USAID | DELIVER PROJECT

Selecting and Implementing Vendor Managed Inventory Systems for Public Health Supply Chains:

A Guide for Public Sector Managers

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Abstract
Vendor Managed Inventory (VMI) systems have gained prominence in the private sector as a task shifting approach to strengthening supply chain performance. With VMI systems, key decision rights concerning the timing and quantity of commodities to be replenished at the custodian's location are transferred from the custodian to the vendor or supplier. Commodities are automatically pushed to the custodian as the supplier checks the custodians' stock status and responds, according to pre-established maximum and minimum stocking limits. To date, little is known about how traditional VMI systems, which are prevalent in the private sector, can be appropriately adapted to public sector supply chains for health commodities. The authors present a public sector–specific definition of VMI and present a number of models of VMI systems that are applicable to the unique context of the public health sector in developing countries. We present a tool that can be used as a rapid assessment of the readiness and suitability of public sector supply chains for VMI systems.

In producing this guide, we have drawn parallel comparisons with successful VMI systems in several fast-moving, consumer-goods enterprises in the private sector. We examined existing logistics system that have a significant task-shifting approach toward the supplier in developing countries, especially those used by the USAID | DELIVER PROJECT during its various iterations over the years. We have also drawn from the experience of related projects; for example, the Supply Chain Management System (SCMS) project. We present these examples in case studies at various points in the guide. We hope that public health managers and policymakers will use this guide to scrutinize their supply chains for areas that can benefit by implementing some of these VMI models.

Cover photo: Jean Jacques Augustin for the Supply Chain Management System (SCMS) project

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Acronyms

3MIS	3rd Party Managed Inventory Services
3RI	3rd Party Replenished Inventory
3P	3rd Party
ACT	artemisinin-based combination therapy (drugs)
AIDS	acquired immune deficiency syndrome
ART	antiretroviral treatment
CD4	cluster of differentiation 4
CHAI	Clinton Health Access Initiative
DRV	Delivery and Receipt Voucher
DTTU	Delivery Team Topping Up (system)
FR	financial resources
HIV	human immunodeficiency virus
IMTA	Inventory Management Technical Assistance
LMIS	logistics management information system
MOH	Ministry of Health
MOU	memorandum of understanding
MSH	Management Sciences for Health
NACA	National Agency for the Control of AIDS
NGO	nongovernmental organization
NMOH	National Ministry of Health
PS	participative structure
SCMA	supply chain monitoring advisor
SCMS	Supply Chain Management Systems (project)
SDP	service delivery point
TA	technical assistance
TI	technical infrastructure
USAID	U.S. Agency for International Development
VMI	Vendor Managed Inventory

VMIS	Vendor Managed Inventory Services
VRI	Vendor Replenished Inventory

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Executive Summary

This guide focuses on the implementation of Vendor Managed Inventory (VMI) models within public sector supply chains. While VMI models are not the only approaches that can be used to improve health supply chain performance, this guide includes sufficient information about implementing these models to improve general health system decisionmaking by ensuring that these decisions are as informed as possible. In this guide, we define VMI and its models, describe the potential benefits of VMI for public health supply chains, discuss the challenges for its implementation, and explain the steps and resources needed to implement and manage the various VMI models.

Defining VMI and VMI Models for Public Health Supply Chains

In a private sector VMI system, the vendor is primarily responsible for managing the customer's stock and making all replenishment decisions. A public health supply chain has a similar definition:

VMI in public health is an approach that leverages the interest and capability of an external party to assume responsibility for managing commodity inventory availability at a public-health facility.

In some cases, this management responsibility can be expanded to inventory management support systems, related physical infrastructure, or other related services. VMI is usually the opposite of the inventory management approach taken by many organizations today. Currently, under typical models, when a custodian needs commodities, they place an order with their supplier (vendor). The customer is in complete control of the timing and size of the order being placed.

Most of the time, a VMI approach in the public health sector includes three parties:

- customer
- custodian of inventory
- VMI partner.

The relationships between these parties are defined and supported by—

- information shared between the custodian and the VMI partner
- how the information is shared
- VMI partner activities
- agreed-to VMI partner objectives.

The *custodian of inventory* is the agency that has physical possession of the inventory and is responsible for handling the inventory. The central store or health facility custodian receives, stores, and issues the inventory.

The *customer* is the agency that controls the custodian and can enter into a contractual relationship with the VMI partner, usually the Ministry of Health (MOH) or donor agency.

The *VMI partner* is the agency that is responsible for managing the inventory for the custodian. VMI partners can be true vendors of the inventory commodity—e.g., a pharmaceutical company or another third party, such as a nongovernmental organization (NGO). This is a significant distinction for VMI in the public health sector because, by allowing more VMI partners, the definition of VMI significantly changes from that used by the private sector.

There are five VMI models:

1. Vendor Replenished Inventory (VRI)
2. Vendor Managed Inventory Services (VMIS)
3. 3rd Party Replenished Inventory (3RI)
4. 3rd Party Managed Inventory Services (3MIS)
5. Inventory Management Technical Assistance (IMTA).

The first four models include the two potential *vendors*—true vendors and third parties—in the VMI program. They also differentiate the levels of managed inventory; for example, simple inventory replenishment and inventory replenishment with additional services. In the fifth model, IMTA, the service provided is technical assistance, with additional inventory service, as needed. In this model, we do not distinguish between whether the service is provided by a true vendor or a third party.

From case studies on these different models, we can make various observations into their operations, including the required skill sets of VMI partners, appropriate forms of information sharing for the developing country setting, and various forms of VMI partner objectives that may guide the performance of VMI partners.

Benefits and Challenges of VMI

The expected benefits of VMI in the public sector can be categorized into—

- immediate benefits that result directly from the dynamics introduced by VMI
- contingent benefits that usually require additional forces to be at work in order for the benefits to be realized.

Immediate benefits usually capture efficiency gains from both the improved communication—the availability and timeliness of the information communicated—and improved decisionmaking that VMI can offer the VMI partner. Contingent benefits result from follow-on changes to the health system and the supply chain, which were built on immediate benefits. VMI is particularly beneficial in correcting supply fluctuations caused by custodians practicing erratic, irregular, or deliberately misleading stock replenishment requests—ignoring standard resupply frequencies, forgetting to order, and placing poorly calculated orders. VMI can benefit the vendor, as well as their customers, even though it appears that the vendor is assuming more responsibilities and activities in the supply chain.

Challenges for VMI can be categorized in five areas—health programs, infrastructure, products, potential VMI partners, and challenges with stakeholders—and they may include issues like funding,

inventory information systems, requisite capability within VMI partners and the health system, procurement policy, and willingness to share information.

Implementing VMI

In implementing VMI, we recommend the following sequence of activities. Initially, a specific set of steps are the same no matter what VMI model is ultimately selected.

1. Evaluate VMI appropriateness using self-administered assessment tool.
2. Apply framework for choice of model.
    a. Analyze current supply chain dysfunction and makeup, and product characteristics.
    b. Analyze potential VMI partner capability.
    c. Identify and prioritize health and supply chain strategic directions.
3. Complete initial assessments of benefits and implementation requirements.
4. Reevaluate the decision to implement VMI.

After deciding on a specific model to implement, activities can begin for the resource components of the implementation approach for the model, the necessary activities, and the operations management after implementation.

Appropriateness of VMI

The evaluation of VMI appropriateness is supported with a scored assessment tool that indicates whether or not the supply chain setting is appropriate. Ideally, VMI is one solution, but not the only solution that could be considered to address supply chain inefficiencies in the health public sector. The initial step in this document will help determine if VMI should be considered as a solution.

Selecting a VMI Model

In choosing an appropriate VMI model, the following factors should be considered:

1. causes of the supply chain dysfunction
2. product characteristics and supply network makeup
3. capabilities of potential VMI partners
4. the country's strategic direction for health systems and supply chain systems.

This guide summarizes the factors that affect the choice of model. It is unlikely that one model will be fully supported by all the factors. Making a choice in situations where multiple models are partially recommended will require decisionmakers to identify priorities for each of the factors, and then evaluate the appropriateness of each model based on these priorities.

Implementing VMI Systems

The highlighted implementation activities are (1) how the implementation should be managed, (2) additional necessary activities needed to implement the VMI model, and (3) a model-specific benchmark for sequencing the implementation activities. The components for managing

implementation include leadership, financial resources, participative structure, and technical infrastructure.

Various necessary activities for implementation include capability assessment of implementation leadership, in-depth analysis of VMI partner capability, periodic revisions of expected benefits, challenges and implementation requirements, and pilot programs for VMI approaches in situations where there is no precedent.

Conclusion

This guide can empower decisionmakers to make informed decisions about health supply systems strengthening, and to advocate for changes in these systems in the most persuasive ways possible. VMI, when it is appropriate, can be a powerful option for strengthening public health supply chains.

Introduction

Vendor Managed Inventory (VMI) is a category of supply system models that holds promise for supply chain performance improvement in developing country health systems. In the private sector, VMI can be simply defined as a method of inventory control where the supplier (vendor) monitors and maintains the quantity of commodities at the customers' location. VMI in public health is an approach that *leverages the interest and capability of an external party to assume responsibility for managing commodity inventory at a public health facility*. In some cases, this management responsibility is expanded to inventory management support systems, related physical infrastructure, or other related services.

VMI is usually the opposite of the decentralized approaches in health systems where public health facilities determine the quantity of products to order and the timing of orders placed with their suppliers (vendors). With VMI, inventory management tasks, and sometimes related activities, are shifted to the vendor or other third party. Examples of VMI operations in public health include the Delivery Team Topping Up (DTTU) system in Zimbabwe and the situation where laboratory supply vendors provide reagents and equipment maintenance to support the national laboratories in Nigeria and Malawi.

But why should public health managers consider VMI for their supply chains? Traditionally, VMI has been implemented in the private sector in retail and commodity distribution to create immediate efficiencies, and to enable long-term relationships that support additional improvements in the supply chain. The fundamental drivers of these improvements support the expectations of similar benefits for public sector supply chains in developing countries. The expected benefits of VMI in the public sector can be categorized into *immediate benefits* that result directly from introducing VMI and *contingent benefits* that usually require other factors for the benefits to be realized. For instance, an immediate benefit of VMI is a reduction in inventory levels in the supply chain (resulting in lower warehousing and distribution costs). A contingent benefit is the vendor's ability to use the improved access to information on the supply chain needs of their customers to schedule and plan their own internal operations, in order to respond better to customer needs. We will discuss these benefits with potential challenges in more detail later in this guide. To benefit from VMI, it must be carefully introduced to ensure a smooth transition; attention must also be given to any additional factors needed to ensure that any contingent benefits are integrated into the new VMI model.

This guide focuses on implementing VMI models within public health to improve the expected outcomes after it is implemented. In the first section, we describe Vendor Managed Inventory models in the public sector. In the next section, we describe the benefits and challenges of these VMI models. In the third section, we use case studies of existing VMI models to examine models of VMI in the public health sector. In the final section, we focus on the requirements and recommendations for implementing the various models.

Vendor Managed Inventory in Public Health

This section includes a general description of VMI, including the parties and the components that define and support the relationship of these parties. It also describes five models for VMI in public health.

VMI Description

With VMI, an external party assumes responsibility for managing the commodity inventory and, potentially, both support systems and the related physical infrastructure at a public health facility holding the inventory. VMI is typically the opposite of the inventory management approach used by many organizations today. With typical models, when a custodian needs commodities, they send an order to their supplier (vendor). The custodian is in total control of the timing and quantity of the order being placed. The USAID | DELIVER PROJECT has traditionally referred to this as a classic *pull* or *requisition inventory control system*. Essentially, VMI *shifts* the approach to inventory management, because the decision for the timing and quantity of stock to be replenished at the custodian's location *shifts* to the vendor. VMI is a type of *push* or *allocation inventory control system*, where the issuer of the commodities uses inventory and consumption data to determine the quantity of commodities that will be distributed to the recipient's location.

A VMI approach in the public health sector usually includes three parties:

- customer
- custodian of inventory
- VMI partner.

The relationships between these parties are defined and supported by—

- information shared between the custodian and VMI partner
- method of sharing the information
- VMI partner activities
- mutually agreeable to VMI partner objectives.

The *custodian of inventory* is the agency that has physical possession of the inventory and is responsible for receiving, storing, and issuing the inventory. The *customer* is the agency that controls the custodian and can enter into the contractual relationship with the VMI partner. In public health settings, the customer is usually the country government or health department; while custodians include, among others, a central medical store, regional warehouse, and hospital.

