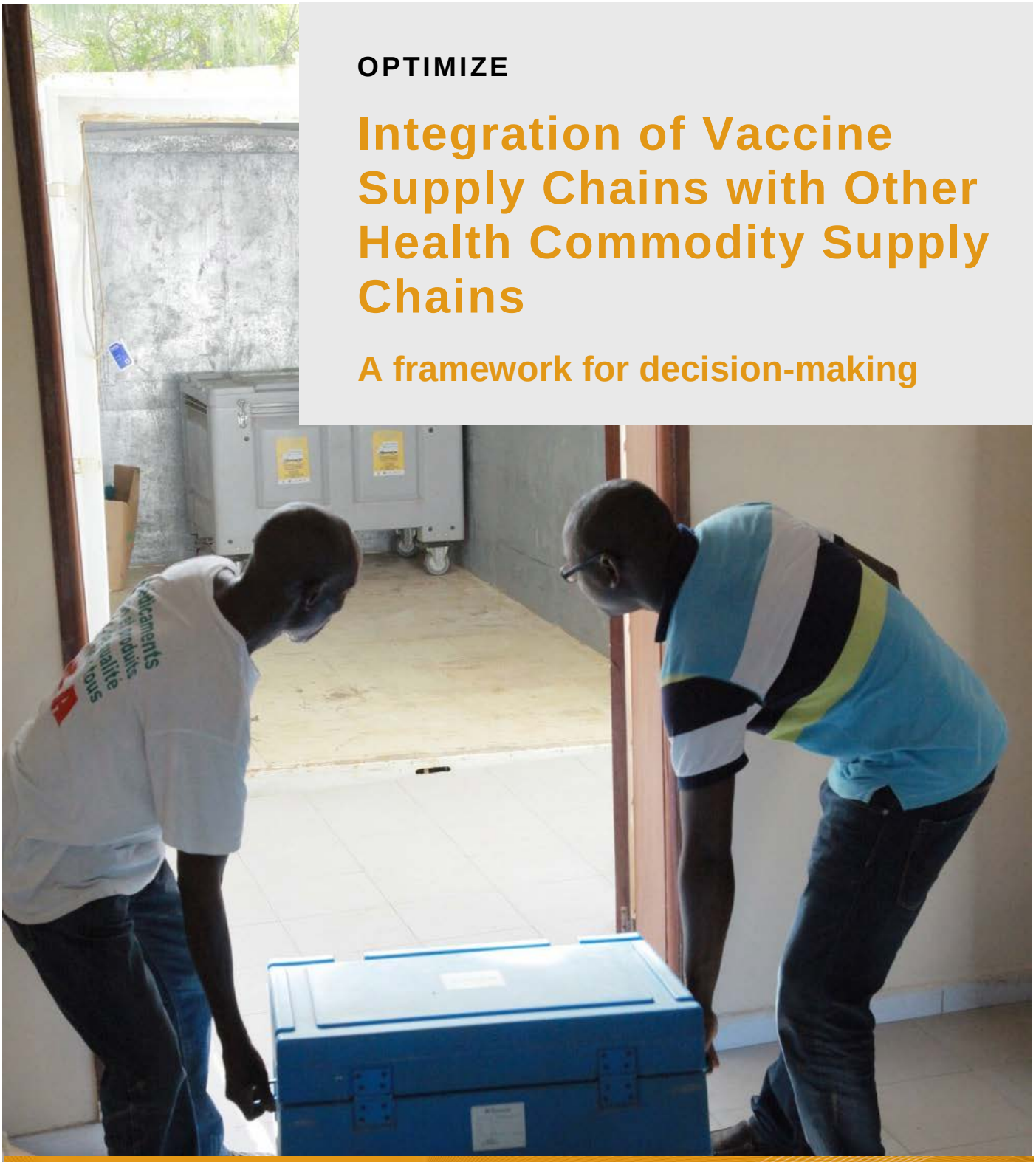
OPTIMIZE

Integration of Vaccine Supply Chains with Other Health Commodity Supply Chains

A framework for decision-making



OPTIMIZE Immunization systems and technologies for tomorrow

PATH World Health Organization

This report was commissioned by Optimize: Immunization Systems and Technologies for Tomorrow, a collaboration between the World Health Organization and PATH. The report was authored by Prashant Yadav, William Davidson Institute at the University of Michigan, and Julianna Oswald at the Stephen M. Ross School of Business.

Contact information:

Patrick Lydon
Technical Officer, Geneva
lydonp@who.int

PATH addresses:

Mail
PO Box 900922
Seattle, WA 98109 USA

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

www.path.org

World Health Organization address:

World Health Organization
20 Avenue Appia
CH 1211 Geneva 27
Switzerland

www.who.int

Suggested citation
World Health Organization (WHO), PATH. *Integration of Vaccine Supply Chains with Other Health Commodity Supply Chains: A framework for decision-making*. Seattle, WA: WHO, PATH; 2013.

This work was funded in whole or part by a grant from the Bill & Melinda Gates Foundation. The views expressed herein are solely those of the authors and do not necessarily reflect the views of the Foundation.

Cover photo: PATH/Mariama Guèye.

OPTIMIZE

Integration of Vaccine Supply Chains with Other Health Commodity Supply Chains

A framework for decision-making

August 2013

CONTENTS

Acknowledgments

This research study has benefitted tremendously from the valuable insights, information, and opinions of the following individuals:

Modibo Dicko, World Health Organization

Patrick Lydon, World Health Organization

Maeve Magner, Imperial Logistics

David Sarley, Bill & Melinda Gates Foundation

Robert Steinglass, John Snow, Inc.

Michel Zaffran, World Health Organization

In addition, many members of TechNet-21 have provided valuable feedback.

Acronyms

The following acronyms are used in this document.

ACT	artemisinin-based combination therapy
AIDS	Acquired Immune Deficiency Syndrome
ARV	antiretroviral drug
DPM	Department of Pharmacy and Medicine
DSR	Department of Reproductive Health
DSRE	Department of Reproductive Health and Child Survival
EPI	Expanded Programme on Immunization
EVM	effective vaccine management
FP	family planning
FTL	full truckload
HIV	human immunodeficiency virus
IPTi	intermittent preventive treatment (malaria) for infants
LMIS	logistics management information system(s)
LTL	less than truckload
MOH	ministry of health
NIP	national immunization program
PATH	Program for Appropriate Technology in Health
PDA	district supply pharmacy
PNA	National Supply Pharmacy
PNT	National Tuberculosis Program
PRA	Regional Supply Pharmacy
SDP	service delivery point
TPLs	third-party logistics companies
UNICEF	United Nations Children's Fund
USAID	US Agency for International Development
WMIS	warehouse management information system
WHO	World Health Organization

Executive summary

One of the primary objectives of national immunization programs is to strengthen and optimize immunization supply chains so that vaccines are delivered effectively, efficiently, and sustainably. As a result of increasingly large investments in global health and a wide portfolio of vaccines, supply chains for vaccines and essential medicines are under increasing pressure to operate at their most optimal levels. This recent focus on efficiency has led to an increased focus on merging multiple disease-specific supply chains, such as vaccines, maternal and child health medicines, and family planning products, into one integrated supply chain. To undertake such integration requires precise coordination, as there are a wide variety of product supply chains, all managed under different agencies, transported to multiple service delivery points, and many have unique needs such as the need for controlled temperatures.

There is ambiguity as to whether or not supply chains for vaccines should be integrated with other supply chains and whether the proposed benefits outweigh the costs. Decisions regarding which supply chains to integrate and which stages of the process to synchronize can be dauntingly complex. Compared to vaccines, products such as malaria medicines have a less predictable and more seasonal demand schedule and require different operating rules than vaccines, which are distributed according to a pre-specified schedule or based on birth-cohort enrollment. Another important consideration is that products with cold or cool chain requirements necessitate stricter stocking, transport, and resupply intervals than essential medicines or other health products. Furthermore, the service delivery points to which the product has to be supplied also impact its resupply interval. National immunization programs are understandably cautious to approach integration, as separate supply chains allow each program management team the full span of control as well as the ability to tailor their supply chain strategies to their program-specific service targets. This reluctance is further exacerbated by the fact that many of the attempts to integrate to date have either (a) not progressed due to political unwillingness, or (b) have not yielded their promised outcomes.

The goal of this technical report is to provide national immunization program managers, their technical support staff, policymakers in ministries of health, and global agencies involved in vaccine and health product supply chains with a better understanding of the benefits and potential risks of integrating vaccine supply chains with other health commodity supply chains. With input from a variety of experts including those from the World Health Organization, project Optimize, TechNet-21, and the International Association of Public Health Logisticians, this report provides both a vision and a concrete framework for such integration. With a specific focus on those health commodities that are delivered to end-patients in public health facilities, this framework can be used as a decision aid by national immunization programs to determine what activities, if any, within their supply chain can yield benefits if integrated. It can also be used as a resource to guide the alignment and coordination of various international initiatives around supply chain integration.

This report incorporates recent case study results on vaccine supply chain integration efforts in Senegal and Tunisia carried out through project Optimize. They demonstrate that it is easier to integrate supply chains for vaccines and other health products at lower levels of the supply chain, such as between the district-level facilities and local health clinics. To integrate further upstream could be more problematic, as programs are coordinated by separate agencies and integration requires more buy-in from political stakeholders. These two cases serve as a means for understanding the barriers to integration and also to inform the development of the proposed framework and report recommendations.

The proposed framework identifies opportunities to integrate supply chains for vaccines with those for other health commodities at different points along the supply chain. Stages evaluated for their integration potential include:

- **Quantification.** It is difficult to integrate the quantification and demand-planning of vaccines and other health products in the quantification stage. The projected number of vaccines needed is calculated based on birth-cohort size, historical or targeted immunization coverage rates, and a buffer for wastage and pipeline inventory. The demand for medicines is more complicated, as projections factor in disease incidence, treatment-seeking behavior, and many other factors, making these two areas hard to integrate. At this level of the supply chain, the only potential for integration is in shared repositories for demographic data so that population-level information can be pulled from the same source.
- **Procurement.** Vaccines and other health products have very different procurement processes. Many national immunization programs procure their vaccines through the United Nations Children's Fund, while medicines are procured through a country's ministry of health or through a third-party contractor. As such, procurement is a difficult stage for much integration.
- **Requisition/ordering.** Due to the very different order schedules and processes, the costs of integration at this point of the supply chain likely outweigh the benefits. Requisitions for vaccines are carried out using a routine order process typically managed based on immunization schedules and birth cohorts. Essential medicines follow a less predictable process that relies on health center staff requesting quantities based on the needs in their specific facilities.
- **Storage.** There are significant opportunities for integration between vaccines and other health products at the storage phase of the supply chain. While most vaccines must be stored at specific cold temperatures (cold chain), this is also true for some medicines for noncommunicable diseases, HIV test kits, and utero-tonics for maternal health. Integration at this level could lead to savings in fixed costs such as storage security or administration and could also lead to improvements in storage conditions across different products. The large need for additional temperature-controlled storage space resulting from the introduction of new vaccines provides a clear integration opportunity at this stage in the supply chain.
- **Transport.** There are tremendous opportunities for integration at the transport stage that could lead to greater efficiency across supply chains. By using the same trucks to transport both vaccines and medicines from delivery points such as the district storage facilities to health clinics, savings can be created in areas such as vehicles, fuel, and personnel costs. Furthermore, integration will allow for fuller truckloads and will also require an increased frequency of delivery, which could further benefit stocking accuracy. The challenge with integration at this stage is to ensure that it does not delay the delivery of vaccines, which must be delivered according to a strict timetable.
- **Information systems.** Vaccines and other health products can be integrated very effectively at the information system level. The commercial sector has demonstrated that while there may be multiple supply chains to suit product- or customer-specific requirements, they can be managed and coordinated using a common information system. In addition to saving on fixed costs, a common system would provide ministries of health with an integrated overview of multiple supply chains that could allow for coordination between otherwise fragmented agencies.

The variety of products contained in the supply chains for vaccines and health commodities is vast and is further complicated by each product having its own unique demand and supply-side characteristics. If not implemented well, integration could lead to mediocre outcomes in program performance or even supply chain disruptions if too much is integrated too fast. However, if attempted with carefully selected

products at specific stages of the supply chain, such integration can greatly enhance both the effectiveness and efficiency of public health supply chains in resource-constrained environments.

