility.
- A copy of the record and requisition is retained by the receiving facility.
- A copy of the goods received note back to the sending facility.

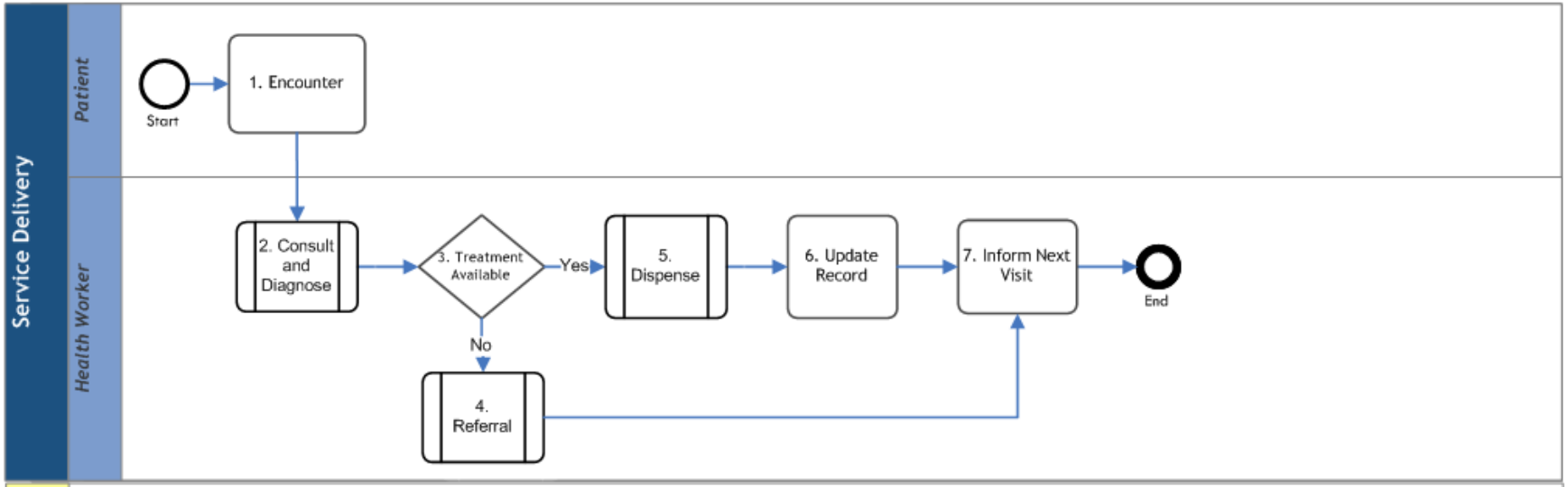
7. Update Dispatch Records

- Copy of the delivery record is filed for record keeping.
- Stock records are updated.

No. 6 Dispense Business Process (Generic)

Logistics Management Information System (LMIS)

Page 1 of 1



Activity Details / Narrative

General Process Notes

Objective: Dispense correct quantity and quality of product and/or service with appropriate information for proper use.

1. Encounter

- The client arrives at the service delivery point.
- Service delivery could include scheduled sessions at health centers/clinic, outreach to outlying areas, single visits to health center/clinic, etc.

2. Consult and Diagnose

- The health worker consults with the client to determine appropriate treatment.

3. Treatment Available

- Determine if the treatment is available for the client.

4. Referral

- Referral is a subprocess or business process to aid the client in making an appointment with a clinician to obtain the chosen treatment.

5. Dispense

- Dispense is a subprocess or business process for delivery of the appropriate treatment to the client.

6. Update Record

- Update client's health record.
- Update stock records and client register/log.

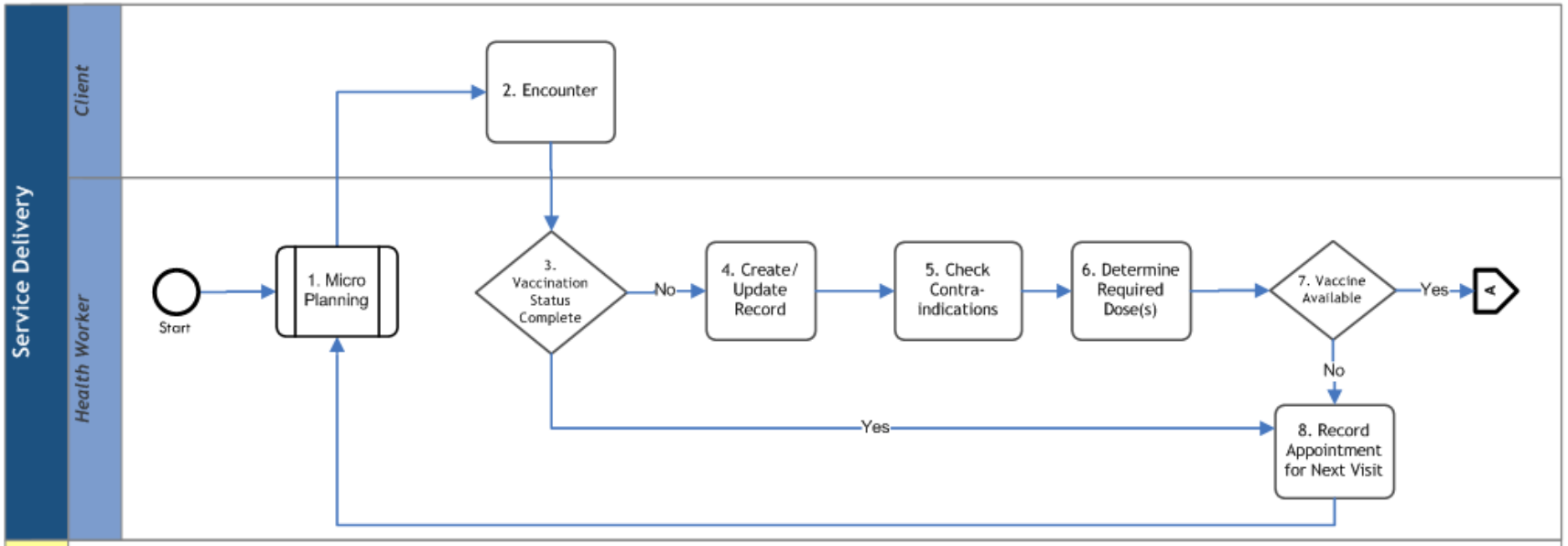
7. Inform Next Visit

- Inform client when follow-up visit is required.
- Trigger the schedule process.