The *VMI partner* is the agency that assumes responsibility for managing the custodian's inventory. One observation from the case studies is that VMI can, potentially, be implemented with parties that

are not the true vendor for the health commodity. This observation is crucial because by broadening the allowable VMI partners in the public sector, it significantly changes the definition of VMI from that used in the private sector. Three reasons may explain why we should consider alternative agents to serve as the vendor in VMI implementations in public health. The first is that true vendors of commodities for the public sector may find the public sector to be an uninteresting or undesirable customer. Usually, dysfunctional management, both operational and financial, is the reason that true vendors hesitate assuming responsibility for managing inventory within the public sector.

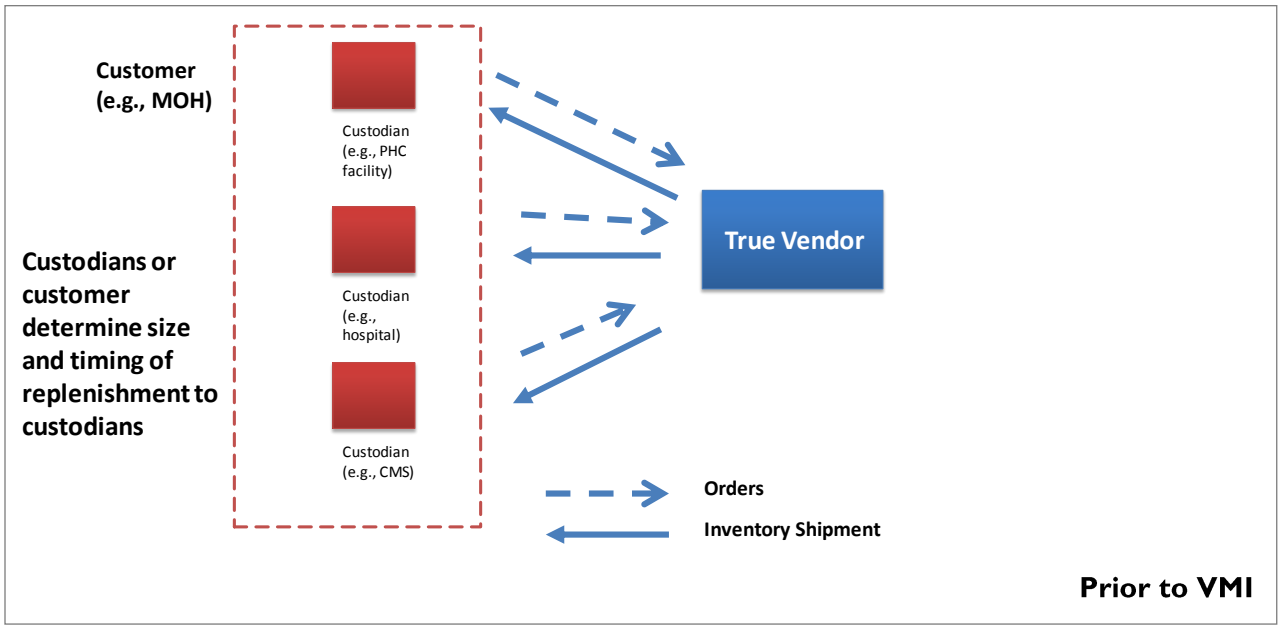
Three reasons for third parties to be VMI partners instead of true vendors:

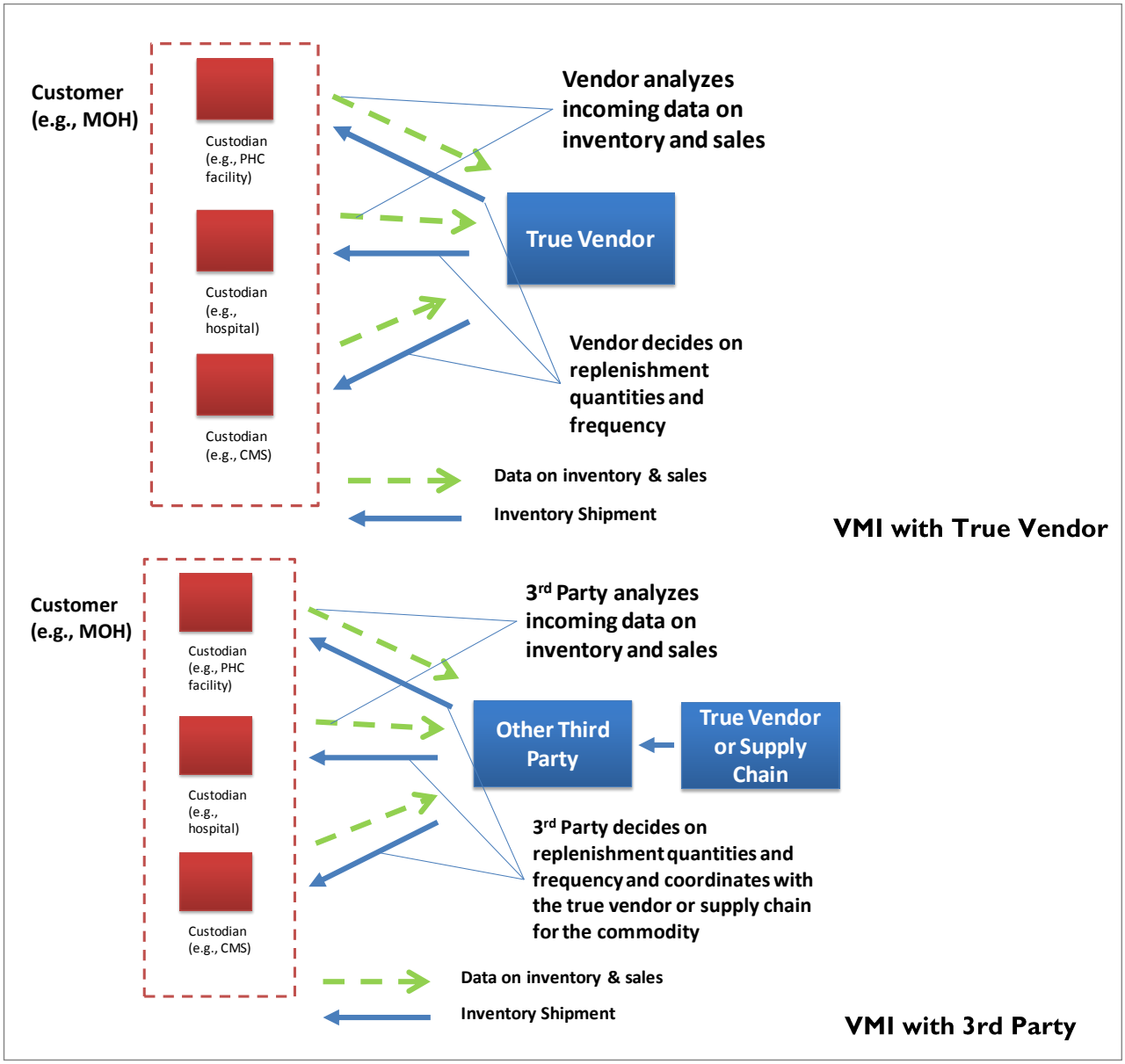
1. Some true vendors are unwilling to assume the responsibility for managing inventory within public health supply chains.
2. In some cases, multiple vendors provide the same commodity; if VMI has only one of these vendors, it would be operationally difficult.
3. Many third parties with legal mandates, or missions, to improve public sector supply chain performance are willing to work with the public sector.

Second, it is customary and necessary for some products in public health to have multiple true vendors and for these vendors to pool their inventory; a custodian may have a relationship with multiple vendors for one product. One example is where multiple vendors are contracted to provide generic commodities, either because of supplier capacity, or for risk management for the supply network. With multiple suppliers, a VMI approach with all or some of the vendors is usually not appropriate because it would be difficult for any one supplier to determine the replenishment needs for all their custodians.

Third, within public health, for candidates that can be responsible for managing inventory within the public sector (see figure 1), many participants, with various vested interests in the performance of the public sector, enlarges the pool of options beyond the true vendors. In addition, the types of relationships possible between the public sector and these participants are also more extensive because of the diverse legal status, mandates, internal restrictions, and freedoms they may have.

Figure 1. Typical VMI Representations





To support the VMI approach, the custodian must share inventory information with the VMI partner. At a minimum, the inventory information that needs to be shared includes—

- stock on hand
- rate of consumption.

Additional information that can be shared includes information that enables the VMI partner to more accurately determine inventory need or additional service needs at the custodian—information about events that may affect future consumption—for example, outreach programs or changes in weather. In the case studies, information sharing is a labor-intensive process when VMI is implemented; information sharing is done through manual reporting, or when the vendor or third party visits the custodian. The private sector is different; information sharing is usually done electronically.

After receiving information, the VMI partner must complete a set of activities that meet agreed-to objectives that have been part of the VMI approach. *These activities will, at least, include determining inventory needs at the custodian's for the next delivery to the custodian.* Other activities can also be included in the VMI approach. These activities either help improve inventory management or additional services at the custodians, or help the VMI partner better manage their own operational activities, including better synchronized production to meet the inventory needs of its customer base. Finally, operational objectives need to guide the activities of the VMI partner to ensure that the VMI partner's performance can be monitored and objectively evaluated. For inventory availability, examples of objectives include maintaining minimum and maximum inventory levels.

VMI Models

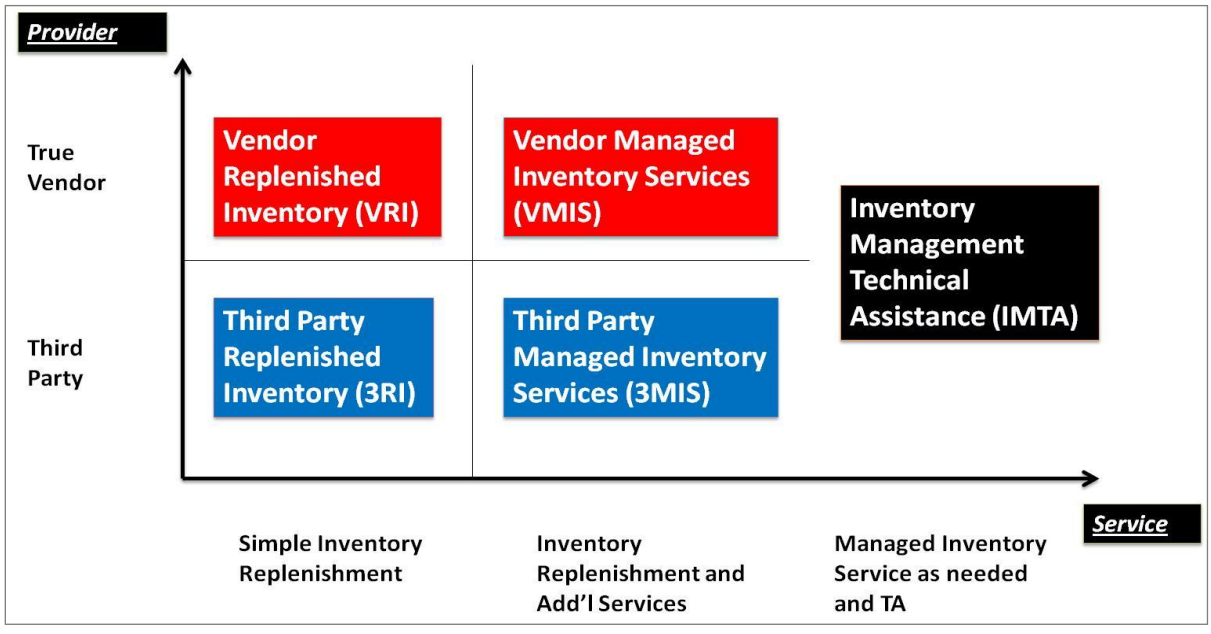
The five VMI models are—

1. Vendor Replenished Inventory (VRI)
2. Vendor Managed Inventory Services (VMIS)
3. 3rd Party Replenished Inventory (3RI)
4. 3rd Party Managed Inventory Services (3MIS)
5. Inventory Management Technical Assistance (IMTA).

The first four models consider the two potential *vendors* in the VMI program—true vendors and third parties—and distinguishing between levels of managed inventory—simple inventory replenishment and inventory replenishment plus additional services. See figure 2.

The fifth model, IMTA, is probably native to public health because of the level of development generally needed in the infrastructure and skill set in host countries. For this model, the service is technical assistance (TA) with additional inventory service, as needed. This model does not distinguish between whether the service is provided by a true vendor or a third party.

Figure 2. VMI Models



Benefits and Challenges of Vendor Managed Inventory in Public Health

This section describes the benefits and general challenges of VMI in the public sector. In considering benefits, we start by examining the source of benefits of VMI in the private sector.