The integration of vaccine supply chains with those for other health commodities can lead to improved economies of scale and scope. Investments in supply chain security can yield better returns, as integration can lead to savings in fixed costs in areas related to transport, warehousing, distribution, and supervisory control. The greatest challenge in integrating multiple supply chains is in managing the variety of product and customer requirements without compromising effectiveness. This report proposes that approaches be crafted that segment health products into groups with closely matched demand and supply-side characteristics.

This report presents a framework developed to weigh the costs and benefits of integrating specific stages of the vaccine supply chain with other health products. It suggests that while the benefits of integration are higher at the upstream stages, there are also significant challenges associated with obtaining the necessary buy-in from policymakers and program managers across multiple agencies. Instead, it recommends trying integration further downstream, at the “last mile” of the supply chain—areas such as warehousing, transport, and information systems. The highlighted case studies help to illustrate how transport and distribution from the district to health facilities can be integrated, as references for national immunization programs. It is critical that supply chain integration be approached with care. Rather than attempting to integrate full systems, minor integration should start at specific points along the supply chain first and move upstream from there.

Introduction

Supply chains for vaccines and essential medicines are under increasing pressure to operate more effectively and efficiently. Large-scale investments and a wider portfolio of vaccines have highlighted the need to achieve higher efficiency in vaccine supply chains.[1,2] Supply chains that deliver public health commodities serve a variety of service delivery points, including hospitals, health centers, health posts, and in some cases private outlets. In addition, a large variety of products flow through these supply chains, including vaccines, malaria medicines, bednets, HIV/AIDS medicines and test kits, family planning (FP) products, and other essential medicines. Most countries reliant on external development assistance for health have separate supply chains for specific categories of products: typically a supply chain for program-specific drugs (malaria, HIV/AIDS, tuberculosis), a FP product supply chain, an Expanded Programme on Immunization (EPI)/vaccine supply chain, and a supply chain for all other essential medicines and health products. A recent World Health Organization (WHO) study in 13 countries found that on an average, there are 18 procurement agencies and 84 distribution channels in each country.[3] Proponents of such an architecture, which leads to almost separate supply chains for each disease program, argue that disease-specific supply chains allow better management span of control and allow supply chain strategy to be better aligned with the program strategy. Program-specific supply chains allow for the design of policies and procedures to achieve program-specific service targets. Others argue that this fragmented structure leads to redundancy, unnecessary complexity, and poor coordination. Multiple parallel supply chains result in poor economies of scale and scope and therefore higher costs and lower efficiency. A recent focus on efficiency has led to numerous initiatives focusing on merging multiple disease-specific supply chains into one “integrated” supply chain. However, many of these attempts to integrate have either not progressed far due to political unwillingness, or in some cases have not yielded their promised outcomes.

The supply chain for vaccines operates within such a context. A typical ministry of health (MOH) in a low-income or lower-middle-income country runs multiple program-based supply chains, of which the EPI/vaccine supply chain is one. In theory, integrating vaccine supply chains with those for other health products could improve overall efficiency by distributing the costs of warehousing, transport, and other such shared functions across a number of program areas. However, in many countries, the supply chains for EPI vaccines are functioning reasonably well relative to some other disease programs. Integration across multiple products adds tremendously to the complexity of supply chain management. In such instances, integrating the vaccine supply chains with other supply chains requires intensive and complex coordination; otherwise, the performance of vaccine supply chains could suffer. Given the varying characteristics required for warehousing and distributing vaccines as compared to many other health products (cold chain, resupply intervals, scheduled vaccination cohorts, etc.), it is evident that integrating vaccines with other health products into a single supply chain could lead to mediocre effectiveness. In some instances, it may not even be able to achieve the intended efficiency gains.

The primary objective of the vaccine supply chain is to deliver vaccines effectively, efficiently, and sustainably. Project Optimize defines the target state of immunization supply systems as “...to maximize effectiveness, agility (to quickly respond to changes in the demand or supply environment), integration with other supply systems (when relevant); and to support continuous system improvement through learning, innovation and leveraging synergies with other sectors (including the private sector).”[4] This definition makes it clear that integration should be pursued only if it acts as a means to achieving the main

objectives of the immunization supply chain, rather than pursuing integration as an objective in and of itself.

Historically, most of the key essential medicines and products that were part of the primary health care package did not require cold chain storage, whereas vaccines did. This led to the EPI functioning through a separate vertical supply chain system for delivering vaccines. As many new and underused vaccines of public health importance are being introduced in developing countries, lack of capacity in the vaccine supply system is becoming a key bottleneck. Integrating the supply chains for essential medicines and vaccines is being touted as a possible way to address this challenge and increase capacity. In addition, some of the newer medicines included in primary care require temperature-controlled chains. MOH and EPI program managers in many countries are faced with the challenge of whether to integrate the EPI/vaccine supply chain with other health products and which products and what portions to integrate. Answering this requires careful analysis and learning from the experiences of other EPI programs. Currently, there are limited evidence and documented case studies to find answers to these questions or even to guide these discussions. While finding the appropriate integration strategy is a very context-specific challenge and there is no one-size-fits-all method, this report attempts to provide a generic decision framework that can be used by global agencies and EPI program managers.

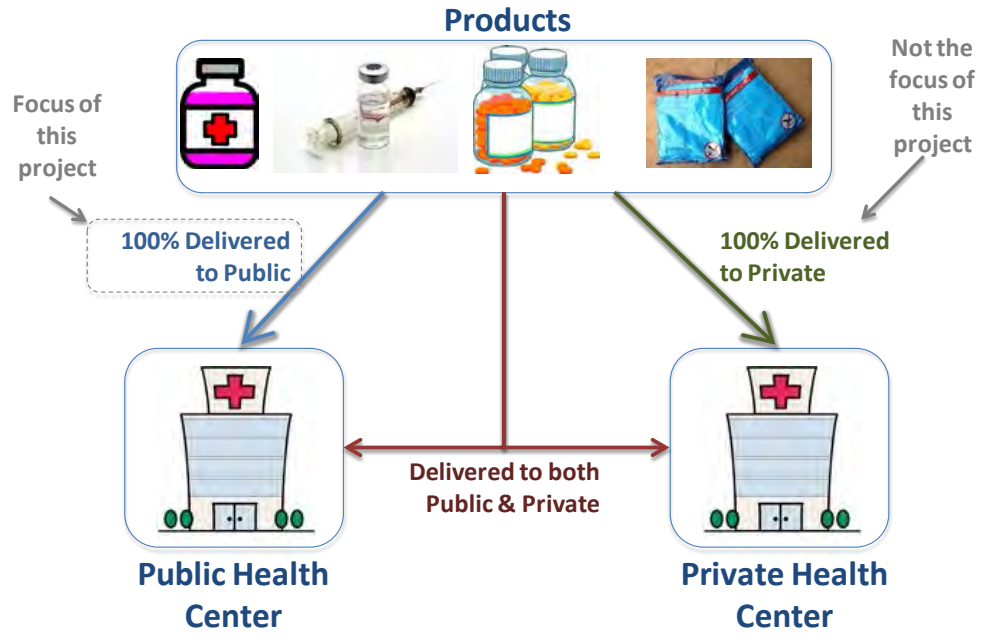
Scope of this report

The purpose of this report is to provide a better understanding of the costs and benefits of integrating vaccine supply chains with other health product supply chains. The report will help national immunization programs (NIPs) and global agencies to evaluate the role of integration while developing strategies for improving the performance of vaccine (and other health product) supply chains. This report also provides a framework that can be used as a decision aid by NIPs to determine what activities, if any, within their supply chain can yield benefits if integrated. A clearly articulated framework for this decision would also provide a foundation to align and coordinate various international initiatives around supply chain integration.

This report is written primarily for NIP managers and their technical support staff, policymakers in ministries of health, and global agencies involved in vaccine and health product supply chains. It analyzes integration of supply chain functions but does not necessarily explore service delivery integration. While integration of primary health care and linking immunization to other services such as integrated management of childhood illness and provision of intermittent preventive treatment of malaria in infants (IPTi) have been noted to be successful approaches in some cases, this report does not delve into understanding the costs and benefits of integrated service delivery.

Supply chains for health products include a vast variety of products, some of which are delivered at public-sector hospitals, clinics, and health posts, whereas others are accessed through private outlets, social marketing, or other channels. It can be challenging to study the costs and benefits of integrating with all such products and in some cases the differences in the service delivery points may not render integration feasible. This study focuses only on those health products which are delivered to end-patients in public health facilities (see Figure 1 below). Also, this report considers supply chain integration only from the perspective of routine immunization services and not as part of supplemental immunization activities (that is, campaigns).

Figure 1. Project scope



Definition of integration

Within the context of global public health, there are a number of different definitions and interpretations for the term “integration” as it is used by the supply chain community.[5] In many instances, supply chain integration refers to the integration of information flows between the different levels and functions within a supply chain. While this definition is important and often such integration can be a source of significant performance improvement, it is not the definition this study is based on. For the purposes of this study, we define integration as: the merging of more than one vertical supply chain for specified programs or product categories.

Methodology

This report covers a review of existing published literature on supply chain integration within the context of public health supply chains, vaccine supply chains, and to some extent the commercial sector, as well as a desk review of background technical documents, including previous technical documents on supply chain integration.

The literature review was used to develop a comprehensive understanding of the benefits, costs, and challenges associated with integration of supply chain functions in public health supply chains. In addition, an earlier literature review by Milstein was used to complement the literature search carried out for this study.[6]

Integration of FP programs into other health services has been pursued by many countries in Latin America, Asia, and Africa, and the USAID | DELIVER PROJECT has successfully captured the key lessons learned from such integration initiatives).[7,8] These findings were used to supplement the published literature and technical documents.

We then used findings from a large sample questionnaire conducted by M. Dicko in 2011 to assess the extent of supply chain integration currently being pursued by different NIPs. This study was used to understand the current state of affairs and to validate our later assessments of the ease of integrating specific functions within the supply chain.

Case studies from Senegal and Tunisia, where project Optimize implemented demonstrations of vaccine supply chain integration, served as a means for understanding the barriers to integration and also to further develop the framework.

Meetings and telephone interviews were then conducted with five to six main stakeholders that are involved in vaccine supply chains at the global level and are knowledgeable about supply chain integration.

Responses to questions posted on the International Association of Public Health Logisticians forum regarding integrating vaccine supply chains with other supply chains were also utilized to gain further insights.

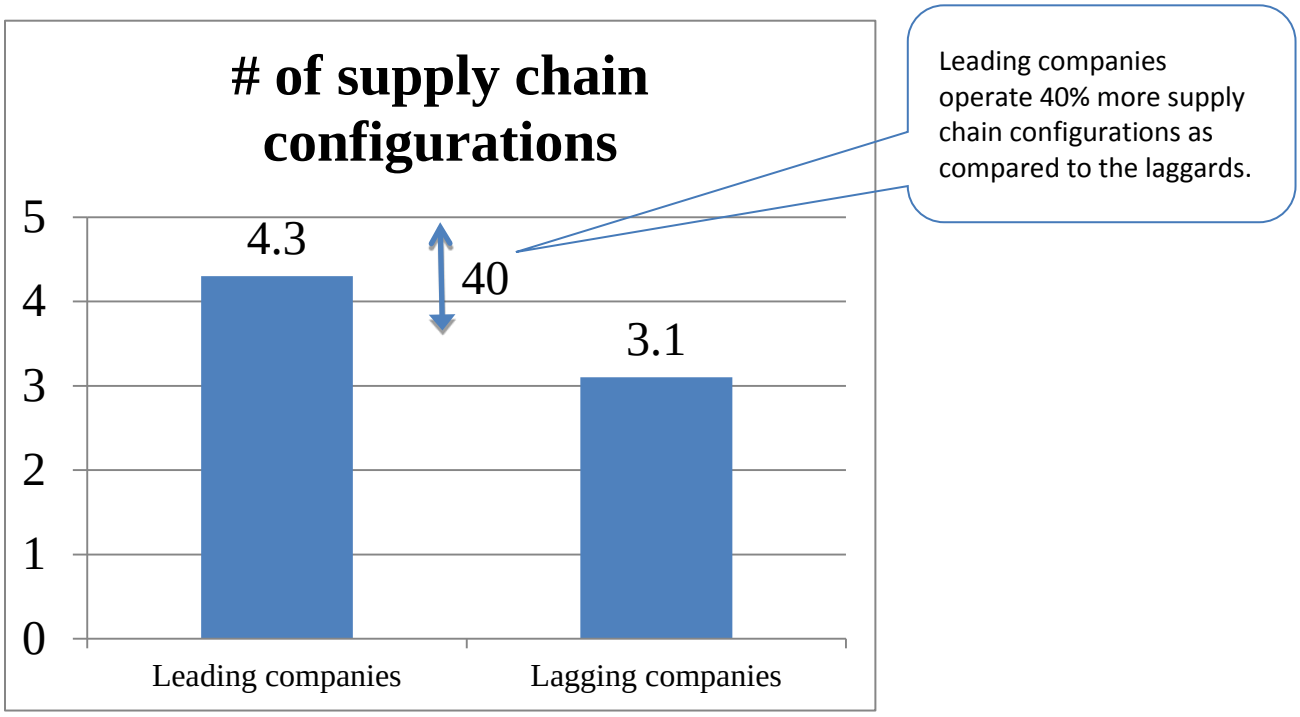
The preliminary framework was presented to a large group of stakeholders at TechNet 2013. Comments from consultations at TechNet 2013 were used to further refine the framework.