No. 6a Dispense Business Process (Administer Vaccine Alternative)

Logistics Management Information System (LMIS)

Page 1 of 2



Activity Details / Narrative

General Process Notes

Objective: Safely administer appropriate vaccine to target individuals as per schedule.

1. Micro Planning

Micro planning is a subprocess or business process for vaccination planning. Possible steps for this subprocess may include the following:

- Get target population data by vaccine.
- Plan vaccination strategy such as routine, campaign or outreach.
- Mobilize and inform the target population of the date, time, and place.

2. Encounter

- The client arrives at the service delivery point.
- Service delivery could include scheduled immunization sessions at health centers/ clinics, outreach to outlying area, single visits to health center/clinic, etc.

3. Vaccination Status Complete

- Are vaccines required for the client?

4. Create/Update Record

- Determine if the client exists in the current system and if the record is updated with correct information.
- Create a client record if a record is not found.
- Enter the date, time, and place of vaccination.
- Record vaccination(s) given to the client.
- Create/identify a unique identifier for each client.

5. Check Contraindications

- Determine contraindications for vaccines and record in client's history.

6. Determine Required Dose(s)

- Age and status of client should determine which vaccine(s) will be administered (vaccine schedule).
- Information may be inferred from the patient's vaccine card, patient log/ register, or recall.

7. Vaccine Available

- Read the label of the vial to validate antigen name.
- Check expiry date.
- Check the vaccine vial monitor (VVM).
- Conduct shake test.
- Determine if the vaccine is usable based on guidelines.
- If unusable, choose different vial.
- Discard unusable vaccine.

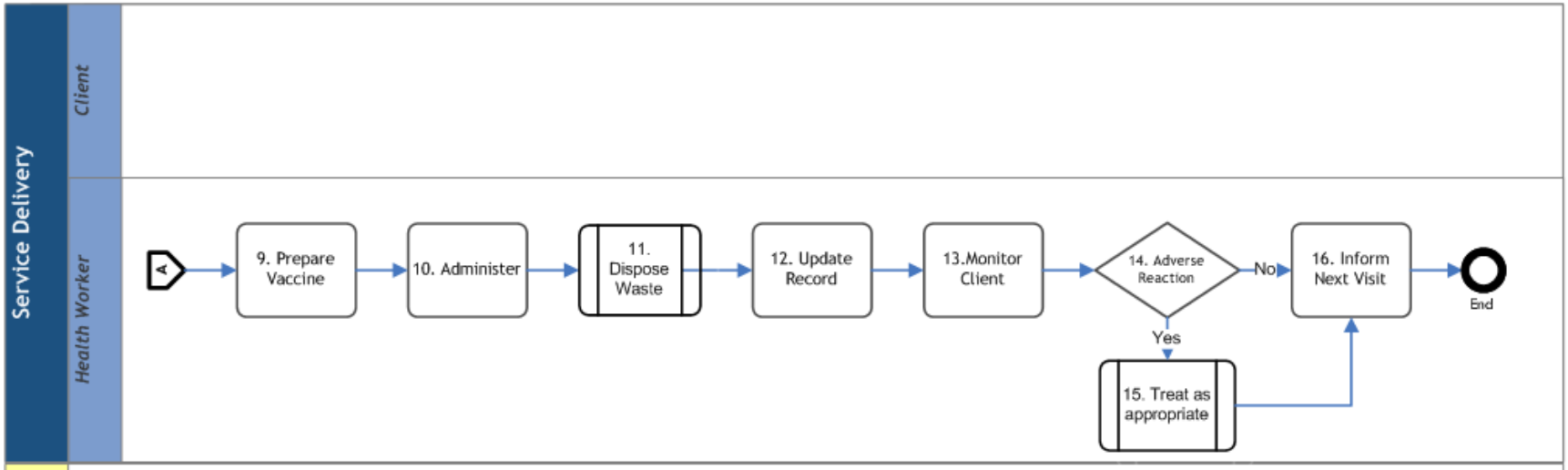
8. Record New Appointment For Next Visit

- Trigger for the Requisition Business Process.
- Trigger for the scheduling process.

No 6a Dispense Business Process (Administer Vaccine Alternative)

Logistics Management Information System (LMIS)

Page 2 of 2



Activity Details / Narrative

9. Prepare Vaccine
- Reconstitute vaccine (if necessary).
- Use appropriate supply items for administration.

10. Administer
- Administer the vaccine(s) to the client according to guidelines.

11. Dispose Waste
- Properly dispose of waste following administration, including sharps, empty vials, etc.
- Dispose of waste is a subprocess or business process carried out according to rules/ guidelines.

12. Update Record
- Update client's vaccine card.
- Update stock records and client register/ log.

13. Monitor Client
- Monitor client for adverse reaction.

14. Adverse Reaction
- Decision point to determine if the client is in need of additional treatment for an adverse reaction/event.

15. Treat as Appropriate

16. Inform Next Visit
- Inform client when follow-up vaccination is required.
- Trigger the schedule process.