Benefits of VMI

VMI can be used to address certain types of dysfunction, particularly ones that include inefficiencies in inventory replenishment and placing of orders. The dysfunctions usually arise from the custodian's lack of infrastructure and resources, a lack of inventory management capability, as well as low levels of staff motivation. VMI address these inefficiencies and can generate mutual benefits for both the VMI partner and the custodian, which may strengthen the health supply system.

VMI in the Private Sector

VMI, in the private sector, is a method to control inventory; the desired inventory level and quantity of commodities at the customers' location (the custodian of the inventory) is monitored and maintained by the supplier (vendor). VMI in the private sector has proved to be a supply chain innovation; which, when successful, provides benefits for both vendors and their customers. Under VMI, supply chain inventory levels and the associated costs of that inventory—handling costs, opportunity costs of capital, obsolescence costs, etc.—have decreased, profitable sales have increased, and distribution and production costs have decreased (Aberdeen Group 2004; Achabal et al. 2000). In some cases, customers and vendors have created interdependencies that make these supply chain improvements sustainable and they position themselves for further improvements (Hammond 1995; Lee, Clark, and Tam 1999). The dynamics governing these improvements are fundamental enough that similar benefits could be expected using this approach for public health supply chains.

Dynamics leading to benefits of VMI in the private sector include—

- Vendor has real-time information about inventory needs and sales trends.
- Vendor has relatively superior forecasting capability and is familiar with the market for the commodity.

The primary reason for efficiencies in inventory replenishment from VMI in the private sector is the vendor's real-time information on inventory needs and sales trends. This enables the inventory-demand mismatches to be identified earlier and it gives the vendor both increased time and options to replenish (Niranjan et al. 2011). Before VMI, the vendor had to rely on the orders from the customer to both signal replenish inventory to the customer and, also, to signal how the vendor should manage their own inventory to meet future needs. In numerous settings, this has led to confusion; it was frequently a source of repeated crises for the vendor and the supply chain. In

addition, the supply chain benefits for two reasons because the vendor usually has superior forecasting capability and familiarity with the market for the commodity: (1) the vendor's products are only a subset and, in some cases, a small subset of the entire range of products that the vendor supplies to the custodian; and (2) the vendor has an aggregate view of the market instead of the customer's narrow view of their specific part of the market.

It should be noted that these dynamics can imply benefits to the vendor, as well as their customers, even though it appears that the vendor is assuming more responsibilities and activities in the supply chain. The improvement in inventory availability for the customer and, therefore, to the end-customer, means increased sales of the vendors' products. The improved visibility that the vendor gains from VMI into the inventory needs at their customers enables the vendor to plan their own operations better, helping to drive down costs; which, in turn, enables them to offer improved service to customers, win greater loyalty, and expand their share of business.

> VMI can imply benefits to the vendor, as well as their custodians, even though the vendor appears to be assuming more responsibilities and activities in the supply chain.

Benefits of VMI in the Public Health Sector

The dynamics described in the previous section that lead to benefits of VMI in the private sector, can be expected to be true for the public health sector in developing countries, as well. First, better visibility into the inventory and consumption patterns of lower levels of the supply chain empowers the upstream parties in the supply chain to better understand what is currently happening and to take proactive steps, instead of reactive ones, to address issues. This empowerment is particularly significant in situations where downstream parties engage in erratic, irregular, or deliberately misleading stock replenishment requests. Examples include ignoring standard resupply frequencies between placing orders and receiving inventory, completely forgetting to order, or placing poorly calculated orders. This dynamic would apply whether we consider vendors internal or external to a country.

> VMI is particularly beneficial in addressing inefficiencies caused when custodians engage in erratic, irregular, or deliberately misleading stock replenishment requests—ignoring standard resupply frequencies between placing orders and receiving inventory, completely forgetting to order, or placing poorly calculated orders.

Second, in public health sector supply chains, there are often fewer personnel and other resources downstream or closer to the clients. As a result, inventory-related tasks tend to take a lower priority to other health-related tasks. The capability for completing logistics tasks, such as inventory management, also decreases. This means that you would expect to find relatively better inventory management capability in the upper levels of the supply chain than in the lower levels. This does not mean that forecasting and inventory management are always adequate in the upper levels; but, it does suggest that even if the upper levels were not better managed, efforts to improve the capability in the upper levels of the supply chain would probably be more successful.

The expected benefits of VMI in the public sector can be categorized into immediate benefits that result directly from the dynamics introduced by VMI, and more contingent benefits that usually require additional forces to be at work if the benefits are to be realized.

The immediate benefits expected from using VMI in public health include—

1. reduction in supply chain inventory levels and associated expenses—for example, handling and storage costs—to achieve the same level of commodity availability
2. reduction in transport and distribution costs for the same level of commodity availability
3. increase in commodity availability at the custodian's location, leading to improved health care consumption and the related health care benefits.

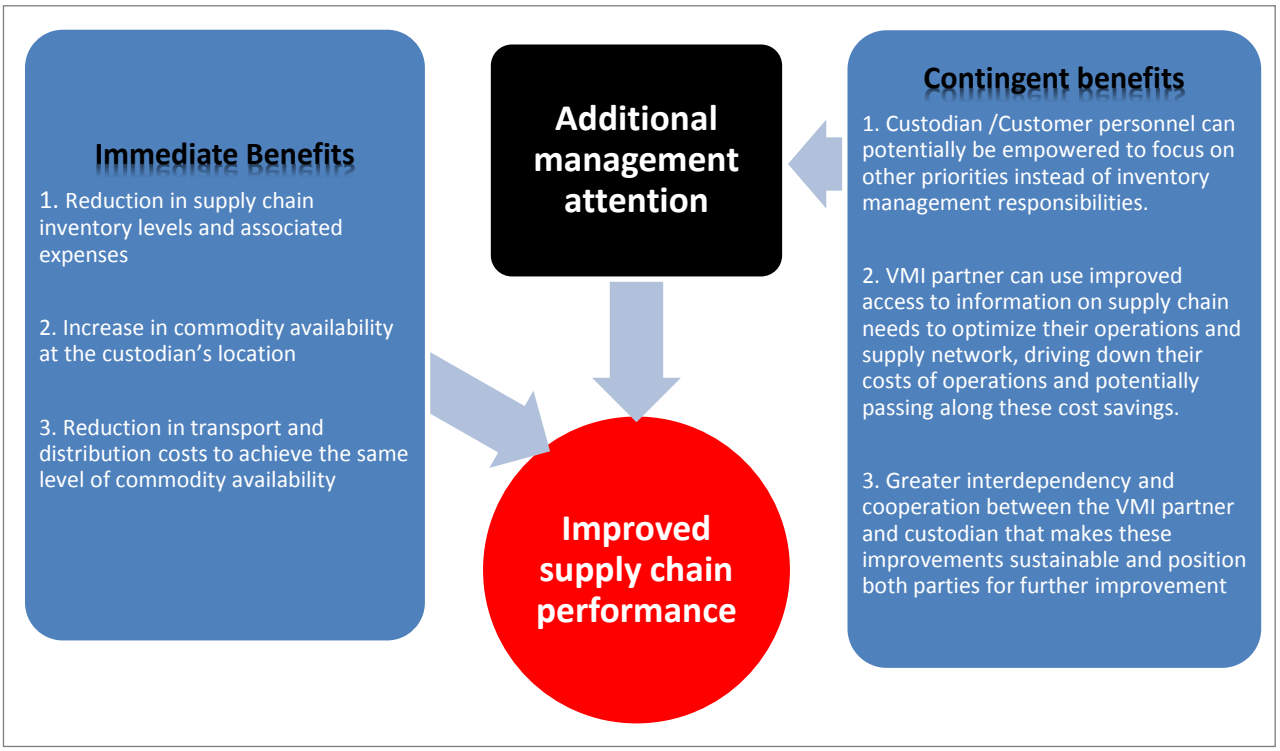
These immediate benefits are primarily gains in efficiency from both the improved communication—the availability and timeliness of the information communicated—and improved decisionmaking by the VMI partner.

Contingent benefits of VMI in public health include—

1. Custodians' personnel can potentially focus on other priorities instead of inventory management responsibilities.
2. VMI partner can use improved access to information on supply chain needs to optimize their operations and supply network, lowering their costs of operations and, potentially, passing along these cost savings.
3. Greater interdependency and cooperation between the VMI partner and custodian that make these improvements sustainable and that position both parties for additional improvements.

The benefits described here include some that, traditionally, have been credited to privatization efforts within the public sector—gains in efficiency from improved capability and empowerment of custodians' personnel. With a private sector partner, VMI is an operationally focused approach to privatization. It ensures that the operational capabilities and dynamics that support improvement are both in place and that they complement the privatization efforts (see figure 3).

Figure 3. Immediate and Contingent Benefits of VMI



Challenges for VMI in the Public Health Sector

Despite the potential significant benefits, attempting to use VMI in the public health sector may cause major challenges, which include health programs, infrastructure, products, potential VMI partners, and stakeholders.

Health Program Challenges

The primary challenges, based on the health program being considered for VMI, are the following:

1. *Public sector health programs may not be stable enough for VMI activities.*

VMI implementations tend to be easier to implement with a sufficient base of routine inventory logistical activity on which to make determinations about the size, scope, and special issues that the VMI program will need to address. Some public health programs do not have this regularity on which to base the design for the VMI program.

2. *Most programs that change their system—for example, implementing VMI—have dramatically increased the volume of managed inventory.*

Complementing the first point, a VMI implementation can prove such a significant shift in operating capabilities and outcomes that this further complicates designing a VMI program with good anticipation of what quantities of commodities will actually be needed to maintain the program. Continuous review of the performance of the VMI system is necessary in order to make timely changes that improve the system, or that allow the addition of more commodities on the VMI schedule to increase efficiency.

3. *Funding for health commodities may not be stable.*

VMI partners, especially from the private sector, will usually avoid agreements if compensation for the commodity deliveries is uncertain. VMI requires a level of trust between the VMI partner and the customer that covers both providing the commodities and, also, payment for the products. This trust is compromised in the public sector setting when the funding for commodities is unpredictable. All efforts should be made at the design and implementation phase to ensure the availability of funds for the long-term VMI system.

Infrastructural Challenges

The primary infrastructure challenges reflect the quality of existing information systems:

1. *Information and communication systems are weak.*

Logistics management information systems (LMIS) are often deficient or underutilized in the public sector in developing countries, whether the systems are electronic or manual. To be effective, VMI needs up-to-date information on inventory levels and consumption. Therefore, not only does the deficiency in these systems hinder VMI, but also the ability to communicate this information, whether electronically or through manual reporting.

2. *The custodian's information system is usually not integrated with the vendors.*

The better the integration between the information system at the vendor and the custodian, the more efficient the VMI program will be. VMI systems function better when data transfer between the VMI partner and the custodian is fast and accurate. The less integrated the systems, the more time and effort must be allocated to verify and validate data and to ensure the speed of transfer.

3. *Procurement policy, practice, and legislation may not support VMI.*

VMI explicitly assumes multiple inventory replenishment opportunities between the VMI partner and the custodian, necessarily implying that VMI is a medium- to long-term relationship between the custodian and the VMI partner. Some national procurement policies, both legislation and practice, do not support medium- to long-term relationships; instead, relying on repeated competition between vendors to drive procurement performance. Although VMI is aligned, in general, with these privatization efforts, it does not rely solely on competitive dynamics to drive performance; but instead relies on very specific operational dynamics that are best supported in repeated interactions between the custodian, customer, and VMI partner.

4. *May not have the requisite third party management capability or may underestimate its importance in the public sector.*

Sometimes VMI involves a third party providing inventory management services that need to be coordinated and managed over the life of the relationship. The capability to manage and coordinate with a third party requires a specific set of skills. In many public sector settings, either this capability is lacking, or its importance is underestimated, which results in less-than-satisfactory outcomes.

Product Challenges

The primary challenge driven by the product is—

1. *Variations in demand may be high.*

As mentioned earlier, the more regular and stable the inventory logistics activities are, the easier they are to implement. Variance in demand of commodities at the custodian's over time tends to reduce the regularity of inventory replenishment activities. It should be noted that some demand variance can be predicted by various demand drivers in the public health setting—outreach for a particular disease, and stockouts of the health commodity in inventory or related commodities. If these demand drivers can be monitored and used to account for demand variance, then the negative effect of variance can be reduced. In some cases, however, even after demand drivers are accounted for, consumption may still be erratic and negatively affect the VMI program.