Supply chain integration in the commercial sector

The commercial sector has developed and operates effective and efficient supply chains for a variety of products. Many argue that the high availability of consumer products at retail outlets in the most remote areas of the world is indicative of the effectiveness and efficiency of commercial-sector supply chains. While there are significant differences between the strategic objectives and operating rules of commercial-sector supply chains as compared to vaccine and essential medicine supply chains,[9] it is worth understanding the extent to which supply chains in the for-profit commercial sector are integrated across product categories.

As discussed earlier in this report, integration in the commercial sector is used more often to refer to integration across functions within a supply chain for a single product category and less for supply chains integrated for different product categories. However, some recent studies have captured the extent of supply chain integration across product categories. A recent study by PricewaterhouseCoopers shows that companies that are leaders in supply chains operate a greater number of supply chain configurations (see Figure 2).

Figure 2. Supply chain integration in commercial for-profit companies[10]



A more comprehensive review reveals that leading commercial companies tailor their supply chains to serve different products to different customer segments through different supply chain configurations. They rely on effective segmentation of product categories based on careful analysis of a select criterion. The segmentation is done based on both customer and product characteristics. Tailored supply chains are then designed for each segment (see Figure 3).

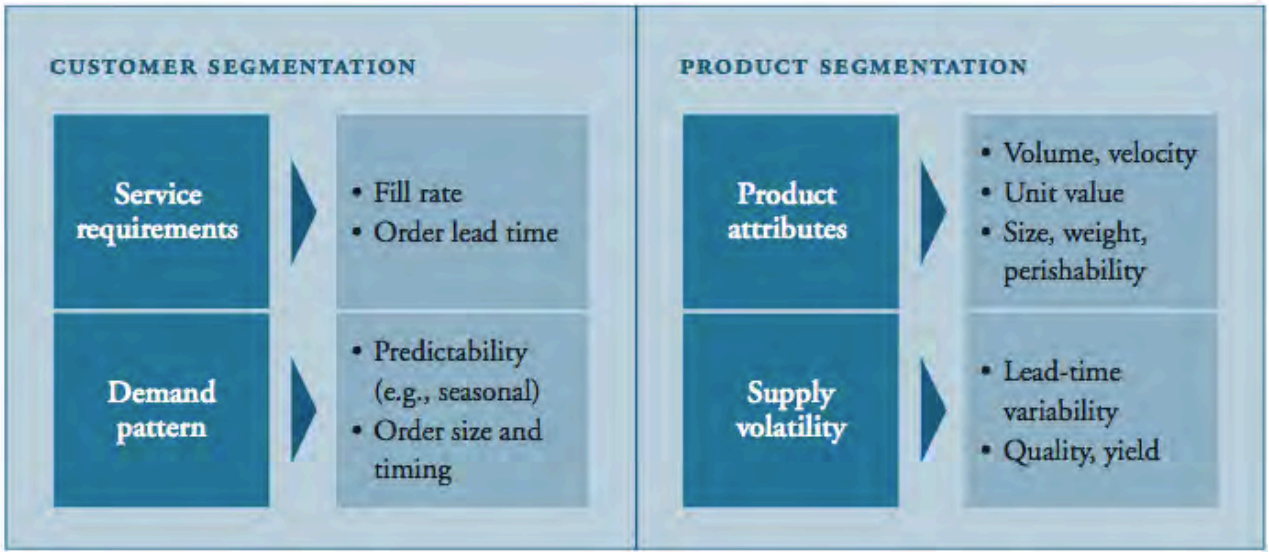
When looking at integration across product categories distributed by the same company, we find that even when physical supply chains are segmented and separate, there is a common information architecture that

allows multiple unique supply chains to reconcile their inventory status, physical flow, and financial information at the highest level.

In many instances, the supply chains of products from different companies are integrated because many of the supply chain functions are carried out by third-party logistics companies (TPLs). The TPLs combine the distribution and transport loads of different companies and also carry out many supply chain planning functions across the range of products they handle. This enables allocating fixed costs to a large number of product categories and achieving the efficiency gains from integration.

The practice under which different companies distributing similar products collaborate to achieve efficiencies in distribution costs is termed as "horizontal collaborative distribution." While some long-term horizontal collaborative partnerships exist in freight transportation, even in the commercial sector, there are large opportunities for efficiency gains through horizontal integration that have not been fully exploited. A lack of appropriate governance structure, unclear rules for sharing the gains achieved, and trust issues have been noted to be reasons why horizontal integration in supply chains is not so common across companies in the commercial sector.

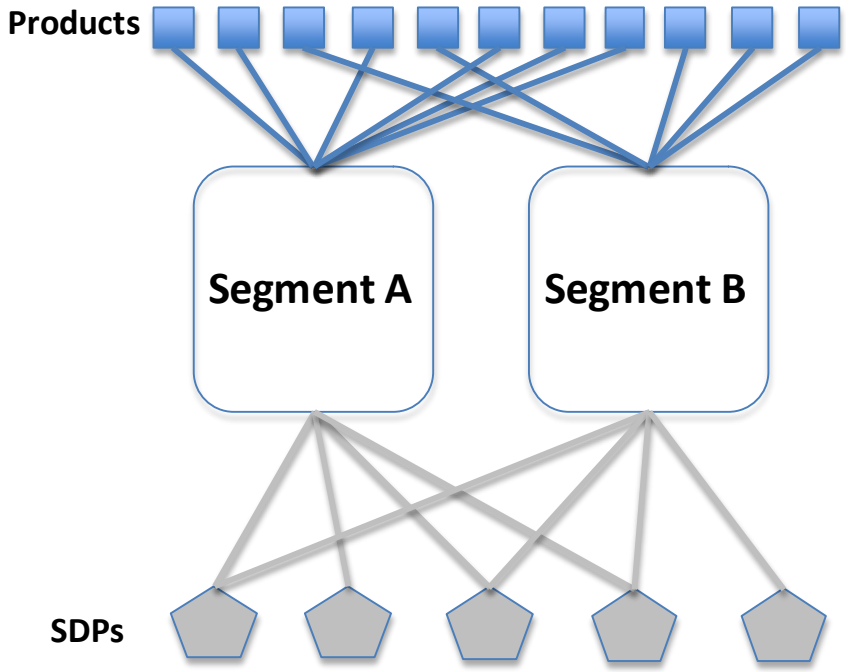
Figure 3. Use of customer and product segmentation in commercial for-profit companies to design tailored supply chains[11]



Segmentation of health products to analyze integration opportunities

Supply chains for vaccines and health products consist of a vast variety of products, each with its own demand and supply-side characteristics. It can be challenging to design an integrated supply chain that can manage this variety of product and customer requirements without compromising effectiveness. A key best practice from the commercial sector is segmenting health products to identify groups of products that are appropriate for integration (see Figure 4). A tailored supply chain can then be designed for each segment which would yield higher benefits from integration and also result in easier implementation (see Table 1).

Figure 4. Segmented supply chain integration



SDPs = service delivery points.

Table 1. A set of product attributes to consider in segmentation

Product attributes for segmentation
• **Planning and quantification requirements and frequency**
• **Supply sources**
• **Demand uncertainty/variability**
• **Demand seasonality**
• **Frequency of supply/resupply interval**
• **Temperature requirements (i.e., cold chain)**

Product attributes for segmentation
• **Shelf life**
• **Locations and types of service delivery points**
• **Distribution security requirements**
• **Volume**
• **Service-level requirements**

While more detailed product-specific analysis can only be done after looking at product demand patterns within the specific geographical context where integration is being pursued, some clear principles emerge from a first-level analysis. Products such as malaria medicines and essential medicines that have less predictable and more seasonal demand would require different operating rules as compared to products which are distributed according to a prespecified schedule (e.g., bednets and vaccines) or based on patient enrollment (e.g., antiretroviral drugs and some vaccines). While cold or cool chain requirements are an important distinction that would necessitate a different segment, often times the more critical components are the frequency of resupply (periodic versus campaign) and the variability in the demand (uncertain consumption versus enrollment/cohort based). The service delivery points to which the product has to be supplied also impact its resupply interval. Products that are mostly stocked in large hospitals with many patients require frequent (once every week) resupply of hundreds of products. Products for primary health centers located in rural areas may see only a few patients per day and would have resupply intervals of a month or more. Therefore, a high degree of overlap between the service delivery points creates synergies in products for integrated distribution.

Table 2 presents our preliminary analysis of products that have a potential of being integrated in storage and distribution with vaccines, based on literature and consultations with different stakeholders. It is evident that many products such as deworming tablets, childhood iron or vitamin A deficiency tablets, and IPTi drugs (e.g., sulfadoxine-pyrimethamine) would all be very suitable for integration given the similarities of their target population and distribution schedule with vaccines. Other products such as HIV test kits are ideal candidates for integration due to the temperature-controlled distribution requirements and preset distribution schedule. Some products that are now receiving increased attention, such as uterotonics for maternal health or insulin for diabetes, also offer opportunities for integration with vaccine storage and distribution, as they also need temperature-controlled distribution.

Table 2. Preliminary analysis of product categories that fit with vaccines on specific attributes for integration

Product	Demand-side characteristics with vaccines	Service delivery points	Temperature-sensitive distribution requirements
Deworming tablets (albendazole, mebendazole, levamisole, praziquantel)	Distributed on a preset schedule	Similar to vaccines	Ambient
Childhood iron or vitamin deficiency tablets	Consumption based but somewhat predictable	Similar to vaccines	Ambient
IPTi drugs (sulfadoxine-pyrimethamine)	Distributed on a preset schedule	Similar to vaccines	Ambient
HIV test kits and reagents	Consumption based but more predictable	Often different from vaccines	Controlled temperature or cold chain
Laboratory reagents	Consumption based but more predictable	Often different from vaccines	Controlled temperature or cold chain
Reproductive health products	Consumption based but somewhat predictable	Often different from vaccines	Ambient Controlled temperature for some
Malaria bednets	Mostly distributed in campaigns	Often different from vaccines	Ambient
Equipment spare parts	Uncertain	Similar to vaccines	Ambient
ARVs	Distributed based on patient enrollment and diagnostic status	Often different from vaccines	Controlled temperature chain
ACTs, malaria medicines	Uncertain and seasonal	Similar to vaccines	Controlled temperature chain
Insulin	Consumption based but somewhat predictable	Often different from vaccines	Cold chain
Utero-tonics (that is, oxytocin)	Uncertain	Often different from vaccines	Cold chain

ACTs = artemisinin-based combination therapies; ARVs = antiretroviral drugs; IPTi = intermittent preventive treatment (malaria) for infants.
Experiences from the integration of family planning products with essential medicines.

In the last 20 years, FP programs in many countries were integrated into other health services, particularly other reproductive and maternal and child health services. As a result of overall FP program integration, the supply chains for reproductive health products were also integrated into larger systems. These experiences[7,8] provide vital learning opportunities for integration of vaccine supply chains with other supply chains.

- **Bangladesh** developed its integration process well, but it was hampered by political issues and extreme animosity that existed between health and FP staff over the issue of integration. The health staff perceived integration as adding to their resources and responsibilities, while their FP staff perceived it as an end to the FP program.
- **Bolivia** experienced challenges, as integration initially led to worsening data quality in the logistics management information system (LMIS), but changes in the reporting forms have gradually helped resolve the problem.

