



WILLIAM DAVIDSON INSTITUTE
AT THE UNIVERSITY OF MICHIGAN

Improving Access to Medicines in Low- and Middle- Income Countries

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Agenda

1. Introduction
2. Overview of public health supply chains
3. WDI's supply chain – focused work:
 - a. Identifying efficient and effective supply chain designs through modeling
 - b. Enabling and incentivizing supply chain performance through a broader systems focus
4. Key takeaways



1. Introduction



My Background

1. Majored in Industrial & Operations Engineering at Univ. of Michigan



2. Joined Peace Corps in northern Zambia

Helped farmer cooperatives build fish farming businesses

Extra year - Helped local health managers diagnose and resolve medicine supply chain problems



3. Worked with U.S.-based healthcare & agriculture startup companies



4. Joined the William Davidson Institute's Healthcare Initiative

Health supply chain

Business Strategy

Health investment
decisionmaking

Forecasting/modeling



What is the William Davidson Institute (WDI)?

University of Michigan Affiliate

- Independent, non-profit research and educational institute
- Housed at the Stephen M. Ross School of Business

Focus on Business + Social Welfare in Emerging Markets

- Use business tools and approaches to improve economic opportunity and social outcomes
- Help local private markets meet demand for goods / services
- Work in Education, Energy, Finance, and Healthcare sectors

Emphasis on Applied Research

- Grounded in research and academic rigor, but not theoretical
- Goal to create practical solutions for businesses and gov'ts
- Collaborate with faculty & students across the University



Our Healthcare Initiative focus areas span the healthcare value chain

Market Dynamics & Procurement

Understanding how different **parameters** impact a product's **performance in the market**

Supply Chain

Designing, evaluating and improving how health products **reach the point of care**

Delivery

Designing, evaluating and **improving** how, when, and where different types of **healthcare** are **delivered**

Information Systems

Connecting and identifying ways to **leverage data** along the healthcare value chain



Key Supply Chain Problem: Patients lack access to basic medicines in many parts of the world, despite significant investment to make them available.

Investment

Largest-ever U.S. aid grant: **\$10 billion over 5 years** for health products and supply chain assistance

Other donor agencies (Global Fund, Gavi, Bill & Melinda Gates Foundation) dedicate **hundreds of millions of dollars per year** to distributing health supplies

Government & private spending?
Probably **billions per year**



Outcomes

As recently as 2011, the typical public clinic in **Africa averaged only 57% availability** of the products included on the WHO Essential Medicines List¹

25% of all low-income country patients were unable to access needed medicines at a recent visit²

“No Product, No Program!”

1. WHO. The World Medicines Situation 2011: MEDICINE PRICES, AVAILABILITY, AND AFFORDABILITY; Geneva: The World Health Organization, 2011.

2. WHO. The World Medicines Situation 2011: ACCESS TO CARE AND MEDICINES: RESULTS FROM THE WORLD HEALTH SURVEY; Geneva: The World Health Organization, 2011.



Why is this? Lack of infrastructure physically preventing distribution?

Bad Roads??



Not enough drones??



Lack of electricity??



CNBC MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV

Zipline, which delivers lifesaving medical supplies by drone, now valued at \$1.2 billion

PUBLISHED FRI, MAY 17 2019 7:20 AM EDT | UPDATED FRI, MAY 17 2019 7:56 AM EDT

Lora Kolodny @LORAKOLODNY

SHARE f t in e ...



No! Lack of infrastructure is absolutely a serious barrier, but people and companies already find numerous ways to overcome this barrier

Bad Roads?



More drones needed?



Jumia: 'Africa's Amazon' in landmark stock market listing

12 April 2019

Share



Lack of electricity?



Clearly it is *possible* to serve even the most remote patients – many companies already do.

How can we bring public health supply chain performance up to the level at which these other companies are already operating?



2. Overview of Public Health Supply Chains



What does a typical public-sector health supply chain look like?