Challenges with VMI Partners

The primary challenges with vendors include the required capability for executing the responsibilities of a VMI partner, the tensions between the public and private sector, and the common use of multiple suppliers for some health commodities.

1. *Potential partners need specific capabilities.*

Because, under VMI, potential partners will need to assume more responsibilities and be more responsible for the expected benefits of the program, they must have the necessary capabilities, which include both skill sets and motivation. Some of the required capabilities include inventory and distribution management, the ability to manage relationships with the various stakeholders involved in the health program, and management of an inventory information system that can be integrated with the custodian/customer.

2. *Do not have high levels of trust and long-term relationships with existing vendors.*

Allowing an external party to make decisions that affect one's own operation usually requires a level of trust that is not always evident between the public health sector and the private sector. To support this trust, long-term relationships imply that parties cannot seek short-term unilateral benefits at the expense of the long-term future.

3. *In public health, it is customary for some products to have more than one supplier.*

Usually, VMI, as practiced in the private sector, can only work with one vendor, for one specific product. In this way, one agent, the vendor, is responsible for replenishment, and the vendor has the same motivation to monitor and replenish its products. With multiple suppliers, a VMI approach with all or some of the vendors is usually not appropriate because it would be difficult for any one supplier to determine all the replenishment needs for which they are responsible. For some products in public health, it is customary and necessary to have multiple true vendors, and for the inventory they provide to be pooled; there is not a one-to-one relationship between a vendor and a particular custodian of inventory. One example is multiple vendors being contracted to provide the generic commodities for either supplier-capacity reasons, or to manage risk management in the supply network. In this setting, VMI would not be recommended unless the system was carefully designed to address the potential issues.

Challenges with Stakeholders

The primary challenge for stakeholders involves their willingness to share relevant information with the VMI partner.

1. *Willingness to share relevant information with VMI partner.*

As described earlier, VMI's primary benefit is the timely sharing of relevant information with the VMI partner to promote timely decisionmaking, which can also address the needs shown by the information. Crucial information here is not only information on current consumption and inventory levels, but also information about decisionmaking by stakeholders that can have an effect on demand—changes to community outreach programs, price changes, treatment guideline changes, and so on. Therefore, if stakeholders are either unwilling or unable to share information with VMI partners, it will be difficult to implement VMI.

Case Studies on VMI Models

This section includes additional comments about the five VMI models, in addition to case studies of models currently in operation. The more significant aspects of each of the models are included.

Vendor-based Models

These vendor-based models include both simple inventory and additional services.

Vendor Replenished Inventory (VRI) is a model of VMI where the vendor of the health commodities is responsible for managing inventory replenishment decisions for the custodian of the health commodities. Of the five models, VRI is closest to the traditional VMI in the private sector.

Vendor Managed Inventory Services (VMIS) is a model of VMI where the vendor of health commodities is responsible for managing not only inventory, but also inventory-related support systems and infrastructure.

VRI and VMIS Cases: Laboratory Supply Chains—Malawi and Nigeria

Laboratories serve their clients with tests and test results. Machines in laboratories vary from basic equipment to very sophisticated automated machines. Regular maintenance and servicing is needed to keep the machines operational and able to provide results of acceptable quality. For laboratories, in addition to reagents for tests, equipment maintenance is a significant part of the support needed from the supply chain. Suppliers of reagents for tests are one source of parts and maintenance for equipment. To meet the challenge of maintaining the equipment, laboratories have developed various models, which include these suppliers.

In one model, the supplier places the equipment in a laboratory, provides maintenance and back-up service for the equipment, and supplies all the reagents and consumables. The laboratory provides information to the supplier on the number of tests that it will do in a given period, and the supplier delivers the needed commodities. If the machine breaks down, the supplier is responsible for back-up; if reagents expire, the supplier must bear the loss. In these arrangements, the machines remain the property of the supplier, including the risks associated with ownership. The laboratory only pays for the tests completed, while the supplier does both maintenance and supplies reagents.

This model works well if the testing volume is high and predictable. National blood transfusion services laboratories and large reference laboratories have used this model, including Malawi's National Blood Transfusion services. In Malawi, the vendor supplies and maintains the equipment, and provides reagents to the laboratory. The laboratory runs the tests on the equipment and provides information to the vendor on the usage of the machines; the vendor uses this information to resupply the reagents.

In Nigeria, the National Agency for the Control of AIDS (NACA) received a grant from the Global Fund to improve access to antiretroviral therapy, and counseling and testing services for 36 states and the country's federal capital territory. To achieve this, NACA had to ensure the availability of laboratory items for HIV and AIDS at service delivery points (SDPs) in the country. NACA selected and sub-contracted a number of local private suppliers of laboratory equipment, reagents, and test

kits to deliver these items directly to the SDPs. Initially, suppliers visited SDPs to assess stock status for HIV and AIDS laboratory items and to set minimum stock levels, maximum stock levels, and review periods. At the end of each review period, suppliers visited each SDP and determined their need for replenishment of types and quantities of test kits and reagents, which the supplier then fulfilled. They also determined if any preventive maintenance services was required on the equipment. The suppliers then prepared an invoice for the quantities supplied to each SDP and sent the invoice to NACA for verification and payment.

In the public sector, the model has not been widely used, primarily because of the lack of a policy framework that allows this approach. Another challenge in the public sector is the sense that the data on the volume of testing may not be reliable enough to determine feasibility, although true volumes are thought to be high enough to provide incentives for the supplier. Finally, political instability and economic risks that the suppliers face may also deter many from entering into arrangements like these with governments in the developing world.

Discussion

As mentioned earlier, the primary difference between VRI and VMIS models is in providing additional services beyond inventory replenishment in VMIS models. Typically, although distribution of the commodity could be considered an additional service beyond determining the quantity and timing of inventory replenishment—because it is so closely related to these activities—a model where the vendor provides distribution as an additional service would still be considered a VRI model. VMIS refers to models that provide additional services beyond inventory management and distribution. Examples of these additional services include information systems management, and maintenance of infrastructure that includes both physical (equipment) and informational (electronic or paper-based systems).

The case studies on laboratory services are examples of both types of vendor-based models. Laboratory equipment suppliers that only provide reagents are examples of a VRI system, while equipment suppliers that provide both reagents and maintenance are examples of a VMIS system. Table 1 describes the laboratory supplies example in Nigeria; it uses the framework explained earlier.

Table 1. VMIS Approach for Laboratory Suppliers in Nigeria

Cases	Laboratory Supplies in Nigeria
Customer	NACA Nigeria
Custodian	Service delivery points in Nigeria's antiretroviral therapy system
VMI partner	Equipment/reagent suppliers
What information is shared	Stock levels Equipment maintenance needs
How information is shared	Through visit to service delivery point
VMI partner activities	Visit at end of review period Determine inventory needs Provide equipment maintenance
VMI partner objectives	Keep custodians laboratories up and running

VMI partner and activities

The set of skills required for VMI partners in both replenished inventory and management information system (MIS) models can be identified. These skill sets are also required for third party VMI partners in 3RI and 3MIS models.

The skills set required of a VMI partner in an RI model include—

1. inventory performance outcome monitoring—for providing information on inventory performance
2. data collection and validation—identifying, collecting, and validating the appropriate information required for forecasting
3. forecasting— using quantification techniques to create demand estimates based on collected data
4. learning—measuring forecasting performance and identifying corrections to forecasting approaches when they result in poor forecasting performance
5. coordination—managing supply network and distribution resources to meet the custodian's needs and to reduce the consequences of any mismatches between supply and demand that may unexpectedly occur.

The skill set requirements for the VMI partner for Managed Inventory Services models include those identified for the RI model, as well as additional requirements specific to the additional services that are being offered in the model.

Both VRI and VMIS rely on a single true vendor as a VMI partner for multiple inventory replenishment opportunities. An arrangement like this reduces flexibility for supply options; but, as a result, should provide sufficient benefit to justify the loss in flexibility. The previous section discussed some of the general benefits of VMI, which helps to justify some of the loss in flexibility. In addition, the loss of flexibility in a VRI model can be justified by either the true vendor's superior inventory management or distribution capability compared to their competition; or by expectations for greater follow-on benefits from the VRI relation, compared to their competition. In a VMIS model, beyond superior capability in the additional services being requested, the loss of flexibility in supply options can be justified by the true vendor's familiarity with the public health sector and commodity, making the additional services a logical evolution.

Information sharing

Generally, the information shared needs to support the responsibilities of the VMI partner. In both models, that information includes consumption history, inventory availability, and other information about decisions or events that can affect consumption. In a VMIS model, this information set needs to be expanded to include additional information that the VMI partner must provide for the additional services; e.g., in the VMIS case study example, the maintenance needs of the equipment also needed to be shared with the supplier.

In the private sector, for information sharing, VMI is usually implemented through some type of electronics. In resource constrained settings, alternatives to electronic means for information sharing must be found. The visiting of custodians, although effort intensive, is one approach to information sharing. It has the advantage of allowing for verification of inventory status via direct observation by the VMI partner.

VMI partner objectives

The case studies are an example of VMI partner's objectives that are not as explicit as minimum and maximum inventory targets; but, for high volume operations, they can be just as effective. Because the vendors' pay is based on actual laboratory volume, as the volume increases so does the vendors' financial compensation. Therefore, the vendor is not only motivated to support the existing demand, but also the increasing demand at the laboratories.

The 3rd Party-based Models

The *3rd Party Replenished Inventory (3RI)* is a model of VMI where, instead of the vendor of health commodities, another autonomous third party is responsible for managing replenishment decisions for the custodian of the health commodities. The *3rd Party Managed Inventory Services (3MIS)* is an approach where, instead of the vendor of health commodities, another autonomous third party is responsible for managing not only inventory, but inventory-related support systems and infrastructure.

The 3RI Case: Delivery Team Topping Up System

The DTTU system is a forced ordering truck-based inventory control system. With this system, health facilities do not place orders. Instead, every review period, a team of trained logisticians travel with a delivery truck loaded with commodities from a central store to the SDPs. At each SDP, the team physically counts the stock levels, reconciles losses and adjustments, tops up SDPs to maximum stock levels, and recovers damaged or expired products. Stocks to deliver are calculated and recorded on the Delivery and Receipt Voucher (DRV).

In Zimbabwe, a DTTU system has been set up for several commodities (e.g., HIV test kits, contraceptives, some antiretrovirals, etc.). From two central stores, delivery trucks travel to 1,600 facilities. At the facilities, logisticians count stock, reconcile losses and adjustments, calculate maximum stock levels, and deliver and retrieve stock, as necessary. Data from the deliveries is entered into an electronic supply chain management database. The system now has 98 percent coverage and less than 5 percent stockout. Initially, the USAID | DELIVER PROJECT managed this system; over time, we transitioned it to more local control.

The 3MIS Case: Clinton Health Access Initiative, Management Sciences for Health, Supply Chain Management Systems, and National Ministry of Health Collaboration in South Africa

South Africa has approximately 5.5 million people living with HIV and AIDS. Of these, about 800,000 people are currently receiving antiretroviral therapy (ART); 30,000 new patients are being added each month. On World AIDS Day, in December 2009, the Government of South Africa reaffirmed its commitment to fighting HIV and AIDS by announcing key changes—they will provide ART to everyone co-infected with TB and HIV, if they have a cluster of differentiation 4 (CD4)-count of 350; provide all infected infants under 12 months with ART; and provide pregnant women with CD4 counts above 350 with prevention of mother-to-child transmission, beginning at 14 weeks gestation.

To support these efforts, a group comprising the Clinton Health Access Initiative (CHAI), Management Sciences for Health (MSH), Supply Chain Management Systems (SCMS), and South Africa National Ministry of Health (NMOH) to help manage the availability of HIV-related

commodities at 10 provincial medical depots and 90 hospitals. Each provincial depot, in turn, supplied several SDPs that offer HIV and AIDS services to the general population. Under this collaboration, CHAI and MSH, working with the NMOH, assumed responsibility for (1) collecting information on HIV-related commodity consumption, stock on hand, and losses and adjustments from depots; (2) forecasting future consumption; (3) aggregating consumption across depots and using leverage to obtain better prices from suppliers; and (4) placing procurement orders to suppliers to match consumption needs. The U.S. Government assigned Supply Chain Management Systems (SCMS) the responsibility for providing procurement and technical support to the South African HIV and AIDS program for two years; SCMS is expected to supply 25 percent of South Africa's annual ARV requirements directly from U.S. Government donations of $120 million. CHAI and MSH split their forecasts of ARV requirements into a 25 percent and 75 percent share; SCMS had the 25 percent share to source through their own relationships with the global and local network of ARV suppliers. SCMS's efforts complemented efforts by CHAI, MSH, and NMOH to source the other 75 percent of ARV requirements and other HIV-related commodities; in some cases, from the same set of suppliers. Suppliers for these various commodities were to deliver the supplies directly to the provincial depots or hospitals. Most suppliers outsourced transportation and delivery to a third party provider (for example, Ralit Total Transportation [RTT]).