- **Mali** integrated FP into the essential medicines program without adequate planning, resulting in poor availability and system disruption.
- **Nepal** successfully integrated all MOH logistics activities under a single entity. LMIS, procurement, forecasting, storage, distribution, and requisitioning have all been integrated across multiple programs. The integration project took several years to reach its intended outcomes but is now considered the hallmark of effective integration.
- **Nicaragua** successfully integrated the distribution of essential medicines and contraceptives, which led to improved availability of both products and cost savings for the national program.
- **Tanzania** integrated FP with essential medicines, which resulted in 40 percent lower distribution costs for the FP program, but it compromised data quality.
- **Zambia** integrated and shifted separate storage for as many as eight different health programs to Medical Stores Limited, making transportation arrangements complicated. After integration, supplies for all vertical programs except the EPI were stored and distributed from Medical Stores Limited, making primary transport much better coordinated. There were significant challenges in the integration of the LMIS across different programs.

A key finding from the integration of FP into health programs was that there is need to carefully analyze which supply chain functions to integrate and which to keep separate. It demonstrates that data quality often decreases when integrating LMIS. It also shows that integrating storage and distribution are technically feasible and yield significant benefits as long as there is sufficient political buy-in and receptiveness toward collaboration between the programs that are being integrated.

Current status of integration of the vaccine supply chain

In order to understand the current landscape of integration in the vaccine supply chain, project Optimize conducted a survey in 2010 and responses were obtained from a total of 30 countries out of the 46 in the WHO African Region. NIP managers were asked about 17 different functional areas of the supply chain and whether they were integrated with other drugs and/or health products. These 17 functional areas were grouped into four main integration areas: ordering and receipt, storage and distribution, management processes, and assets (see Table 3).

Table 3. Current status of vaccine supply chain integration

Functional area	Percentage integrated
Ordering and receipt	35%
Storage and distribution	42%
Management processes	60%
Assets	57%
Overall	50%

Note: Percentages are the proportion of supply chain activities within that area that were integrated.

Table 3 shows that ordering and receipt is the least integrated area. This is perhaps due to the fact that in the WHO African Region, a large number of countries procure their vaccines through the United Nations Children's Fund (UNICEF). Even within the immunization areas in some instances, the ordering, receipt, and storage of injection supplies was managed separately from that of vaccines. In addition, it reflects the complexities in the ordering and procurement processes of vaccines and essential medicines, which may render integration difficult.

Management processes that include conducting joint activities, such as planning, training, monitoring and evaluation, and supervision, are relatively easier to integrate, and 60 percent of those activities are integrated. While storage and distribution is more challenging to integrate due to differences in resupply intervals, demand uncertainty, and inventory rules, it appears that a large number of countries are still able to achieve some level of integration in that area, especially at the subnational level.

Table 4 shows the exact status of integration in the 30 countries that responded to the questionnaire.

Table 4. Status of integration of vaccines into supply systems for drugs and other health products across the WHO African Region: results from surveys with NIP managers in February to March 2010

	Eastern and Southern Africa Region																	West Africa Region											Central Africa Region					Africa
	Kenya	Madagascar	Malawi	South Africa	Uganda	Comoros	Eritrea	Ethiopia	Lesotho	Mauritius	Mozambique	Seychelles	Swaziland	Tanzania	Zambia	Zimbabwe	Average for region	Cape Verde	Gambia	Ghana	Guinea	Guinea-Bissau	Liberia	Mauritania	Niger	Nigeria	Sierra Leone	Average for region	Angola	Equatorial Guinea	Central African Republic	Sao Tome and Principe	Average for region	Average for Africa
Ordering and procurement	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	No	38%	No	Yes	No	No	No	No	No	Yes	No	No	20%	No	Yes	Yes	Yes	75%	37%
Arrival and transit operations	No	No	Yes	No	No	Yes	Yes	No	No	No	No	No	No	Yes	Yes	No	31%	No	Yes	No	No	No	No	No	Yes	No	No	20%	No	Yes	Yes	Yes	75%	33%
Ordering and receipt	50%	0%	100%	0%	50%	100%	100%	0%	0%	0%	0%	0%	0%	50%	100%	0%	34%	0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	20%	0%	100%	100%	100%	75%	35%
Central store	No	No	Yes	No	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	63%	No	No	Yes	Yes	No	No	No	No	No	No	20%	Yes	No	Yes	Yes	75%	43%
Regional store	Yes	No	Yes	Yes	No	Yes	Yes	No		No	No		Yes	Yes	Yes	Yes	56%	No	No	Yes	Yes	No	No	No	No	Yes	No	30%	Yes	No	No		33%	43%
District store	No	No	Yes	Yes	No		No	No	No	No	No	No		Yes	Yes	Yes	31%	No	No	Yes	Yes	No	No	No	No	Yes	No	30%	Yes	No	No	Yes	50%	33%
Central store to regions	Yes	No	Yes	No		Yes	Yes	Yes		No	No	Yes	Yes	Yes	Yes	Yes	63%	No	No	Yes	Yes	No	No	No	No	No	No	20%	No	No	No	Yes	25%	37%
Regional store to districts	No	No	Yes	Yes			Yes	Yes	Yes	No	Yes		Yes	Yes	Yes	Yes	63%	No	No	Yes	Yes	No	No	No	No	Yes	No	30%	Yes	No	Yes		75%	53%
District store to service delivery	No	No	Yes	Yes	Yes		No	Yes	Yes	No	Yes			Yes	Yes	Yes	56%	No	No	Yes	Yes	No	No	No	No	No	No	20%	Yes	No	Yes		67%	43%
Storage and distribution	33%	0%	100%	67%	17%	50%	67%	50%	50%	0%	33%	33%	67%	100%	100%	100%	55%	0%	0%	100%	100%	0%	0%	0%	0%	50%	0%	25%	83%	0%	50%	67%	54%	42%
Trainings	Yes	No	Yes	No	No	No	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	No	50%	No	Yes	No	Yes	No	No	No	Yes	No	Yes	40%	Yes	No	Yes	No	50%	53%
Planning	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	69%	No	Yes	No	Yes	Yes	No	No	Yes	No	Yes	50%	Yes	Yes	Yes	Yes	100%	67%
Monitoring and evaluation	No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	75%	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	50%	Yes	No	Yes	Yes	75%	67%
Supervision	No	No	Yes	Yes	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	75%		No	No			Yes	No		No	Yes	33%						54%
Management processes	25%	0%	100%	75%	75%	0%	100%	100%	75%	0%	100%	75%	100%	100%	100%	50%	67%	0%	100%	0%	100%	33%	33%	0%	100%	0%	100%	43%	100%	33%	100%	67%	75%	60%
Staff	No	No	Yes		No	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	63%	No	Yes	No	Yes	No	No	No	No	No	Yes	30%	Yes	No	Yes	Yes	75%	53%
Equipment and infrastructure	No	No	Yes	Yes	No	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	63%	Yes	Yes	No	Yes	No	No	No	No	No	Yes	40%	Yes	No	Yes	Yes	75%	57%
Vehicles	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	81%	Yes	Yes	No	Yes	No	No	No	No	No	Yes	40%	Yes	Yes	Yes	Yes	100%	70%
Information system	No	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	No	Yes	Yes	50%	No	Yes	No	Yes	No	No	No	No	No	Yes	30%	No	Yes	Yes	Yes	75%	53%
Assets	No	No			No	No	Yes	Yes	No	No					Yes	Yes	40%	No	Yes	No	Yes	Yes	No	Yes	No	No	Plan	40%	Yes	Yes	Yes	Yes	100%	50%
Overall	20%	0%	80%	60%	0%	20%	80%	100%	80%	0%	80%	60%	60%	60%	100%	100%	59%	40%	100%	0%	100%	20%	0%	20%	0%	0%	80%	36%	80%	60%	100%	100%	85%	57%

Detailed findings from a case study in Tunisia

Project Optimize worked with the Tunisia NIP and MOH to demonstrate the feasibility and benefits of integrating the vaccine supply chain with supply chains for other health products. Slightly different levels of integration were implemented at different levels of the supply chain network.

Selectively integrated primary distribution (national to regional level)

From the national warehouse to the regional level, only products that required storage and transportation at temperatures from 2°C to 8°C (that is, vaccines, serums, biological products, and temperature-sensitive drugs) were to be integrated into a common supply system. Procurement, quantification, and other upstream aspects were to maintain their status quo (carried out separately for vaccines and other products). For a variety of reasons, including the political situation in the country, the integration between the national level and the regional level was not undertaken in 2012.

Fully integrated secondary distribution (regional to service delivery points)

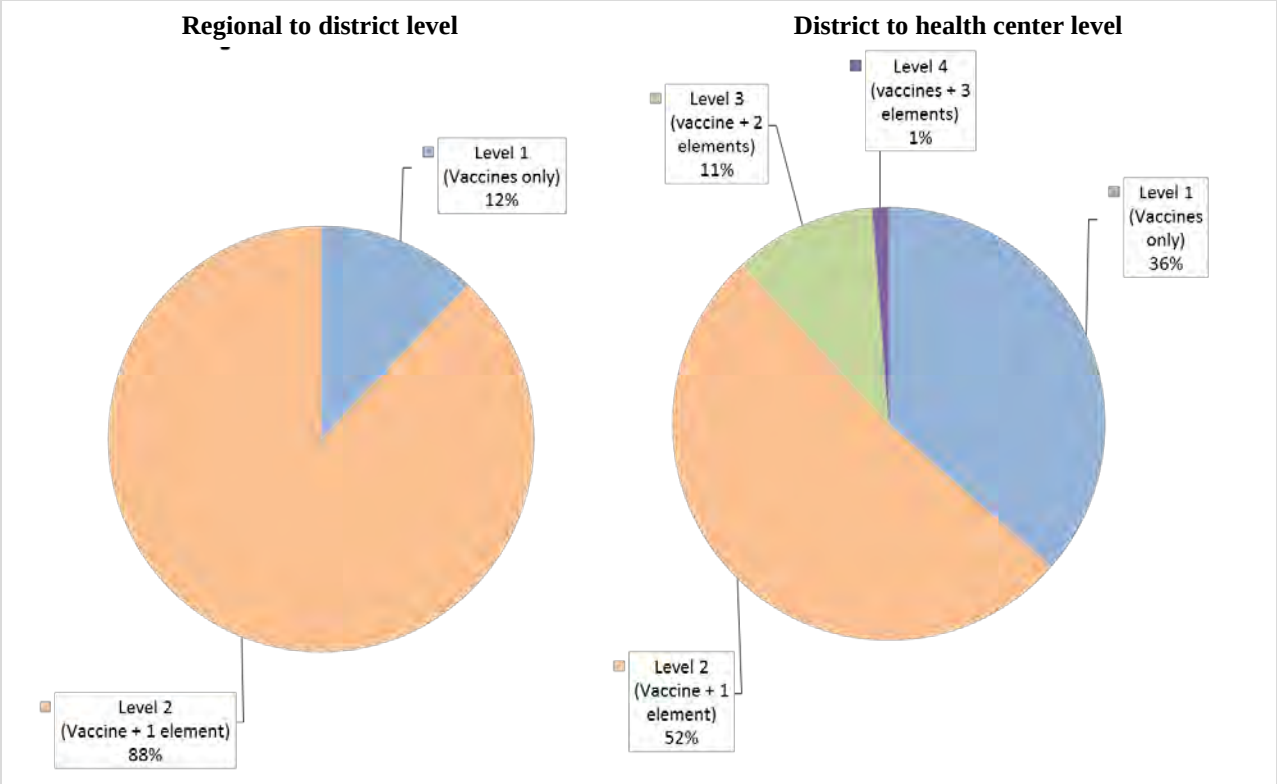
From the regional level to service delivery points, full integration was pursued, wherein regional and district stores for vaccines, drugs, and temperature-sensitive products were consolidated. All cold, temperature-controlled, and dry health products were warehoused together and transported in the same delivery circuit from the regional level down to the health center level, and better route-planning was instituted for those deliveries.

In order to assess the extent to which integration was working, vehicle drivers were asked to record detailed information regarding the products transported in each trip. These were broken into four main categories of activities: (1) for transporting vaccines and supplies, (2) for transporting drugs and pharmaceuticals, (3) for service delivery-related activities, and (4) for supervision. Any given trip could combine multiple elements, in which case the driver would mention all the elements related to a particular journey. Trips that were not related to the four main categories of activities were excluded from the analysis. The logbook information was analyzed, and each trip was classified into four different levels of integration.

- **Level 1.** Transport vaccines only.
- **Level 2.** Transport vaccines and carry out 1 additional activity.
- **Level 3.** Transport vaccines and carry out 2 additional activities.
- **Level 4.** Transport vaccines and carry out 3 additional activities.

Integration Level 1 implies the trip was carried out only for vaccine transport and essentially no integration occurred. On the other hand, a trip coded as integration Level 4 meant that the journey was comprehensively integrated and included all elements of vaccines, drugs/pharmaceuticals, service delivery, and supervision. The results of the analysis of integration levels are presented in Figure 5.