- Global network of manufacturers, donors, distributors, governments, and healthcare workers, supplying clients in low- and middle-income countries (LMICs)
- In sub-Saharan Africa, **50 - 60%** of health services provided by public sector
- “Public” often means government owns and operates warehouses and trucks.
- Assumption that most clients can’t pay for full cost of healthcare and medicines; most systems have a net inflow of cash, usually top-down



The Kenya Medical Supplies Authority national warehouse in Nairobi



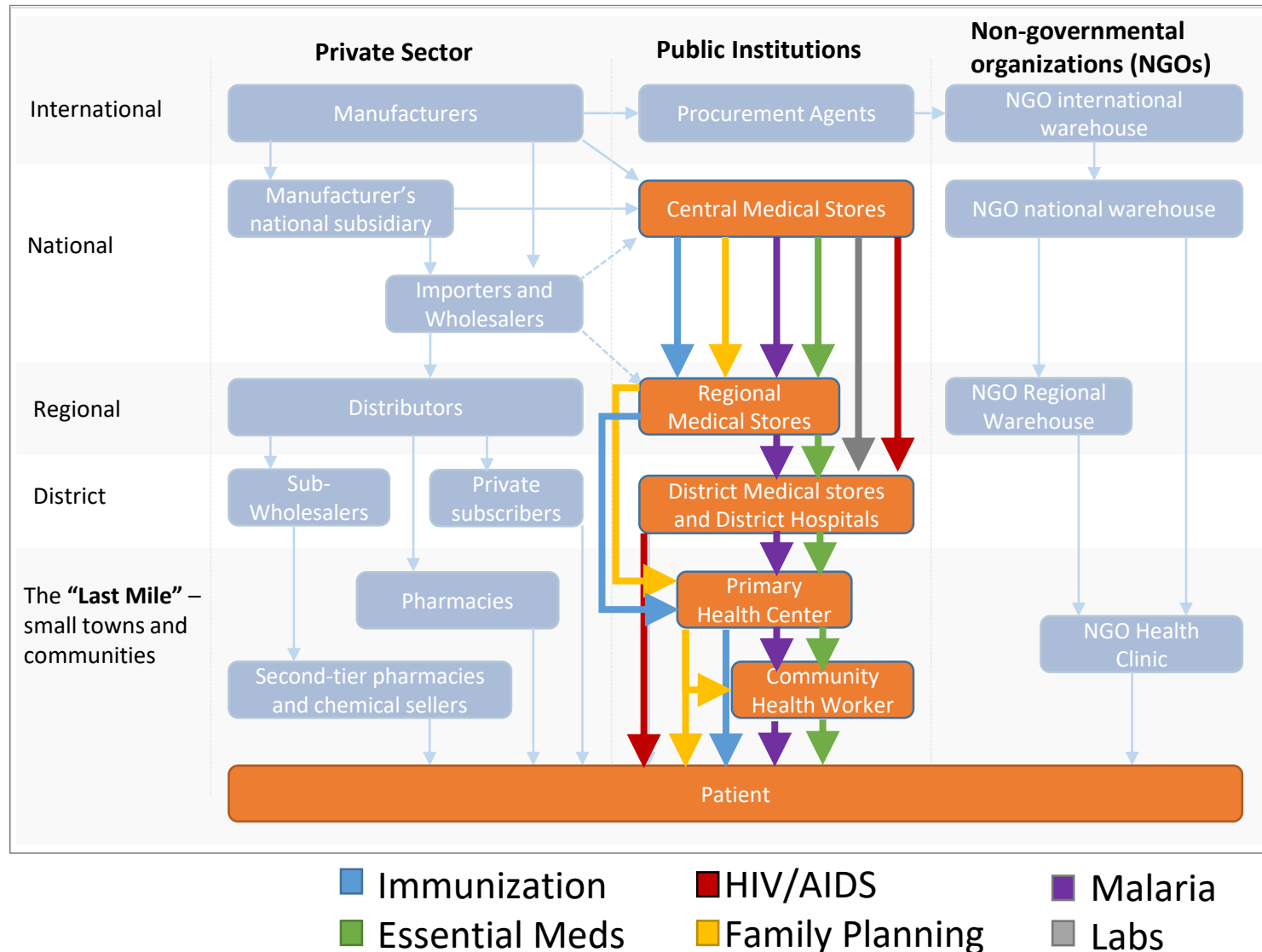
Health commodities being loaded onto a truck for delivery in Dakar, Senegal



A primary health clinic in Lilongwe, Malawi



How is a typical public-sector health supply chain structured?