The SCMS approach in South Africa was particularly interesting. As a relatively new third party participant for ARVs in South Africa, SCMS had limited personnel and infrastructure to manage all the responsibilities of a VMI partner. Therefore, SCMS outsourced procurement (to I+ Solutions), and warehousing and distribution (to RTT) to more experienced private companies.

However, as a global player in the ARV market, SCMS had established relationships with the international network of suppliers, including access to information on competitive price and service offerings within the market. They also had established access to manage these relationships, driving and sustaining procurement savings and inventory availability. SCMS essentially *owned* the ARV commodities that it donated to South Africa, purchasing these commodities with U.S. Government funds.

The benefits of the collaboration were significant—a 53.1 percent reduction in cost savings (U.S.$630 million). Some of the challenges to the program included establishing and maintaining standard channels of communication between suppliers and depots, and the negative effects of long lead times. Although only collaboration personnel are authorized to contact the provincial depots and hospitals, sometimes to solicit for larger orders, vendors also contact them. Sampling and quality assurance testing on the delivery of commodities were significant contributors to the long lead times (sometimes 2–3 months), and sometimes compromised the timing of deliveries to meet consumption needs. Examples of such poor timing were less likely with SCMS-delivered commodities—on more than one occasion, SCMS-delivered commodities met the timing mismatches for ARVs that are not sourced by SCMS.

Discussion

As mentioned previously, a third party would be considered for a VMI partner instead of a true vendor, because (1) the true vendor being uninterested in the role, (2) multiple vendors providing the same commodity, and (3) multiple third party options that may be more motivated or could be more easily be motivated to assume the responsibility for managing inventory. Table 2 summarizes the DTTU system in Zimbabwe, an example of 3RI. The CHAI, MSH, SCMS, and NMOH collaboration in South Africa is a good example of 3MIS.

Table 2. The 3RI and 3MIS Approaches in Zimbabwe and South Africa

Cases	Delivery Team Topping Up Zimbabwe	CHAI, MSH, SCMS, and NMOH Collaboration in South Africa
Customer	Zimbabwe Ministry of Health	SA NMOH
Custodian	Service delivery points	Provincial depots
VMI partner	Initially, USAID | DELIVER PROJECT	CHAI, MSH, SCMS in South Africa
What information is shared	Stock levels through physical count	Stock on hand Rate of consumption Losses and adjustments
How information is shared	At visit to service delivery points	Visit or contact
VMI partner activities	Provides moving warehouse	Forecast demand across provincial depots Aggregate across regions/leverage bulk purchases for discounts from true vendors Act as liaison between NMOH and true vendors especially
VMI partner objectives	Tops up inventory to maximum level	Support planning targets and ensure general availability of commodities

VMI partner and activities

The models here are similar to VRI and VMIS, except the VMI partner is not the true vendor. The option of choosing a separate third party can add tremendous flexibility to the VMI models. The third party has a great diversity in legal status, mandates, internal restrictions, and freedoms; whereas, the true vendors tend to be more homogeneous. In addition, some third parties tend to have well-developed capabilities for managing relationships with various stakeholders. Finally, although more difficult to manage, multiple third parties can work together to implement a VMI model. The 3MIS case study in South Africa is an example of multiple third parties serving as the VMI partner.

The capability requirements of the VMI partner include the skill sets identified for the VRI and VMIS models. Additional skill sets include those necessary for acting as an intermediary, as well as the requirements specific to the additional services being offered in the model. As part of its inventory replenishment responsibilities, VMI partners must play an intermediary role of interacting with the true vendor so they can coordinate supplier actions toward meeting future consumption. For 3RI models, this role may only involve placing orders with the supplier and monitoring supplier shipments and responses. For some 3MIS models, intermediary responsibilities may include managing additional services that the VMI partner provides. For example, the VMI partner may be required to interact with the supplier to get better prices or overall service from suppliers, or to provide better supplier insight for customers more strategic decisionmaking. In these cases, the intermediary role for the VMI partners will require additional operational and strategic capabilities. Finally, as observed in the case of SCMS in South Africa, not all the required capabilities need to be internal. Rather, another layer of third party organizations can provide these capabilities, with the VMI partner acting solely as a layer of management for these additional third party organizations.

Information sharing

The information needs for 3RI and 3MIS are generally the same as for VRI and VMIS models. As with the VRI example in Zimbabwe, visiting the SDPs is one way to share information, pulling replenishment away from the traveling warehouse. The 3RI and 3MIS models provide an additional benefit over VRI and VMIS models because they control information that is shared with true vendors.

Because third parties play an intermediary role, they can receive information that they can filter or process so that when they communicate with the supplier, they do not share the detailed, sensitive information; but, the information will still impact coordination with the supplier. In the South Africa case study, the coalition of third parties knew all the procurement details with the various suppliers, but each supplier only knew their own contract details. With information filtering, care must be taken, however, to ensure the coordinating information to the suppliers is not compromised by too much filtering—possibly to the point where they lose the credibility needed to guide the suppliers.

VMI partner objectives

Both case study examples are characterized by relationships with VMI partners that are not contractual—there is no actual contract between the customer and the VMI partner (although memorandums of understanding [MOUs] can often guide expectations). However, these third parties have shown their ability to manage inventory and provide additional services and their goodwill toward developing country public health settings; this has increased their acceptance and trust from other stakeholders in these roles. The motivation for these third parties to assume management responsibilities usually comes from their own specific missions related to health strengthening in developing countries. In Zimbabwe, the USAID|DELIVER PROJECT was motivated to make the VMI approach succeed, because it was one of the first of its kind being applied to global health. Despite the lack of contracts seen in the case study in Zimbabwe, the objectives for the VMI partner were more explicit than in the VRI example, with actual inventory targets as the focus. In South Africa, all the third parties have stated their mission of strengthening health services in developing countries and improving health access, especially for HIV and AIDS commodities. Generally, because of their diversity, the types of relationships possible between the public sector and these VMI partners are more extensive than with true vendors.

Inventory Management Technical Assistance

Inventory Management Technical Assistance (IMTA) is a strategy where an autonomous third party—that could be the true vendor of the health commodities—is responsible for managing inventory at the custodians. This could include managing support systems and related infrastructure; but, primarily, it means providing TA that enables the custodian to directly perform these management duties. Under the IMTA, the autonomous third party is ultimately responsible for mismanaged inventory, even when the custodian has regularly assumed inventory management duties.

IMTA case: SCMS supply chain monitoring teams in Tanzania

The mandate of SCMS Tanzania is to provide TA, foster global collaborations, and procure and distribute HIV and AIDS and related commodities. All health commodities in the public sector in Tanzania are distributed through the Medical Stores Department (MSD). MSD comprises one central warehouse in Dar es Salaam and nine zonal warehouses. SDPs receive commodities through a requisition (pull) system, directly from the zonal warehouses. By the end of 2009, an estimated

287,183 patients were receiving ART services. As of May 2010, under the national system, 909 approved sites provided HIV and AIDS care and treatment services. As part of its supply chain strengthening activities, SCMS Tanzania designed and implemented a logistics system for the HIV and AIDS vertical program; this increased the visibility of essential logistics data items and provided an early warning mechanism for possible system failure. The backbone of this logistics system is the group of supply chain monitoring advisors (SCMAs); they work exclusively on the HIV and AIDS commodities vertical program.

SCMAs are pharmacists working in each of the zonal warehouses; they are a vital bridge between SDPs and zonal warehouses. They have access to a vehicle and a driver solely for monitoring HIV and AIDS commodities. Their primary function is to ensure that zonal stores from SDPs receive accurate and timely orders for all HIV and AIDS commodities. At the end of each review period, SCMAs will visit each SDP that has not provided summary reports for HIV and AIDS commodities to ask why. If necessary, they will do on-the-spot training and a physical stock count; and complete a Report and Requisition Voucher and send it to the respective zonal store. SCMAs also ensure that orders are filled. If needed, they will deliver commodities from the zonal warehouses directly to SDPs that offer HIV and AIDS services. They are also mandated to deliver emergency orders between review periods. They carry out physical counts at zonal warehouses and ensure that commodities are ordered from MSD's central warehouse.

This logistics system has a 100 percent forced ordering for all HIV and AIDS commodities. It has also created visibility of information that improves the accuracy of quantification and forecasting. The availability of on-the-spot training has quickly developed a competent workforce. The main drawbacks with this system are the high operational costs and the investment for a limited category of health commodities.

Discussion

The IMTA model couples a TA focus with the additional activities of a RI or Managed Inventory Services model. The approach tends to result in more immediate supply chain improvements than a strictly TA approach; however, its goal is to transition ownership of these improvements to the customer and their custodians. The IMTA is a dilemma for the VMI partner, because they have the final responsibility for inventory replenishment and other services; but, they may also be transitioning these activities to the customer and their custodians. Because of the transition, some activities will have inconsistent performance. Table 3 summarizes the example of an IMTA, SCMS monitoring in Tanzania.

Table 3. Inventory Management Technical Assistance Approach in Tanzania

Cases	Supply Chain Management System (SCMS) Team Monitoring in Tanzania
Customer	Tanzania Ministry of Health
Custodian	Service delivery points (SDPs) in antiretroviral therapy (ART) system
VMI partner	SCMS
What information is shared	Whether orders from SDPs to zonal warehouses have been sent
How information is shared	Directly from regional warehouses
VMI partner activities	Call SDPs Provide training Physical count Produce order Deliver, if necessary
VMI partner objectives	Get compliance in orders

VMI partner and activities

It is possible that the VMI partner in an IMTA model can be either a true vendor or an external third party. It is more likely that the VMI partner will be a third party because of the level of effort involved. True vendors usually expect to have a continued relationship as a vendor after the management of inventory reverts back to the custodian.

Because IMTA covers many areas, the requirements on the VMI partner are much greater than for similar Replenished Inventory or Managed Inventory Services models. The set of skills required for a VMI partner in an IMTA model include—

1. ongoing capability assessment skills—to continually assess the custodian and respond accordingly with an appropriate mode of operation
2. multiple modes of operation—different modes of operation enable the VMI partner to respond accordingly to specific and changing needs of the custodian
    a. replenished inventory—for replenished inventory operating requirements
    b. managed inventory services—for managed inventory services operating requirements
    c. in-service training—for providing in-service training
    d. process monitoring—for monitoring the custodian when inventory management responsibility has been transferred to the custodian
    e. contingency-based operations—for reacting to the custodian's temporary breakdowns in process compliance.

The additional skill sets listed above reflect the additional responsibilities and the operational processes that must be in place to support these responsibilities. Ongoing capability assessment is required, because the IMTA model involves a flexible and changing response to the evolving capability of the customer/custodian. For example, as the customer/custodian improves their

inventory management capability, the VMI partner would shift more of those activities back to them. The ability to assess the customer and custodian is essential for choosing the right response from the VMI partner.

The other set of skills that the VMI partner must have enable the VMI partner to operate in multiple modes that match the results of the custodian or customer's assessment. For example, process monitoring focuses on assessing whether custodians and customers are complying with processes that are either considered crucial in the sequence of steps for managing inventory, or otherwise imply that there is discipline in the performance of those steps. In the case study example, SCMAs were the source of the process monitoring capability for the VMI partner. Process monitoring is particularly important when the inventory management activities are transitioning to the customer and their custodians, but the VMI partner is still responsible for the inventory management activities.

Information sharing

As expected, information sharing within an IMTA model is more complex than for RI and Managed Inventory Services models. Additional information that needs to be shared includes information about the current capabilities of the customer and custodians, and process compliance during the transition of management activities to these customers and custodians.

VMI partner objectives

Particular significant for this model are the VMI partner objectives. In an IMTA, objectives tend to include process-based objectives, as well as outcome-based objectives. Process-based objectives focus on improving results from process monitoring. For example, in the case study, a process-based objective is compliance in placing an order for commodities. Such process-based objectives more closely reflect the TA focus of the model.

Summary

The following summarizes the observation from the case studies on the different VMI models.

General Case Study Observations

1. VRI and VMIS models sacrifice flexibility in supply options; and, as a result, the arrangement must provide sufficient benefit or advantage to compensate for this loss.
2. Third parties, other than true vendors, can add tremendous flexibility to the VMI models because of their diversity in mission, capabilities, and regard within public health.
3. The 3MIS models can include a collaboration of third parties providing services.
4. IMTA tends to result in more immediate supply chain improvements than does a pure TA approach.