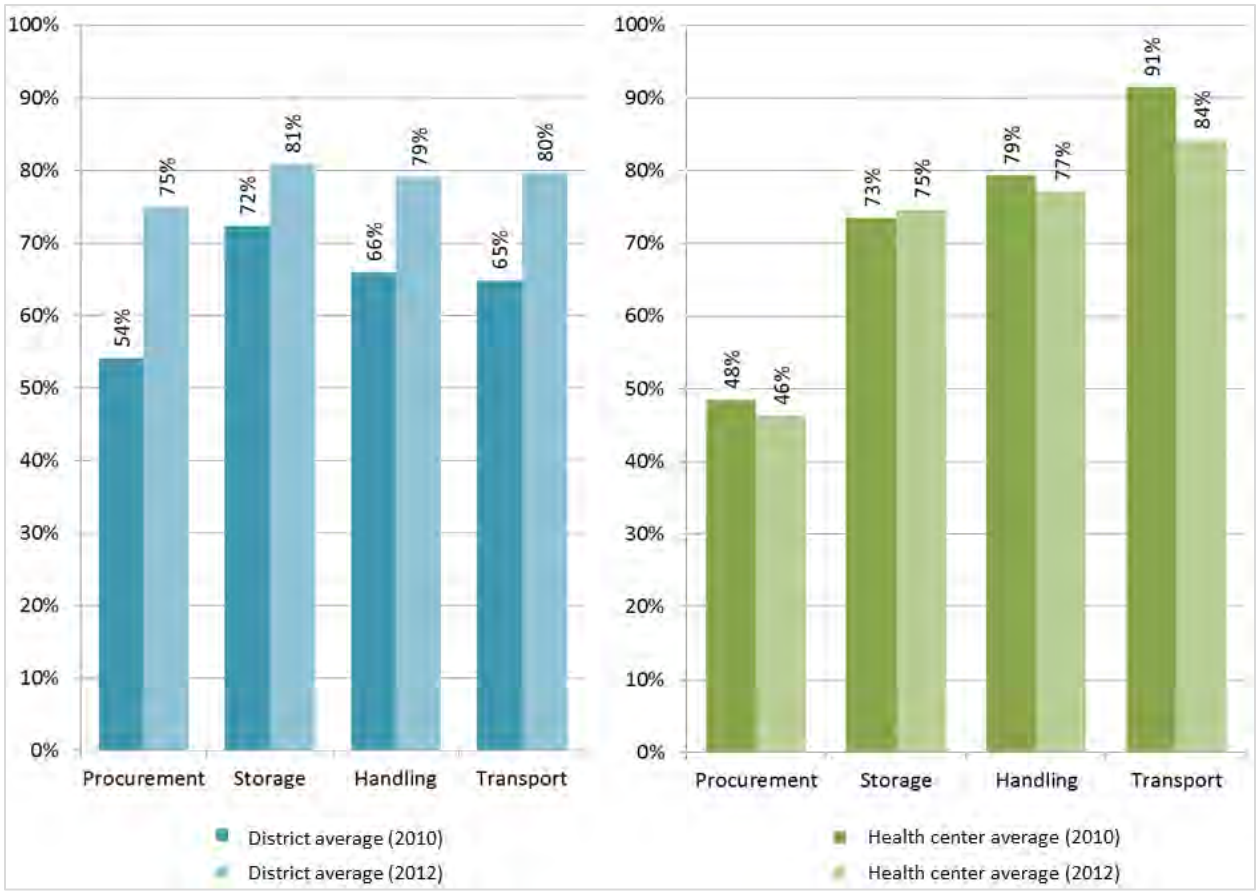
Figure 5. Degree of integration at regional and district levels



Thirty-six percent of trips from the district to the health facility were made solely for transporting vaccines and without any integration. This could be due to national vaccine supply constraints and non-availability of vaccines at the district level in time to coordinate with deliveries for other items. It is noteworthy that 12 percent of trips were for transporting vaccines and for carrying out two other activities. Often the transport of other essential medicines was one of them. From the regional level to the district, 88 percent of trips were for transporting vaccines and at least one additional activity, often the transport of other essential medicines.

The team implementing the integration demonstration in Tunisia also verified whether or not the more integrated approach resulted in any decreases in performance on vaccine availability, transport, and storage. The effective vaccine management (EVM) scores for the districts and health center implementing this were reviewed before and after the integration project and are presented in Figure 6.

Figure 6. EVM scores for pilot districts and health centers: before and after integration



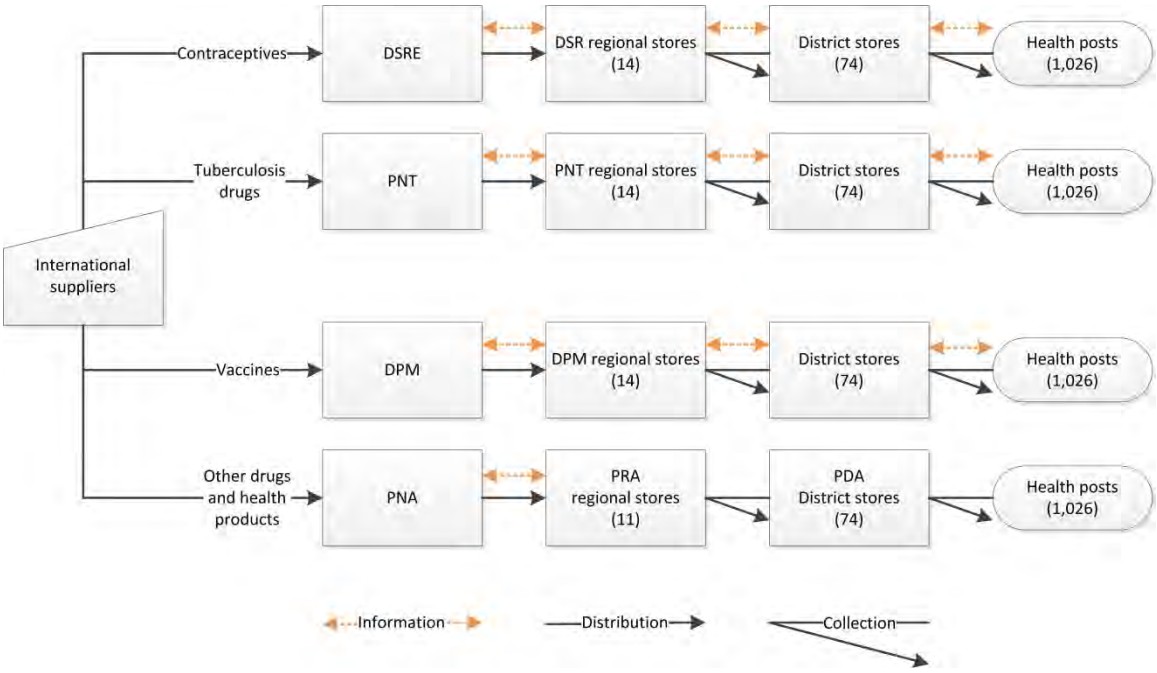
At the district level (represented by the three districts that implemented integration), the EVM scores improved between 2010 and 2012, suggesting that integration did not decrease performance of the vaccine supply system. At the health center level (represented by one health center in each of the three districts), the EVM scores declined slightly between 2010 and 2012. It is unlikely that this change can be attributed to the integration exercise but was rather due to some other confounders.

Physical integration of vaccines, temperature-sensitive products, and other health commodities and supplies is a feasible solution and has the potential to bring important efficiencies in the supply chain system. While it is challenging to obtain political buy-in for integration at higher levels, integrated delivery of vaccines and other health products was shown to be feasible in Tunisia at the district level. In addition, delivery trips at the district level also present an opportunity for MOH staff to join a trip to provide service delivery and supervision-related activities.

Detailed findings from a case study in Senegal

In Senegal, the supply chains of disease control programs are often managed independently of each other. However, without collaboration or even coordination between programs, these parallel supply chains put serious pressure on the system. For example, at the national level, vaccines are distributed by the Department of Prevention, contraceptives by the Department of Reproductive Health and Child Survival, tuberculosis drugs by the National Tuberculosis Program, and other drugs and health products by the National Supply Pharmacy (PNA). Figure 7 illustrates some of these parallel supply chains.

Figure 7. Pre-integration structure of supply chains in Senegal

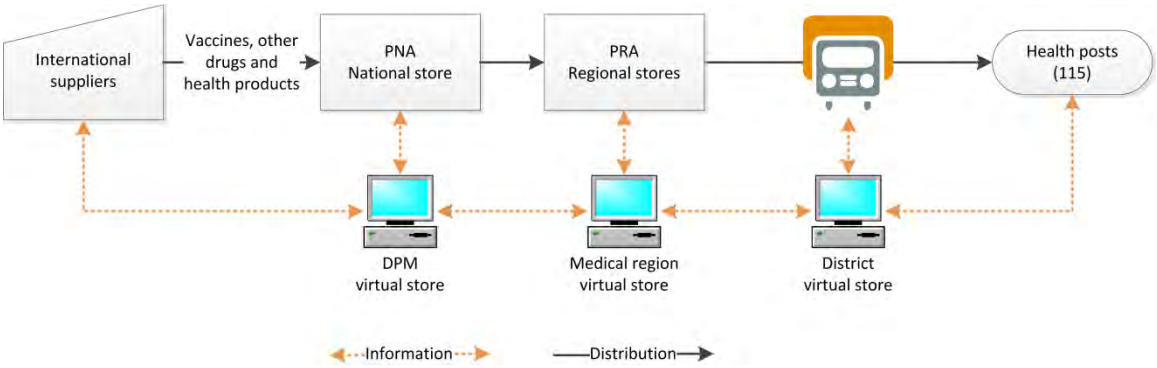


DPM = Department of Pharmacy and Medicine; DSR = Department of Reproductive Health; DSRE = Department of Reproductive Health and Child Survival; PDA = district supply pharmacy; PNA = National Supply Pharmacy; PRA = Regional Supply Pharmacy; PNT = National Tuberculosis Program.

To alleviate many of the problems associated with the fragmented structure of this system, the MOH in Senegal, in collaboration with project Optimize, designed a single, integrated health supply chain for public-sector vaccines, drugs, and other health products from the national level to the regional level. This required the PNA to start receiving and storing vaccines and distributing them to the Department of Pharmacy and Medicine regional stores (see Figure 8).

In the pilot region of Saint-Louis, vaccines would be distributed along with other drugs and health products from the PNA directly to the Regional Supply Pharmacy. To streamline the vaccine supply chain from the regional level to health posts and health centers, specially equipped trucks known as the "moving warehouse" were deployed to transport vaccines from regional stores directly to more than 100 health centers and posts. The moving warehouse would also deliver essential medicines and health products for HIV/AIDS, malaria, and tuberculosis programs along with the vaccines, and on each delivery trip, moving warehouse staff would record stock levels and replenish stock as needed.

Figure 8. Post-integration intended structure of the supply chain in Senegal



DPM = Department of Pharmacy and Medicine; PNA = National Supply Pharmacy; PRA = Regional Supply Pharmacy.

National-level integration has led to more coordinated planning and distribution at the PNA. EVM assessments have shown that vaccine supply chain performance attributes have not been adversely impacted by the integration but in fact have improved considerably in some cases.

The moving warehouse has been a great success. It has:

- Ensured a regular, sufficient, and high-quality supply of vaccines, drugs, and other health products to all health centers and posts in Saint-Louis.
- Improved cold chain performance in health centers and posts.
- Provided greater availability of vaccine stock data, enabling their use in decision-making.
- Improved productivity of village health center nurses and district store managers because they no longer need to collect vaccines and supplies from regional stores.
- Improved management of biomedical waste at health posts and district stores.
- Reduced the likelihood of stockouts and oversupply of vaccines, drugs, and other health products, as inventories and restocking are conducted at delivery points.

Studies were not carried out to understand the cost implications of running the moving warehouse and whether it leads to significant efficiency gains when the costs are apportioned to the different products it distributes.