Observations on VMI Partner and Activities

1. The 3RI and 3MIS models usually require the same set of capabilities as the VRI and VMIS models; however, they must also be able to play an intermediary role between the customers and the suppliers.

2. For all models, not all the required capabilities need to be internal to the VMI partner. Rather, another layer of third party organizations can provide some of these capabilities, with the VMI partner acting as a layer of management for these additional third party organizations.
3. The IMTA models require additional capabilities beyond replenished inventory and managed inventory services models. These include ongoing capability assessment of the customer and custodian, in-service training, process monitoring, and contingency-based operations.
4. For IMTA models, it is more likely that the VMI partner will be a third party instead of a true vendor because of the high level of effort involved with this approach.

Observations on Information Sharing

1. Creative approaches may be necessary to enable economical information sharing, allowing information records to be validated; and, if possible, incorporating the information into other necessary activities.
2. In 3RI and 3MIS models, third party VMI partners can help control information sharing, but still allow that information to guide coordination with suppliers in cases where that information would not have been shared with true vendors; but the information can be shared with third parties.
3. For IMTA models, additional information that needs to be shared includes information about the current capabilities of the customer and custodians, and the process compliance when management activities are transitioned to these customers and custodians.

Observations on VMI Partner Objectives

1. In high-volume operations, implicit operational objectives can be appropriate for guiding VMI partner activities; whereas explicit objectives—e.g., minimum and maximum inventory targets—allow for more straightforward monitoring of VMI partners. In high-volume operations, the intrinsic importance of the VMI program to VMI partners, because of its size, may be a sufficient platform to motivate VMI partners just as effectively as explicit performance targets.
2. VMI relationships need not all be based on explicit contracts, especially with third parties that are not true vendors.
3. For IMTA models, VMI partner objectives should include both outcome-based objectives and process-based objectives.

General Implementation of VMI

This section describes the steps and structures required for implementing VMI models. Initially, a specific set of steps are the same, regardless of the VMI model ultimately considered. These initial steps are the following:

1. Evaluate VMI appropriateness using self-administered assessment tool.
2. Apply framework for choice of model.
    a. Analyze the current supply chain dysfunction and makeup, and product characteristics.
    b. Analyze the potential VMI partner capability.
    c. Identify and prioritize the health and supply chain strategic directions.
3. Assess benefits and implementation requirements.
4. Re-evaluate the decision to implement VMI.

Implementation can begin after deciding on a particular model, management components of the implementation approach for the model, necessary activities, and operations management.

This section describes the initial step and an assessment of the appropriateness of the setting for any VMI model, and it includes a tool for this assessment. The results of administering the tool are scored, which indicates whether the setting is appropriate for VMI, or if it should not be considered. Ideally, VMI is not the only set of approaches being considered to address supply chain inefficiencies in the health public sector. This initial assessment determines whether VMI should be considered; even if the assessment indicates that VMI is appropriate, it does not mean that a VMI model should be implemented immediately.

The next step, assuming that VMI is to be implemented, focuses on the decision surrounding the choice of VMI model. This step is followed by an initial assessment of benefits, challenges, and implementation requirements; and a review of the decision to implement VMI.

Assuming a VMI model is chosen, the next step discussed is implementing the VMI model—how an implementation should be managed and the required activities. As a benchmark, a detailed and model-specific chronological sequence of implementation activities is provided. Finally, the challenges are described for managing operations for the VMI model after implementation.

Evaluating VMI Appropriateness

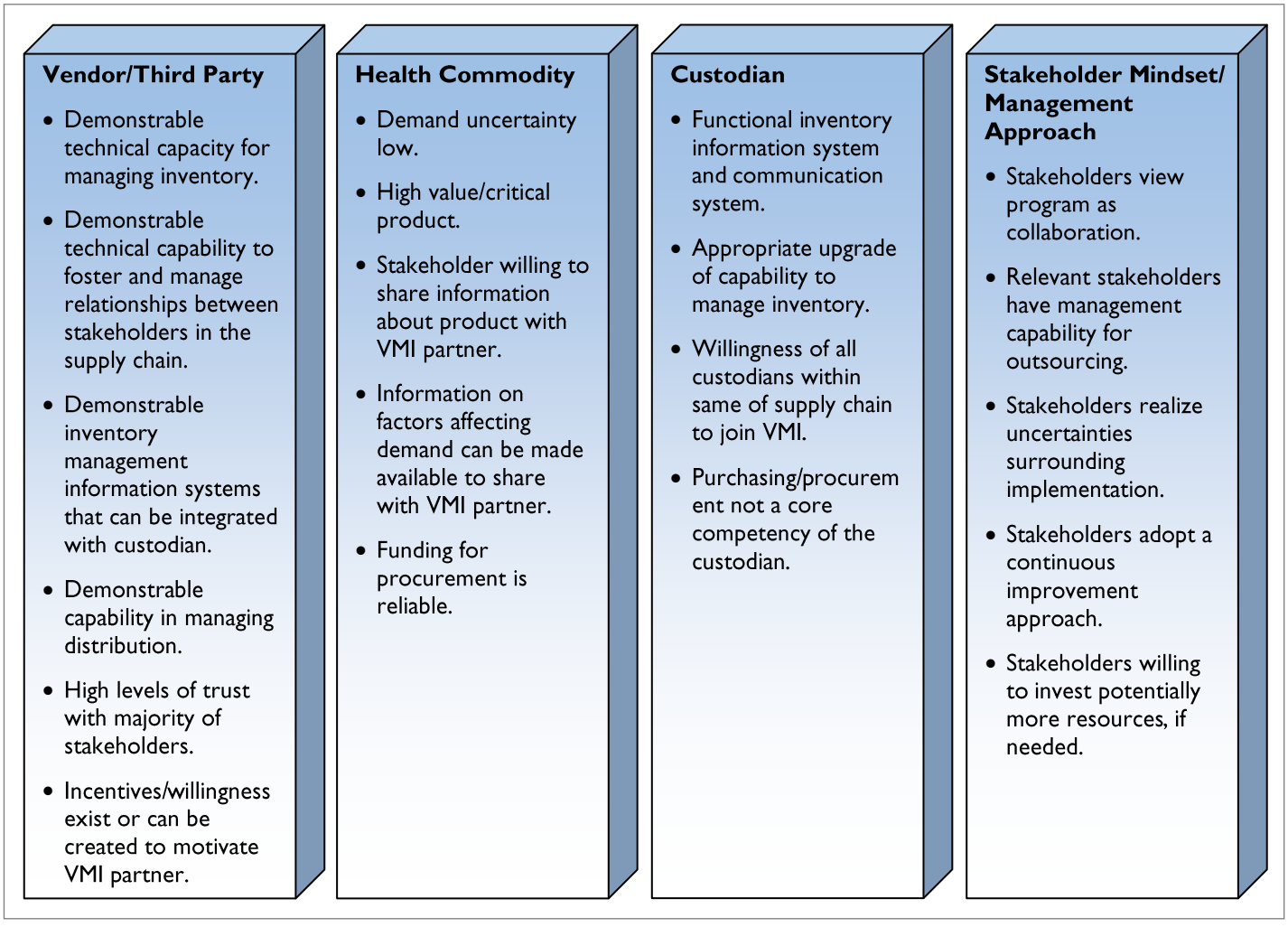
This step determines whether VMI is an appropriate strategy to address the current issues in the public health supply chain. For this step, a framework was developed as a self-administered assessment tool; it uses four dimensions of the public health setting—custodian, product, vendor/third party, and stakeholder mindset/management. The approach draws heavily on a similar approach to a VMI appropriateness framework developed for the private sector[6]. As with that approach, the premise of the framework is simple. It is not sufficient for any single factor, or even a

group of factors, to achieve a high score. Rather, it is the composite score of all features that will reliably predict how ready the program or public sector is to adopt VMI. The framework is a quick and simple first step to evaluate a sector's or program's VMI appropriateness. It must be seen as a complement to, not a substitute for, a more thorough analysis.

Assessment Tool

The dimensions covered by the assessment tool involve all the particular elements that will influence the potential for VMI: custodian, product, vendor/third party, and stakeholder mindset/management. Figure 4 shows the four dimensions and 20 factors in the tool. Each of the 20 factors has a weight that represents the relative strength of that factor's contribution to the appropriateness of VMI. These weights were generated by interviewing field personnel in public health and academics in supply chain management who have experience with VMI models in the public or private sector. See appendix A for the assessment tool.

Figure 4. Dimensions Covered by VMI Appropriateness Assessment Tool



Assessing these various dimensions requires a broad understanding of the public health setting and insight into the various agents acting within the setting. In particular, when considering the dimension of vendor/third party, it is necessary to have some idea about potential third party candidates. It is unlikely that one individual would have such broad insight into the public health setting; therefore, it is advisable for the assessment tool to be completed in a workshop by a group of individuals having sufficient visibility into the public health setting and insight into the relevant participants. This group of individuals can include MOH representatives, donors, health system representatives (especially from potentially affected custodians), implementation agents, NGO representatives, and private-sector representatives (e.g., potential donors).

Each factor considered across the four dimensions can be classified as either controllable or not controllable—either within the influence of the public/private sector or beyond. From these factors, it is possible for multiple scores to be generated for a particular setting, based both on the current evaluation of these factors and any improvements in these factors that are expected or could be planned—even those in response to the results of the assessment. Similarly, with respect to multiple potential vendors or third party candidates for the VMI model, individual and multiple scores can be created for each candidate, based on both their current performance and also expected performance after planned or estimated improvements.

Instructions for Using the VMI-readiness Assessment Tool

In a large group, discuss each statement in the tool, then do the following:

1. On the scoring chart, use the rankings zero to four to show how well the group agrees that the statement represents the current situation.
2. Multiply each statement's ranking by the weight provided.
3. Add the weighted rankings to calculate the final score for VMI-readiness; it will be somewhere between zero and 400.

Scoring Chart	
Do not agree	0
Barely in agreement	1
Somewhat in agreement	2
Agree	3
Strongly agree	4

Interpreting the Final Score

As mentioned earlier, VMI is one approach; but it is not the only one that should be considered to address supply chain inefficiencies in public health. The final score from the assessment will determine if VMI should be considered.

A final score of more than 300 (75 percent) suggests that it is appropriate to implement VMI in the supply chain being analyzed. A score between 200 and 300 (50 percent to 75 percent) suggests that more analysis is needed to determine if VMI is appropriate; this is a borderline situation, and without qualifying context and deeper analysis, it is difficult to judge the appropriateness of VMI. Further analysis can involve the additional implementation steps described in this section; e.g., choice of VMI model and assembling implementation resource components, and others. It is likely that, with these additional steps, the appropriateness of VMI will be clearer. However, unlike a higher score (above 300), it is likely that these additional efforts will determine that VMI is inappropriate. Given this score, decisionmakers must consider, beforehand, whether it would be a better use of resources to examine and analyze other system improvement approaches with less uncertainty about their appropriateness, instead of continuing to focus on VMI.

A score of less than 200 (50 percent) suggests that VMI will not benefit the supply chain, and it should not be considered as a potential solution. In the unlikely case that VMI is already deployed, the supply chain managers should consider withdrawing from it.

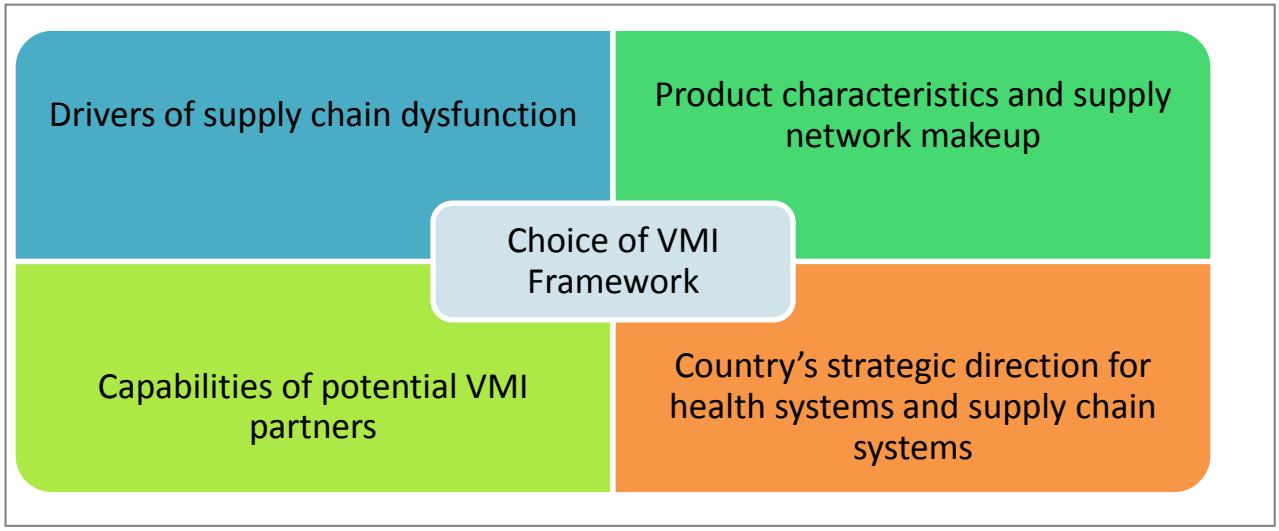
In general, if a low score is primarily due to controllable factors, the situation can be improved and the setting could become VMI-appropriate with time. If the low score is primarily from uncontrollable factors, the framework suggests that little can be done to improve the overall situation, and VMI should not be considered as an option.