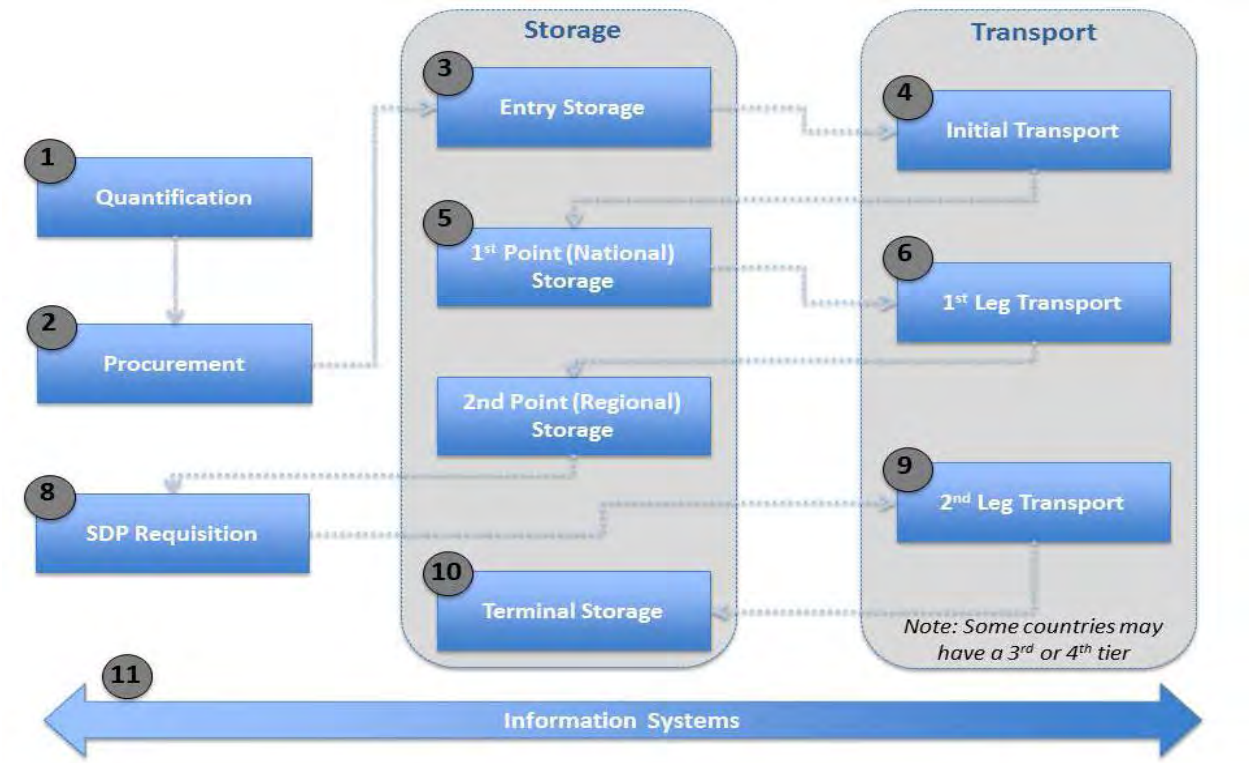
The Senegal MOH and project Optimize demonstrated that integration of transport at the last leg of distribution is feasible in Senegal, and also leads to more effective distribution. For integration at the higher national level, the project demonstrated that several challenges remain pertaining to change management, political support, and perceptions of risks.

In both cases, integration required changes in processes and practices that had been in place for more than 30 years, causing some stakeholders to be resistant to the integration initiative. Well-designed advocacy and communication plans and participatory project design helped to alleviate some of these concerns and obtain stronger support for integration.[12]

A framework for identifying the opportunities for integration

The supply chains for vaccines in countries take various forms, but usually consist of quantification, procurement, requisition, storage in warehouses at the central, regional, and/or district levels, and transport of the vaccine from a higher-tier storage location to the next tier. Typically, two to three tiers of storage occur before the vaccine reaches the immunization service delivery point. Information systems capture product flow information at each step in the delivery process. While each country varies in its exact structure, comparisons and generalized conclusions can be drawn from the simplified structure in Figure 9.

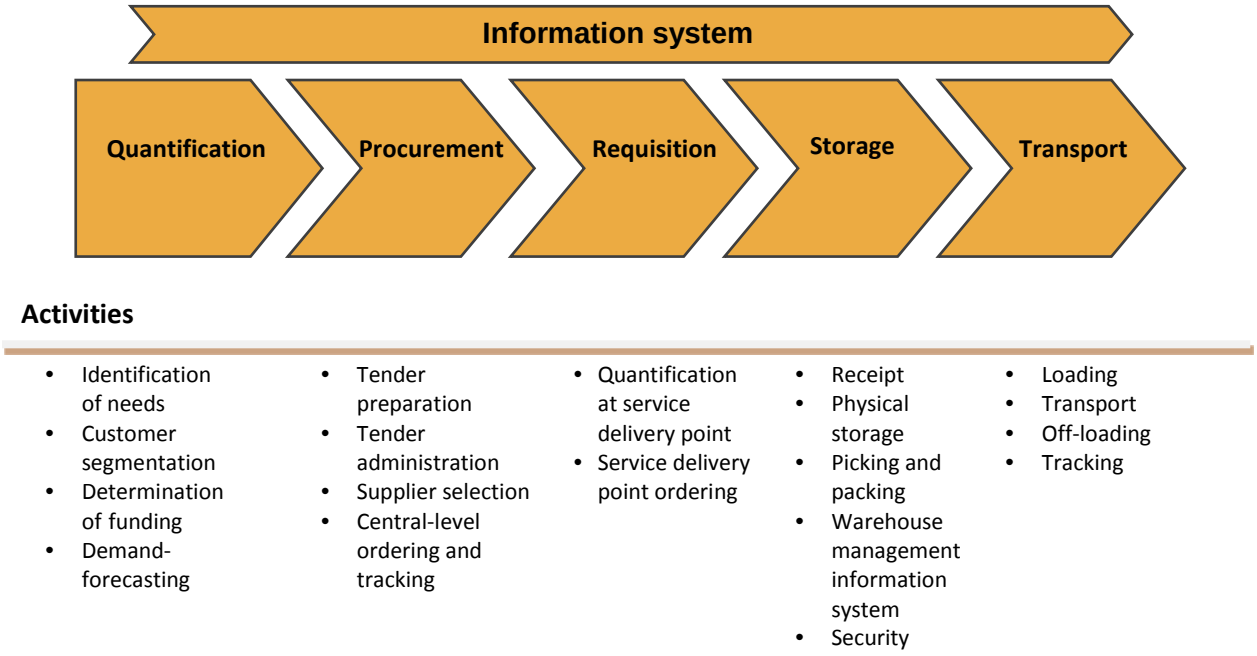
Figure 9. Typical structure and steps in the vaccine supply chain



SDP = service delivery point.

Figure 10 provides the detailed activities within each of the broad categories shown in Figure 9.

Figure 10. Activities in the vaccine supply chain



Integration results in multiple benefits, but in some instances could also lead to disadvantages for the vaccine supply chain. Economies of scale and scope resulting from the allocation of fixed costs across multiple products are the most evident economic advantage of integration. The extent of these benefits depends on the specific function that is integrated. Storage and transportation, for example, have relatively high fixed costs and should be allocated across as many items as possible, which encourages fuller integration. In addition to direct benefits from integration, there are many other less direct benefits that result from integration. For example, when vaccines are included in the integrated package, the strict stock management required for vaccines appears to limit leakage of products of the other sectors.[13] When human resources are already constrained, job openings for supply chain positions are not filled or are filled with individuals without adequate training; integration enables more effective utilization of limited human resources. When trying to attract the best qualified personnel, it becomes easier to fulfill supply chain jobs and functions that have roles integrated across health products. Scarce transport and other such resources can be better utilized, leading to higher effectiveness. A common voice and pooled demand for vaccines and medicines increases the bargaining power of supply chain staff within ministries of health, allowing them to advocate for investments in LMIS and training.

Integration is not easy, though. It brings additional technical and political complexities. Managers of vertical disease programs fear losing control over their portion of the supply chain, and they fear that diffused management oversight may hamper performance of their programs. In order to support integration, program managers have to weigh the benefits against the potential risks. The ease of implementation of integration activities at a given stage depends on the perceived benefits and also on the political and managerial complexities associated with integrating an activity or step. In the following sections, we present the benefits, potential disadvantages, and a five-point score to the ease of integration at each stage in the supply chain. The benefits are captured from existing literature, whereas the potential

disadvantages and ease of implementation are based on the two detailed case studies, experiences from integrating FP products into essential medicine supply chains, and discussions with stakeholders.

Quantification

Quantification is defined as the estimation of quantities of health products that will be going through the supply chain over defined periods of time.

Benefits	Considerations
Coordinate collection of data, reducing burden of staff to send data to multiple stakeholders.	• All data points for quantification are not the same, so data collection can be coordinated but not fully integrated. • Demographic data inputs are common, so this part of data collection analysis can be integrated.
Leverage best practices across multiple quantification processes.	• Coordination benefit may be realized even if activity is not integrated.
Understand health technology requirements and products landscape at the central/country level.	
Disadvantages	**Ease of implementation**
• Extra burden added in outlining and taking into consideration the different sources of funding. • Uncertainty of demand, seasonality, and other factors for medicines and other products will add complexity to the more predictable birth-cohort based vaccine quantification. • At the subnational level, vaccines may not be requisitioned by local staff, so different systems/processes may be required in different regions, adding cost and complexity.	  Difficult Easy

Integration of vaccine and medicine/health product quantification activities may be relatively difficult. Forecasting and quantification are activities that require in-depth knowledge of program history, plans, and activities in the field and a thorough understanding of the product category and its demand drivers. It is hard to integrate a function that needs such product-specific expertise. While vaccines follow a very predictable schedule, following epidemiological and population data, pharmaceuticals and other health products vary greatly based on disease burdens, treatment regimens, and seasonal patterns. This uncertainty in demand and complexity in the quantification process of health products would add an extra burden to the relatively well structured vaccine quantification process. Further, medicines and vaccines have very different sources of funding and the predictability of funding is much lower for essential medicines and some health products. The variability in funding for medicines and health products would also add a burden to the vaccine process by requiring a more detailed outline and consideration of different sources. In combination, the dissimilarity between the quantification processes, sources of

funding, and training/skills of quantification staff will make integration of quantification for vaccines and other health products relatively difficult.

Procurement

Benefits	Considerations
Improve human resource efficiency and reduce the time needed to prepare, issue, and evaluate tenders.	• Generic proposal section (that is, capabilities, general operating practices, corporate overview) evaluations can be integrated. • Technical requirements can be coordinated but not integrated. • May need different experts to evaluate product-specific choices.
Improve manufacturing site/preshipment inspection efficiency.	• Preshipment inspections (especially ex-works incoterms) and general operating practices can be performed by same staff. • Benefit realized when multiple product categories are ordered from the same supplier.
Reduce administrative costs and time of ordering when ordering separately.	• Benefit realized when multiple product categories are ordered from the same supplier.
Increase negotiating power, leading to lower total costs.	• Extent of product category overlap varies between suppliers. • Vaccine markets are different and may provide limited pricing advantage.
Increase visibility of both product categories.	• Increased visibility leads to stronger focus on quality and efficiency in the process.
Formalize tracking policies and procedures.	• Dedicated staff (that is, pipeline supply manager) becomes pertinent with integrated orders. • Service-level agreements and lead times can be enforced.
Disadvantages	**Ease of implementation**
• Procurement for vaccines is often outsourced to third-party logistics agencies (e.g., UNICEF), so integrating with other products is challenging. • Multiple stakeholders, including different funding sources, evaluating integrated tender may add complication and delay the overall decision process. • Could create delays in procurement for both categories.	  Difficult Easy

UNICEF = United Nations Children's Fund.

Integration of procurement activities for vaccines and medicines is also considerably difficult to implement. While the tender preparation is similar in the generic types of questions and screening processes, such as good manufacturing practices verification, there are specific qualifications associated with vaccines. In the evaluation of the tender, the involvement of several stakeholders, specifically different funding sources, may be required, adding some additional complexity in coordination and potential delay for both vaccines and medicines. It is worth noting, however, that in a number of countries in the Africa region, the procurement of vaccines is often outsourced to a third-party agency (that is, UNICEF), so integrating the procurement of these vaccines with the medicines procured by the MOH and/or local entities will be extremely difficult, and potentially infeasible. To achieve leverage on prices, many countries pool their vaccine procurement with others in their region or income level.[14] UNICEF, the Pan American Health Organization, and the Gulf Coordination Council are all commonly used vaccine procurement pools.

Requisitioning and ordering

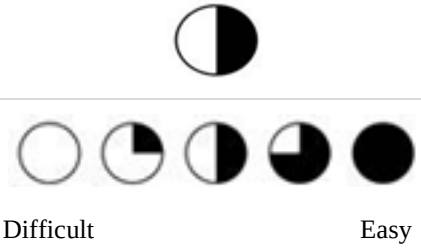
"Requisition" is a term used in vaccine and public health supply chains to mean the process by which health care workers place orders for medicines, vaccines, clinical supplies, and health products. Historically, it involved filling out a paper requisition form, but in modern-day supply chains, this essentially involves placing an order.

Benefits	Considerations
Improve human resource efficiency.	• Optimized staff structure for performing quantification within hospital departments.
Reduce the time waiting for approval from local procurement hierarchy.	• Integrated orders require one approval instead of approval for two separate orders.
Improve ordering information system efficiency.	• Where duplicative electronic ordering systems exist, consolidate to one system.
Decrease mistakes in ordering due to reduced complexity in order process.	• One order process and one system reduces complexity.
Increase order accuracy for other health products.	• In some instances, more frequent and less ad hoc ordering for vaccines will result in better routine monitoring of inventory levels of medicines.
Disadvantages	**Ease of implementation**
• Variable and uncertain nature of requisitions/underlying demand drivers for medicines and other products may disrupt the vaccine order process. • May need to spend time and resources in training staff on new requisition process.	  Difficult Easy

Integration of the requisition activities for vaccines and medicines may be very difficult. Vaccines follow a routine order process typically managed based on an immunization schedule and birth cohorts. These requisitions are placed at predefined times and quantities. On the other hand, requisitions for essential medicines typically follow a "pull" fulfillment strategy in which health center staff identify the needs in their individual facility and request quantities accordingly. The resupply intervals for medicines and health products in many cases are significantly different as compared to the resupply intervals for vaccines. Even when there is a set order schedule (that is, requisitions are sent to the Central Medical Store quarterly) or when the country employs a "push" system for medicines, quantities of medicines will vary greatly between orders. With two vastly different order schedules and processes, integration would require significant investment in staff training and an overhaul of the current systems, which may not be outweighed by the benefits.

Storage and warehousing

Benefits	Considerations
Reduce capital investment in multiple warehouses.	• Applicable where vaccines and medicines are currently in separate facilities.
Improve WMIS efficiency and increase effectiveness of inventory management.	• Applicable where vaccines and medicines are currently in separate facilities and/or use separate information systems.
Reduce administrative and personnel costs of staffing multiple warehouses.	• Applicable where vaccines and medicines are currently in separate facilities; some specific technical skills may be required for each product category.
Increased security across products, leading to a reduction in pilferage and greater spread of security costs.	• Where current security staff are underutilized in cold storage areas, the staff can locate partial time to dry storage areas.
Reduce time to inspect multiple shipments.	• Applicable where product categories are consolidated in one shipment. • Initial verification of invoice, bill of lading, and order form can be integrated, but some specific technical checks may be different.
Reduce time in picking and packing items.	• At the central/regional levels, this would apply for shipments sent to the regional level or service delivery points that require multiple product categories. • At service delivery points, this would apply for kits sent to hospital departments.
Decrease medicine inventory levels and potential stockouts.	• With more frequent vaccine delivery, medicine inventories will be monitored regularly and smaller orders placed to keep inventory levels consistent.

Disadvantages	Ease of implementation
• Requires capital investments in some cases. • May lead to increased waste if staff are pulled away from managing and monitoring individual product category expiries.	 Difficult Easy

WMIS = warehouse management information system.

Integration makes the most sense for functions such as warehousing and storage; savings in these two areas are substantial when managed efficiently, as they reduce management, warehousing, and inventory holding costs. However, in many cases, this requires capital investment before vaccine warehouses and warehouses for other health products can be integrated. Existing warehouses may need to be refurbished, expanded, or replaced to support increased requirements in number, volume, and storage temperature of products. As more new vaccines are introduced and non-vaccine health products such as HIV test kits and uterotonics require cold chain warehousing, the need for cold chain warehousing is growing very rapidly. The need for warehousing space by both vaccine programs and programs using other health products presents opportunities for them to share the fixed and operating costs of additional warehousing capacity through more integrated warehousing.

Integration at the storage level also requires training warehouse staff to handle a variety of additional products with different storage temperature requirements, adding to the complexity of their tasks. Effective supervisory capacity is crucial before integrating the warehousing function; otherwise, it can lead to confusion and adverse outcomes for vaccine storage conditions and also for the health products being integrated.

Transport

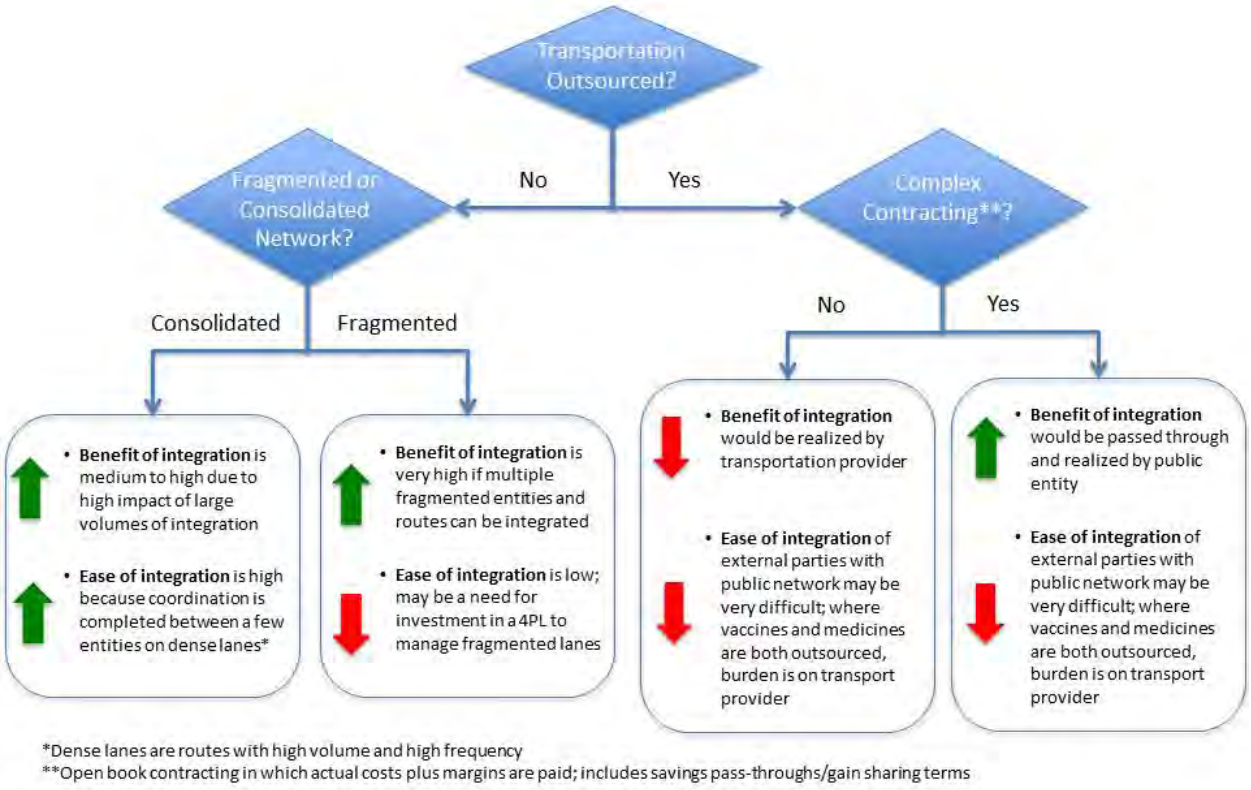
Benefits	Considerations
Higher frequency of deliveries becomes more economical and reduces forecast horizon, thereby reducing the uncertainty and inventory carried at downstream facilities.	• Leverage full cold truckload on LTL cold loads. • Leverage fully dry truckload on short runs where coolers can be used for vaccines to fill LTL dry loads. • Service delivery points must be the same or within an economically close distance. • Time-sensitive nature of vaccines drives delivery schedule and benefits medicines delivery schedule when integrated. • If current system is already running fully utilized loads (or dry FTLs), integration at central level may not add benefit other than negotiating power.

Benefits	Considerations
Reduce transportation and administrative costs for medicines and pickup.	• Where vaccines are direct-delivered to facilities, medicines can piggyback on the delivery system to eliminate downstream transportation and coordination costs.
Reduce lead time by packing and unpacking trucks faster.	• Where the above considerations apply.
Reduce tracking requirements to only one shipment.	• On routes which utilized private contractors.
Increase negotiating power with private trucking providers.	
Reduce overall uncertainty of transport costs.	• By pooling the uncertainty of all medicine transportation costs (that is, rough percentage added to each unit), overall uncertainty is reduced.
Disadvantages	**Ease of implementation**
• Waiting for shipments to arrive or requisitioned in order to create a full truckload may delay shipment load. • A fragmented primary care system will reduce the opportunity for integration, as service delivery points for vaccines and other health products will not significantly overlap. • Increased transport costs when service delivery locations do not overlap.	  Difficult Easy

FTLs = full truckloads; LTL = less than truckload.

Examples from Senegal and Tunisia have clearly demonstrated that transport at the last leg of the supply chain can be effectively integrated for vaccines and other health products as long as their temperature requirements, resupply intervals, and service delivery points are well matched. Scarcity of transport assets also means that achieving higher transport utilization is central to improving performance. Shared transport can lead to a higher frequency of delivery, which increases the resupply interval and reduces the reliance on health facility-level forecasts for more than a few weeks. Transport coordination, however, is not always an easy task. Lack of strong and effective communication channels between different product supply chains that are attempting to integrate transport can lead to significant delays. In some instances, the existing vehicle fleet may need to be upgraded in order to support integrated delivery and its related volume and temperature challenges. Figure 11 shows how the nature of the current transportation network affects the level of benefit and ease of integrating.

Figure 11. The nature of the current transportation network affects the level of benefit and ease of implementation



The benefit of transport integration also depends to a great degree on whether transport is carried out using an in house fleet or using an outsourced TPL and the nature of the contract with the TPL. The benefit of transport integration is highest when there are multiple entities and a fragmented transport network is being used by the supply chain. Additionally, in some transport contracts, any gains from integration/higher asset utilization are passed on to the shipper, but in most others they are not. Complex contract structuring is used under some gain-sharing types of transport contracts.

Information systems

Benefits	Considerations
Reduce capital investment in multiple information systems.	• Where multiple systems currently exist.
Increase visibility of health technology requirements and product landscape.	• With all data in one place, more effective analysis can be performed and requirements understood.
Increase coordination between supply chain levels.	• May be able to interconnect information systems between supply levels to more effectively monitor inventory, seamlessly place orders, and coordinate transportation.
Reduce transaction costs.	• Applicable when the order point (supplier or central/regional store contact) is the same.
Increase efficiency in ordering, tracking, and managing inventory.	• Where multiple information systems exist, integration will only require management through one system.
Reduce data entry errors.	• With fewer touch points, the likelihood of error decreases. • With greater visibility, errors may be identified quicker.
Disadvantages	**Ease of implementation**
• Technology requirements may be different; more stringent requirements for vaccines may increase overhead costs for medicines.	
• Integrating data from multiple systems may be time consuming and expensive.	
• Training may be required for a new system.	Difficult Easy

Typically each vertical program has its own management information system and after many years of training and experience, the staff in the program are well trained in the use and reporting of their specific LMIS. When integrating LMIS, the first question that arises is which LMIS to pick for the integrated supply chain. There is an additional complexity because vertical programs that are funded by different donors have varying requirements for reporting. Sometimes it can be a challenge to make the various programs accept a single reporting system. Even when they accept, staff have to be trained on new reporting/management information system procedures. Many previous examples have shown that the quality of LMIS data falls after integration unless significant training is conducted proactively or human machine interface design and form design are very robust and have sufficient poke yokes embedded in them. However, the advantages of an integrated LMIS are very many. Having shared and common data enables coordination across multiple levels in the health system.

Country-specific factors in applying this framework

The extent of benefits that may accrue from integration depends on the stage of integration and the readiness of the overall political economy in the country (see Figure 12). Integration is often considered as a continuum, with each element of the supply chain finding its correct place within the continuum depending on different context-specific factors. The overlap that exists between the supply chain for medicines, health products, and vaccines influences the benefits and readiness for further integration. Political buy-in and support from the highest levels of leadership in the health sector, a national focus on efficiency in the supply chain, and advocacy of global agencies together create the right climate for initiating integration activities. The absence of any of these can result in significant hurdles for integration, as was shown in the detailed case studies and many examples from FP integration. Apart from political factors, the macroeconomic context also influences the readiness of a country for integration. Countries with a well-developed transport sector and TPLs to which the MOH can outsource transport and distribution of vaccines and other health products have a much easier case to build for integrated transport and distribution.