Decision Framework for Choice of VMI model

In choosing an appropriate VMI model, you should consider the following factors (see figure 5):

1. why the supply chain is dysfunctional
2. product characteristics and supply network makeup
3. capabilities of potential VMI partners
4. country's strategic direction for health systems and supply chain systems.

Figure 5. Decision Framework for VMI Model



Drivers of Dysfunction

As mentioned earlier, the types of dysfunction that VMI can address are ones that include inefficiencies in inventory replenishment/procurement. They can result from a lack of infrastructure and resources; or the lack of capability—including motivation of the public health personnel—or both. The lack of capability alone tends to suggest replenished inventory models. Other dysfunctions tend to suggest managed inventory service models. Additionally, if strategically it is better for the custodian to ultimately assume inventory management and maintenance of inventory management systems, then TA models are appropriate, no matter what caused the dysfunction.

Product Characteristics and Supply Network Makeup

Products have unique requirements for the supply chain that supports them. For products that need only basic logistics activity for support in the health system—products requiring little special handling in storage or transportation—the replenished inventory models tend to be more appropriate. However, products that require special resources, systems, or processes to be effective tend to suggest managed inventory service models; if the VMI partner needs to provide additional services to maintain these resources, systems, and processes. The expected stability of the demand for the product also influences the choice of the model. The more stable the demand for the product, the more appropriate it is to use the replenished inventory models. When demand for the product is not expected to be stable, managed inventory service models tend to imply that additional resources are being brought to bear on the management of inventory, which can indirectly or directly help address the instability of demand.

As mentioned earlier, multiple vendors and products from these vendors that will be pooled to meet demand in the health system suggests that it is more appropriate that a third party be the VMI partner, rather than one of the vendors.

Capabilities of Potential VMI Partners

It is obvious that the potential VMI partner will need the required capability for the VMI model, whether it is a replenished inventory, managed inventory service, or TA model. The VMI appropriateness assessment tool also suggests additional components for this capability, including the ability to manage relationships with various stakeholders, to integrate inventory information system, to manage distribution, and to gain trust from the stakeholders. Finally, true vendors are usually very familiar with their products and the additional services these products need to be used effectively. In these cases, it will be more appropriate for a true vendor to be the VMI partner than the third parties that are less familiar with the product.

Country's Strategic Direction for Health Systems and Supply Chain Systems

A country's strategic direction for health systems and supply chain systems represent choices about the ultimate makeup of these systems and the developmental directions that improvements in these systems will follow. As such, the choice of the VMI model should match the strategic choices determined by country decisionmakers.

Replenished inventory and managed inventory service models tend to support a privatization health reform direction, while TA models tend to support a decentralization health reform direction. The expected length of the VMI and its sustainability also affect the choice of models. Longer engagements and requirements for strong sustainability tend to suggest true vendors as VMI partners, and both replenished inventory and managed inventory service models.

Discussion

Table 4 summarizes the factors that affect the choice of model discussed earlier. More than likely, no one model will be fully supported by all the factors. Making choices in these situations, where multiple models are partially recommended, will require decisionmakers to identify priorities for each of the factors; and then evaluate the appropriateness of each model, depending on these priorities.

Table 4. Factors Affecting Choice of Model

Inventory Replenishment Only	Managed Inventory Services	Managed Service As Needed plus TA
• Poor inventory management technical capability at custodians • Product requires basic logistics activity for use in health system • Demand for product expected to be stable • Health reform direction: privatization	• Additional activities needed beyond inventory management (infrastructure maintenance/support) • Product requires additional resource/system/processes to be used effectively, which vendor/third party can provide • Demand for product not expected to be stable • Health reform direction: privatization	• Custodian can, ultimately, assume inventory management capability and/or capability for additional activities • Short-term engagement • Health reform direction: decentralization • Supply chain strategy: capability development in public health supply chain

Vendor	Third Party
• Product or additional service requires vendor's strong familiarity with product • Sufficient capability for managed inventory models • Long-term engagement	• Multiple vendors and product from vendors will be pooled to meet demand • Sufficient capability for managed inventory models

Initial Assessment of Benefits, Challenges, and Implementation Requirements

General benefits and challenges of VMI are described in earlier sections. At this point, as part of the implementation process, you should generate a list of benefits and challenges specific to the likely VMI models and potential VMI partners identified.

Frameworks for identifying and presenting benefits include the immediate and contingent benefits used earlier. Where possible, benefits in cost saving and objective supply chain performance improvements should be included, with more qualitative expectations.

Challenges can be presented using the categories used earlier—health programs, infrastructure, products, and potential VMI partners and stakeholders.

Implementation requirements list the required resources and timelines for implementing the model. A framework for identifying these resources and likely expectations for each model is given later in this section. Components of the framework for managing implementation include leadership, financial resources, participative structure, and technical infrastructure.

Reevaluate Decision to Implement VMI

At this point in the sequence of implementation activities, you should re-evaluate the decision to implement VMI; or, in the case of initial uncertainty about the appropriateness of VMI, formally

consider your decision. At this point, you should understand the likely VMI approaches, benefits, challenges, and course of implementation for a more informed decisionmaking process about the potential implementation of VMI, especially when compared to other systems strengthening approaches.

Implementing VMI

The implementation activities in this section are—

1. how to manage the implementation
2. additional necessary activities needed to implement the VMI model
3. model-specific benchmarks for sequencing implementation activities.

The components for managing implementation include leadership, financial resources, participative structure, and technical infrastructure. Each component is defined in table 5. The subsections that follow describe implementation for replenish inventory, managed inventory service, and TA models. These descriptions are summarized in table 6.

Table 5. Implementation Management Components

Implementation Management Component	Definition
Leadership (L)	Responsible for managing relationships across various stakeholders, including third party relationships and sequencing activities required for implementation
Financial resources (FR)	Includes financial resources needed for additional resources and commitments to implement the VMI model. For reference, to address deficiencies in resources and capabilities causing deficiencies in supply chain performance, high financial resources would be needed to completely refurbish custodians and retrain custodian personnel.
Participative structure (PS)	For its best chance to succeed, the set of stakeholders that should also participate, with leadership, to implement the VMI model.
Technical infrastructure (TI)	IT systems and decisionmaking operational processes, as well as technical assistance. For reference, high TI would be required to completely refurbish the custodian's systems and train custodian/customer personnel for commodities with particularly complex consumption patterns—such as artemisinin-based combination therapy or rapid diagnostic tests for malaria.

Table 6. Implementation Management Components and Necessary Activities

VMI Model	How Should It Be Managed? Resources	Necessary Activities
VRI, 3RI	• L: dedicated MOH team • FR: low to moderate (depending on information system) • PS: relevant stakeholders & affected tiers of supply chain • TI: low to moderate (depending on information system)	• Capability assessment of VMI partner and implementation management leadership • Continued reassessment of benefits, challenges, and requirements for implementation • Pilot programs, if no precedence for task shifting
VMIS, 3MIS	• L: collaboration (MOH team and third party/vendor) • FR: moderate to high (depending on systems involved) • PS: all stakeholders • TI: low to moderate	• Capability assessment of VMI partner and implementation management leadership • Continued reassessment of benefits, challenges, and requirements for implementation • Defining key performance indicator to match services being provided • Pilot programs, if no precedence for task shifting
IMTA	• L: collaboration (MOH team and third party/vendor • FR: moderate to high (depends on length of TA) • PS: all stakeholders • TI: moderate to high (depends on extent of original dysfunction and targets for technical assistance)	• Capability assessment of VMI partner and implementation management leadership • Continued reassessment of benefits, challenges, and requirements for implementation • Defining monitoring systems to determine who is responsible for poor technical assistance progress (vendor/3rd party or custodian)

Replenished Inventory Models

For replenished inventory models, the most appropriate leadership is a dedicated MOH team. The financial resources and technical infrastructure required to setup this VMI model tend to range from low to moderate, depending on the quality of the custodian's inventory information system; the higher the quality, the lower the financial resources needed. The appropriate participative structure for these models includes interaction among the stakeholders that will potentially be affected by improvements in the performance of the replenishment of the commodities; and representatives of the custodian and other tiers of the supply chain also affected when the model is implemented—SDPs who receive deliveries of the commodities.

Managed Inventory Services Models

For managed inventory services models, the most appropriate leadership is a collaborative team of a dedicated MOH team and the VMI partner. This model requires a team, unlike the replenished inventory models, because of the increased complexity. Introducing the VMI partner into the leadership team, in addition to its obvious participation in overall implementation, gives the VMI

partner sufficient authority to help design the features of the VMI model, because they will be responsible for providing the additional services. The financial resources and technical infrastructure involved in setting up this VMI model tends to range from moderate to high, depending on the additional systems that must be introduced or improved, and the number of additional services needed for the model. The technical infrastructure will also depend on the complexity of providing the additional service. The appropriate participative structure for these models similarly involves all stakeholders identified for the replenished inventory models; and other stakeholders who may not be directly affected by inventory availability performance, but who have general interest in the public health system. It may be appropriate for such stakeholders to be involved in the implementation; because the managed inventory service model involves a much more significant interdependence with the VMI partner, including implications about health and supply chain strategy that these stakeholders will want to monitor.

Inventory Management Technical Assistance

As with the managed inventory service, the most appropriate leadership for inventory management TA models is a collaborative team of a dedicated MOH team and the VMI partner. Again, a team is required, unlike the replenished inventory models, because these models are more complex. The financial resources and technical infrastructure for setting up this VMI model tends to range from moderate to high. The technical infrastructure tends to increase as the dysfunction of the resources increases, and decreases when the skill set in personnel is strengthened and is the core of the strategy being used for TA. The financial resources increase with the length of the TA; and, generally, with the extent of the custodians' inventory management dysfunction. The appropriate participative structure for these models include all the stakeholders identified for the managed inventory service models, including stakeholders with only a general interest in the public health system.

Necessary Activities

Across the different models, one required activity is a capability assessment of implementation management leadership. Table 6 describes some of the expectations for this leadership.

Another necessary activity across the different models is a deeper capability assessment/ confirmation of potential VMI partners. The previous section described the set of skills required for VMI partners in the different models. Examining historical performance, current management approaches, and resources of potential VMI partners is crucial for determining if they have the requisite capability for a VMI partner. Recall that for IMTA and Managed Inventory Services models, the capability requirements for the VMI partner include the additional services that are being offered in the model. For the IMTA model, the capability requirements for the VMI partner are greater than for other models—not only must the VMI partner be able to provide inventory management services, as needed; but the VMI partner must also be able to provide TA.

Finally, across the different models, a concerted effort should be made to continually revise expectations for benefits, challenges, and implementation requirements. These revisions ensure that changes in expected outcomes from the VMI approach, for whatever reasons, are highlighted as soon as possible. This will facilitate different types of course corrections—including potentially cancelling or postponing the implementation—to ensure that the expected savings are realized and scarce resources are not wasted.

A particularly important activity for RI and Managed Inventory Services models is piloting the VMI model with a small number of custodians or a virtual pilot. To test the model in a controlled setting

before a full-scale implementation; document, on paper, the decisions that VMI partner would have made and compare them to the actual decisions made by the custodian.

Managed Inventory Services and IMTA models have additional required activities for performance monitoring. A necessary activity for the Managed Inventory Services model is creating appropriate objectives to guide the performance of the VMI partner. These objectives are particularly crucial as they must guide all the services being provided. For the IMTA model, objectives for the VMI partner's performance and evaluation must be carefully selected to guide both the inventory management services and the TA. As such, the objectives should include both process-based indicators (to capture TA performance), as well as outcome-based indicators.

Sequence of Implementation Activities

This section includes a detailed sequence of activities that you can use as a reference for implementation. The sequence of activities is structured in two subsections: the first represents activities for implementing replenished inventory and Managed Inventory Services models; and second, the activities meant for the inventory management TA model. For brevity of presentation, the second subsection for the IMTA model will draw, where appropriate, from the description of implementation for the RI and Managed Inventory Services models.

Implementation of replenished inventory and managed inventory services models

This sub-section presents a sequence of activities that you can use as a reference for implementing the replenished inventory and managed inventory service models. Highlights of this sequence of activities include details into pilot activities, including collaboration with VMI partners to determine the operational parameters of the model; virtual pilots; and evaluation of pilot results to structure the parameters for the final model.

Implementation Steps for Replenished Inventory and Managed Inventory Services Models

1. Develop a memorandum of understanding (MOU) between the Ministry of Health (MOH) and VMI partner.
2. Pilot
    a. Select a small number of diverse facilities to run the pilot.
        i. Given the constraints on VMI partner's resources, make sure the number of facilities is large enough, and similar in geographical location and other relevant factors, to ensure that sufficient scale of economies exist for the VMI partner to assume their share of financial costs for participating in the pilot.
    b. Share available historical inventory and consumptions data with VMI partner.
        i. If no data is available, use at least four months of data that is diligently collected and shared.
    c. VMI partner designs or adjusts information system to ensure it is integrated with the custodian.
        i. If historical data is not available, share any historical data or collection of new data to test some parts of the newly designed information system.
    d. VMI partner designs forecasting approaches used for replenishment decisionmaking.
    e. Collaboratively create inventory targets and expectations for transaction processing for VMI partner.
        i. Involve the custodian, VMI partner, and other stakeholders, especially if stakeholders provide funds for procurement.
        ii. One collaboration goal is to agree on inventory targets/objectives that will drive VMI partner's decisionmaking and jointly agree on how these targets will affect the resource requirements—funding, storage space, transportation, etc.
        iii. Another goal is to understand the transaction processing that will ensure transparency in and integrity of records of inventory movement, especially to ensure inventory target/objective compliance and financial compensation, if needed.
    f. Run virtual pilot for 2–3 months by paper-tracking the supplier's recommended replenishment quantities and timing deliveries with the current custodian's approach.
        i. Ensure that the virtual pilot allows for additional testing of supplier's inventory system and forecasting approaches.
        ii. Extend the length of the paper-tracked pilot to allow for improvements in both information system and approaches and for credibility in these systems, which will be built with custodians and stakeholders.
    g. Run physical pilot for six months.
        i. Physical pilot includes the full set of physical and management activities that would be part of the final VMI project implementation.

ii. To alleviate anxieties about the physical pilot, make visible contingencies for potential unforeseen challenges to ensure that inventory availability will not be adversely affected. For example, set aside a buffer stock of inventory in nearby locations in case of delivery issues; or, during implementation, give the supplier a physical presence at the facility much more often than expected.
iii. Collect detailed information on the performance of the pilot covering areas such as—
    1. inventory targets/objectives compliance
    2. inventory availability
    3. custodian staff perspectives.

h. For pilot results, refine processes and systems and evaluate—
i. inventory targets/objectives for supplier with all stakeholders, including updated implications for required resources
ii. transaction process for transparency and integrity
iii. information systems and forecasting approaches
iv. resulting levels of inventory availability
v. facility staff perspectives on performance of pilot.

3. Establish detailed contract or understanding between VMI partner and MOH, particularly based on results from pilot.
4. Implementation
a. Given constraints on supplier resources, plan a phased introduction of the approach.
i. For the full-scale implementation, select the number of facilities in each phase to ensure a sufficient scale of economies for supplier to assume their share of financial costs and operational disruption.
b. Share available historical inventory and consumptions data with VMI partner.
i. If no data is available, use at least two months of data that was diligently collected and shared.
c. Execute the phased implementation.

Implementation for inventory management technical assistance model

This sub-section presents a sequence of activities that you can use as a reference for implementing the inventory management TA models. The highlights of this sequence of activities include the mapping of assessed capability deficits to VMI mode of operations and the approach to the pilot.

Implementation Steps for Inventory Management Technical Assistance Model

1. Execute a memorandum of understanding (MOU) between the Ministry of Health (MOH) and the VMI partner.
2. Assess the capability of the custodian.
    a. Determine how much development the custodian will need.
3. Map the sequence of operational modes that will probably be required for the length of the engagement, which will depend on the capability deficits in the custodian.

The following sequence is for three levels—poor, mediocre, and fair:

- a. Poor (human resource, infrastructure, and processes are weak)
    - i. Replenished Inventory/Managed Inventory Services (to stabilize inventory availability)
    - ii. in-service training
    - iii. contingency based (after activities begin to transition back to custodian)
    - iv. process monitoring.
- b. Mediocre (infrastructure and processes are weak)
    - i. in-service training
    - ii. contingency based (after activities begin to transition back to custodian)
    - iii. process monitoring.
- c. Fair (process-compliance is weak)
    - i. in-service training
    - ii. contingency based (after activities begin to transition back to custodian)
    - iii. process monitoring.

4. Pilot

- a. Poor capability at custodian
    - i. Pilot Replenished Inventory/Managed Inventory Services (see section above)
    - ii. After custodian sufficiently stabilized, pilot process improvements/compliance (see *Fair* capability at custodian below)
- b. Mediocre capability at custodian
    - i. Pilot improved infrastructure—information systems, forecasting approach, etc.
        1. Select several facilities, etc.
- c. Fair capability at custodian
    - i. Pilot process improvements/compliance
        1. Select several facilities, etc.

5. Establish detailed contract or understanding between VMI partner and MOH, particularly based on results from pilot.
6. Implement on a full scale.
    a. in phases, if appropriate
    b. transition through operation modes as activities transition to custodian.

Operations Management

This section describes the significant issues involved in the operational management of the VMI models after they are implemented—from the perspective of the public health customer—and it focuses on the challenges for continual execution. Table 7 summarizes the issues.

Table 7. Challenges for Continuous Execution of VMI Model

VMI Model	Challenges for Continual Execution
Replenished Inventory (RI)models	• Monitoring inventory quantities and matching with invoices • Readjusting vendor objectives, if needed • Sustainability, if not funded from operations revenue (3RI)
Managed Inventory Services models	• RI model challenges • Problem solving for additional services • Tensions with private sector (VMIS)
Inventory management technical assistance	• Vendor or third party may not completely control outcomes

Replenished Inventory Models

The main challenges for the continual execution of RI models is the monitoring of inventory quantities, matching inventory flow with invoices, and readjusting vendor objectives when, and if, needed. If not funded from its operations revenue, a third party as a VMI partner introduces an additional challenge to the financial sustainability.

Although the VMI partner is responsible for managing inventory for the custodian, to verify the inventory flows being claimed by the VMI partner, especially for compensation and performance evaluation, the customer must be able to monitor inventory at the custodian. The inventory information system at the custodians is the primary source of this information; its maintenance will be key to addressing this challenge.

As aspects of the public health system evolve over time—for example, demand increases or funding conditions change—it will be necessary to periodically readjust vendor objectives. Instituting and managing the short- and long-term consequences of those changes, while maintaining availability, will be a collaborative effort involving the VMI partner and the public health customer.

Managed Inventory Services Models

The main challenges for Managed Inventory Services models, in addition to those of RI models, are the increased demands for problem solving because of the additional services being provided. Problem solving is raised here as a challenge for the public health customer because, although the VMI partner is primarily responsible for providing the additional services, problem solving will, in many cases, involve changes at the custodians, as well as with the VMI partner. This problem solving should be thought of as a collaborative endeavor between the public health customer and the VMI partner, not only the VMI partner's responsibility.

An additional challenge for true vendors as VMI partners is the reality of the traditional tensions between the public health sector and the private sector. When the true vendor provides additional

services, it creates additional interdependencies between the public health customer and the vendor. Because of these existing tensions, there may be more resistance than with the simpler replenishment models.

Inventory Management Technical Assistance Models

The main challenge for IMTA models will be the operational reality that the VMI partner will not be in complete control of outcomes. As part of the learning process of the TA, at times the VMI partner must relinquish responsibility to the custodian to manage their own inventory. This will introduce more variability in overall performance than in any other model where the VMI partner is always responsible. Again, for the public health customer, recognizing this is important if they are to accurately interpret the performance of the VMI partner; and, to minimize the effects of this inevitable variability in performance, they can manage other areas of the public health system.

Conclusion

The authors of this guide consider the implementation of various VMI models within the public health sector to be a possible way to improve health supply chain performance and access to health products in developing countries. However, implementing VMI is not the only approach that can improve health supply chain performance. But, by providing sufficient information about implementing these models, decisionmaking about supply chain design can be improved by ensuring that such decisions are as informed as possible about the implications.

In conclusion, it is important to stress one of the factors identified in the VMI Appropriateness Assessment Tool as being highly contributive to the appropriateness of VMI models—the consensus among stakeholders of the VMI approach as a collaboration. As a mindset, this collaboration implies that stakeholders and VMI partners are willing to work together to define activities, set expectations, react to unforeseen circumstances, and others. Such a mindset, and the implications of initiating and sustaining it, are particularly crucial for ensuring success in any health systems strengthening approach that involves multiple partners working together—including VMI models.

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Appendix A

VMI Appropriateness Assessment Tool

Instructions for Using the VMI-readiness Assessment Tool

As a large group, discuss each statement in the tool, and then—

1. On the scoring chart, use the rankings zero to four to show how well the group agrees that the statement represents the current situation.
2. Multiply the ranking of each statement by the weight provided.
3. Add the weighted rankings to calculate the final score for VMI-readiness. It will be somewhere between zero and 400.

Scoring Chart	
Do not agree	0
Barely in agreement	1
Somewhat in agreement	2
Agree	3
Strongly agree	4

	Rank (0–4)	Weight	Weighted Score
Custodian/Stakeholders			
An inventory information system, e.g., stock cards, is in regular use at the custodian *and* there is a communication system for inventory information.		5.18	
Custodian has appropriately upgraded its capability to manage inventory if given good data from an inventory management system, e.g., forecasts demand accurately and consistently, identifies inventory management targets—min-max levels—appropriate for its demand environment, etc.		4.14	
All custodians in the same tier of the supply chain are willing to be on managed inventory program, e.g., participate in the inventory, communication, etc.		4.59	
Purchasing/procurement is *not* a core competency for the custodian.		3.47	
Product			
After accounting for known demand drivers, demand uncertainty is low.		4.18	
Product constitutes a high percentage, by value, of the total purchase orders, or is otherwise critical—e.g., condoms, ACTs.		4.8	
For the specific product, stakeholders are willing to share information with supplier/third party.		5.83	
Information about promotions, plans, or other decisions by stakeholders that may affect demand can be communicated, with sufficient lead time for reaction.		5.36	

	Rank (0–4)	Weight	Weighted Score
Funding for procurement is reliable—user fees for sale of commodities, availability of donor funds or government funds.		5.28	
Supplier or Third Party (Would become responsible for managing inventory under the program)			
The supplier/third party candidate has shown technical capability in managing inventory—forecasting, choosing inventory targets, etc.		5.56	
The supplier/ third party candidate has shown capability to foster and manage relationships between various stakeholders and participants in the supply chain.		5.56	
The supplier/ third party candidate has shown inventory management information systems that can be integrated with the custodian(s)—semantics and syntax in the information systems can be synchronized between supplier/ third party and custodian(s).		4.94	
The supplier/ third party candidate has shown capability in managing distribution of health commodities to a supply chain node similar to that of the custodian(s).		4.94	
The supplier/ third party candidate has cultivated high levels of trust with the majority of stakeholders.		5.49	
If required, incentives/willingness exist or can be created for the supplier/ third party candidate to want to assume a management role.		5.15	
Mindset/Management			
Stakeholders view the managed inventory program as a collaboration with the supplier/ third party and are willing to work together to define activities, set expectations, react to unforeseen circumstances, etc.		5.69	
Relevant stakeholders have management capability for outsourcing—contract negotiation, key performance indicators, design and monitoring, etc.		5.36	
Stakeholders understand the uncertainties around implementing a new model; success could be much greater or much less than expected.		4.39	
As a response to inherent uncertainties, when implementing the managed inventory program, stakeholders will adopt a continuous improvement approach; based on monitoring of system status, identifying gaps in performance, and determining root causes of gaps.		4.88	
Stakeholders are willing to potentially invest more resources, if needed.		5.21	
		Final Score	

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