Figure 12. Stages of integration and macroeconomic and political factors impacting the ease of integration*

Current country supply chains

Fragmented	Minor integration	Substantial integration	Full integration
• All activities independently managed	• Already captured low-hanging fruit • Integrated easy-to-implement activities	• Only a few activities not integrated (that is, storage space—cold versus dry)	• All activities coordinated from planning through execution

Increasing potential benefit from further integration
Increasing difficulty of implementation

Other factors impacting potential benefit

Country context factors	Benefit	Difficulty of implementation
Outsourced and/or fragmented activities (that is, transportation).	↓	↑
Stakeholder buy-in/support (that is, MOH, central stores).	↑	↓
Service delivery points overlap.	↑	↓
Global and national focus on efficiency.	↑	↓
Global agency collaboration and national/regional relationships.	↑	↓

*Integration success is rooted in high-level agency relationships and lower-level people relationships.

Note: An upward-pointing green arrow signifies the benefit from integration is likely to be higher if that context factor is present or the difficulty of implementation will be higher. A downward-pointing red arrow signifies the opposite.

Conclusions

Integrating vaccine supply chains with those for other health products provides opportunities for efficiency enhancement. The integrated system benefits from economies of scale and scope. The fixed costs of transport, warehousing, distribution, supervisory control, etc., get spread over the supply chain of all health products and not just vaccines. Much needed investments in supply chain security can yield better returns on investment, as they would be spread over the entire portfolio of health products and programs. In addition to increased efficiency, integration could also lead to effectiveness gains. Scarce transport and other such resources can be better utilized, leading to higher effectiveness. Apart from efficiency, integration could alleviate severely resource-constrained supply chains and increase the effectiveness of human resources. When trying to attract the best qualified personnel, it becomes easier to fulfill supply chain jobs and functions that have roles integrated across health products.

There is vast product variety in the supply chains for vaccines and health products, and each product has its own demand and supply-side characteristics. It is challenging to design an integrated supply chain that can manage this variety of product and customer requirements without compromising effectiveness. An approach that segments health products into groups of products with closely matched demand and supply characteristics is more appropriate for integration. Each segment can then be served with a customized supply chain that best meets the needs of the segment. This would result in easier implementation and also higher benefits from integration. A cautious and careful evaluation should therefore precede any integration initiative. Products such as HIV test kits, medicines for IPTi, products for vitamin A and iron deficiency, some maternal health products such as oxytocin, and insulin could be useful starting points to explore integration with vaccines.

In this report, a framework was developed to weigh the costs and benefits of integrating specific functions of the vaccine supply chain with other health products. The framework reveals that while the benefits of integration are higher at the upstream stages (e.g., quantification and procurement), there are significant political hurdles at the upper levels. Integration at this stage requires the support and commitment of policymakers along with the active involvement of many disease program managers. However, given that managers of vertical disease programs might lose control over part of their prerogatives and resources in the process of integration, they are likely to resist integration. Instead, integrating last-mile transport, warehousing, and supply chain information systems could yield significant economic benefit and is easier to implement in many instances. Scarce transport, warehousing, and human resources at the lowest levels in the supply chain make this a prime candidate for integration, with all relevant stakeholders recognizing the resulting benefits. NIPs should learn from the few successful case studies of integrating transport and distribution from the district to health facilities and explore how their programs can implement such integration.

If not implemented well, integration could lead to mediocre outcomes in program performance. Integrating too much and too fast might cause a decrease in performance and also result in supply chain disruptions. Adequate training and sensitization of staff is critical before starting any integration initiative. We often tend to underestimate the effects that changing roles and responsibilities will have on people's willingness to cooperate and lead the process forward. Integration may also lead to diffused management oversight, as the staff responsible for a single product may now have to oversee the supply chain for multiple products. Assigning broad oversight responsibilities and a wider span of control to staff with inadequate managerial skills may hamper their ability to effectively manage performance.

Despite its challenges, integrating vaccine supply chains with carefully selected similar products at specific stages in the supply chain will greatly enhance the effectiveness and efficiency of public health supply chains in a resource-constrained environment.

Annex 1

Opportunities for further research on integration of vaccine supply chains with other health commodity supply chains

Background

Supply chains for vaccines and essential medicines are under increasing pressure to operate at higher levels of efficiency. Merging multiple supply chains that are disease-specific (for vaccines, maternal and child health medicines, and family planning products) into one integrated supply chain has been argued as a means to achieve higher efficiency. However, there is ambiguity as to whether or not supply chains for vaccines *should* be integrated with other supply chains and whether the proposed benefits outweigh the costs. Decisions regarding which supply chains to integrate and which stages of the supply chain to integrate can be complex. A recent report, commissioned by the World Health Organization (WHO)/Expanded Programme on Immunization and project Optimize, created a framework for how to approach the integration of vaccine supply chains with other health products. While the framework acts as a guide for national immunization programs considering integration, it also raises further questions about where and how to best pursue supply chain integration. This annex highlights the need for such operational research.

Research themes to address in future work

How does transport integration contribute to supply chain effectiveness and sustainability?

Lessons from Senegal and Tunisia suggest that there are tremendous opportunities for integration at the last mile that could lead to greater efficiency across supply chains. By using the same trucks to transport both the vaccines and medicines from delivery points (for example, the district storage facilities to health clinics), vehicle, fuel, and personnel costs can be reduced. Furthermore, integration will allow for fuller truck loads and increased frequency of delivery, which could further benefit stocking accuracy. Therefore, transport integration is not just an efficiency enhancing intervention but could also increase the effectiveness of both the vaccine supply system and the supply system for essential medicines. In the case of Senegal, a moving warehouse was found to be highly effective in improving the availability of vaccines and essential medicines. However, interventions such as the last-mile transport of integrated essential medicines sometimes require an initial capital investment. While these capital investments lead to higher efficiency and effectiveness gains in the long term, the business case for making such capital investments is not very convincing for policymakers and health-sector resource allocators, both at the international and national levels. A research study should attempt to capture basic cost parameters and build a generic business case for such capital investments. The generic business case should be flexible enough to be customized for each country, based on its supply chain structure and cost parameters. In addition to technical experts, the research team for such a project should include a person with knowledge of advocacy and the health-sector financing landscape.

Simulation model for supply chain integration with select maternal health- and child-targeted commodities

A preliminary analysis of products that have a potential of being integrated in storage and distribution with vaccines based on literature and consultations with different stakeholders highlighted multiple

opportunities. Many products such as deworming tablets, childhood iron or vitamin A deficiency tablets, and intermittent preventive treatment of malaria in infants drugs (sulfadoxine-pyrimethamine) would all be very suitable for integration given the similarities of their target population and distribution schedule with vaccines. Other products such as HIV test kits are ideal candidates for integration due to the temperature-controlled distribution requirements and a pre-set distribution schedule. Some products that are now receiving increased attention such as uterotonics for maternal health or insulin for diabetes also offer opportunities for integration with vaccine storage and distribution, as they also need controlled-temperature distribution. A supply chain simulation exercise with costs, frequencies, service-delivery points, and simulated demand for each of these commodities should be used to determine the "theoretical best cases" for integration. These theoretical best cases should then be tested and validated based on the political economy and one to two operational research pilot programs should be designed to test these ideas. Given the high importance of select maternal health commodities such as uterotonics placed by the United Nations Commission on Maternal and Child Health, this presents a significant window of opportunity to conduct such pilot experiments. Once again, a research team consisting of supply chain technical experts, a program person from maternal health, and political economy experts should be assembled to conduct this initial scoping exercise.

Outsourced transportation and warehousing as a mechanism for integration

The current framework shows that the nature of the current transportation network affects the level of benefit and ease of integrating the transport leg. The benefit of transport integration depends to a great degree on whether transport is carried out using an in-house fleet or using an outsourced third-party logistics company (TPLC) and the nature of the contract with the TPLC. Use of a TPLC wherever possible facilitates integration or in some cases makes the need for transport and warehousing integration somewhat redundant, as the TPLC could be carrying the transport role for multiple programs. Whether all the benefits resulting from such an exercise are being passed on to the ministry of health depends on the exact nature of contracts used and whether there are any gain-sharing components built into the contract. While it is clear that outsourced transportation and warehousing could act as an indirect mechanism for integration in the supply chain, its applicability is perceived to be limited. Experiences and case studies have started accumulating from multiple countries, but a synthesis of these findings is lacking to create a policy guidance document. This could be an area of research with high impact if it is conducted in collaboration with key partners who have the requisite field experience, have academic or private-sector knowledge, and understand the vaccine supply chain landscape well.

Warehousing capacity expansion and integration

The developed framework has shown that there are significant opportunities for integration between vaccines and other health products at the storage phase of the supply chain. Integration at this level could lead to savings in fixed costs such as storage security or administration and could also lead to improvements in storage conditions across different products. The introduction of new vaccines in many countries is highlighting the limited capacity in warehousing and storage space, especially at the subnational level. Many disease programs, including new maternal health programs, are also expanding and facing the same challenges. The large need for additional storage space (cold chain) for medicine and vaccine programs provides an opportunity to either make joint integrated investments or a common framework for locating and contracting third-party storage space, if available. For this opportunity to be realized further research is required to pinpoint the geographical areas where such constraints are the steepest for vaccine and medicine programs. A research team equipped with global information system

mapping and warehouse capacity estimation capabilities should be engaged to accomplish this task. Higher visibility of this information will act as precursor to more integration at this level.

References

1. Sabot O, Yadav P, Zaffran M. *Maximizing Every Dose and Dollar: The Imperative of Efficiency in Vaccine Delivery*. Seattle, WA: The National Bureau of Asian Research; 2011. NBR Impact and Innovation Series. Available at: http://tinyurl.com/msyuqx5. Accessed July 25, 2013.

2. Zaffran M, Vandelaer J, Kristensen D. The imperative for stronger vaccine supply and logistics systems. *Vaccine*. 2013;31(Suppl 2):B73–80.

3. Yadav P, Tata HL, Babaley M. *Supply Chain Management, World Medicines Situation Report 2011*. Geneva: World Health Organization (WHO); 2011.

4. PATH, WHO. *Developing a Vision for Immunization Supply Systems in 2020: Landscape Analysis Summaries*. Seattle, WA: PATH, WHO; 2011.

5. Allain L, Goentzel J, Bates J, Durgavich J. *Reengineering Public Health Supply Chains for Improved Performance: Guide for Applying Supply Chain Segmentation Framework*. Arlington, VA: USAID | DELIVER PROJECT; 2010.

6. Milstien J. *Literature Search of Experience with Integration of Vaccine Supply Chains with Those of Other Commodities*. Geneva: WHO; 2009.

7. Olson N, Sánchez A, Quesada N. *Nicaragua: Integrating Logistics Functions at the Ministry of Health: A Case Study Assessing the Effects of Integration on Supply Chain Performance and Contraceptive Security*. Arlington, VA: USAID | DELIVER PROJECT; 2008.

8. Beith A, Quesada N, Abramson W, Sánchez A, Olson N. *Decentralizing and Integrating Contraceptive Logistics Systems in Latin America and the Caribbean, With Lessons Learned From Asia and Africa*. Arlington, VA: USAID | DELIVER PROJECT; 2006.

9. Yadav P, Stapleton O, Van Wassenhove LN. *Always Cola, Rarely Essential Medicines: Comparing Medicine and Consumer Product Supply Chains in the Developing World*. Palo Alto, CA: Stanford Social Innovation Review; 2013.

10. PricewaterhouseCoopers. *Next-Generation Supply Chains: Efficient, Fast and Tailored*. 2012. Available at: http://www.pwc.com/et_EE/EE/publications/assets/pub/pwc-global-supply-chain-survey-2013.pdf. Accessed: July 25, 2013.

11. AT Kearney Inc. *How Many Supply Chains Do You Need? Matching Supply Chain Strategies to Products and Customers*. Chicago, IL: AT Kearney Inc.; 2004.

12. PATH, WHO. *Integrating Vaccine and Other Health Commodity Supply Chain Systems*. Geneva: PATH, WHO; 2013.

13. Milstien J, Batson A, Wertheimer AI. *Vaccines and Drugs: Characteristics of Their Use to Meet Public Health Goals*. Washington, DC: World Bank; 2005.

14. Privett N, Yadav P. *Analysis of the Procurement and Pricing Architecture for New Vaccines. Working Paper*. New York, NY; 2012.