- **Overall Structure**

- Central warehouse to manage procurement & break bulk
 - Regional/district warehouses to pre-position inventory
 - Service delivery points to serve clients/patients
- Different products take different paths through the structure
 - Public-sector supply chain the most common area of focus




How does an order become a delivery?

General Process

1. Health facility staff conducts monthly or quarterly physical count of products and completes order form
2. Order form relayed to local-level supervisor, who validates and relays upstream
3. Upstream warehouse receives order form, enters into a computer system, and packs the order.
4. Order transported downstream to health facility

Clinic inventory reporting & ordering form - Zambia

VB HCs Only


REPORT AND REQUISITION FOR ESSENTIAL DRUGS

☐ Emergency Order

Reporting Period: From: 3/10/2009 to 3/11/2009 Province: EASTERN Maximum Stock Level: 4 Months
 dd/mm/yyyy dd/mm/yyyy

Facility: CHIFUNDA RHC District: CHAMA Emergency Order Point: 0.5 Months

| Drug Product | Unit | Beginning Balance of stock in storeroom | Total Quantity Received during the month | Total Quantity Issued from the storeroom during the month | Losses and Adjustments | Physical Count of stocks in the storeroom at the end of the month | Quantity ordered but not yet received | (AMI) = (E + previous 2 months issues) ÷ 3 | Maximum Quantity | Order Quantity |
|---|--------------|---|--|---|------------------------|---|---------------------------------------|--|------------------|----------------|
| A | B | C | D | E | F | G | H | I | J=(I x 4) | K=(J-H-G) |
| Acetylsalicylic Acid, tablet 300mg | 1000 Tablets | 20 | 30 | 23 | — | 27 | 25 | 19 | 76 | 24 |
| Adrenaline Acid Tartrate, Injection, 1mg/ml | 1ml Ampoule | 7 | 3 | 5 | — | 5 | 4 | 8 | 32 | 23 |
| Amoxicillin (Trihydrate), Dry powder for suspension 125mg/5ml | 100ml bottle | 0 | 30 | 30 | — | 0 | 25 | 40 | 160 | 135 |
| Amoxicillin (Trihydrate) Capsule 250mg | 1000 caps | 43 | 25 | 37 | — | 31 | 60 | 30 | 120 | 29 |
| Artemether/Lumefantrine, tablet 120/20mg | 6 Tablets | 270 | 90 | 260 | — | 100 | 130 | 220 | 880 | 650 |
| Artemether/Lumefantrine, tablet 120/20mg | 12 Tablets | 120 | 60 | 130 | — | 50 | 90 | 135 | 540 | 400 |
| Artemether/Lumefantrine, tablet 120/20mg | 18 Tablets | 110 | 0 | 110 | — | 0 | 120 | 90 | 360 | 240 |
| Artemether/Lumefantrine, tablet 120/20mg | 24 Tablets | 90 | 60 | 85 | — | 65 | 90 | 70 | 280 | 125 |

Explanation for Losses/Adjustments: _____

Discrepancies or Remarks: _____




How does an order become a delivery?

Variations on the General Process

- Travel responsibilities:
 - Facility staff travel upstream to submit order form and/or collect product
 - Upstream staff travel to facilities to take orders and/or deliver product
- Timing of ordering & delivery
 - Simultaneous: Orders filled on-the-spot, either at the facility or at an upstream level
 - Separate: Orders collected in one period, then filled in subsequent period (e.g. 15 days later)

Clinic inventory reporting & ordering form - Zambia

VB HCs Only

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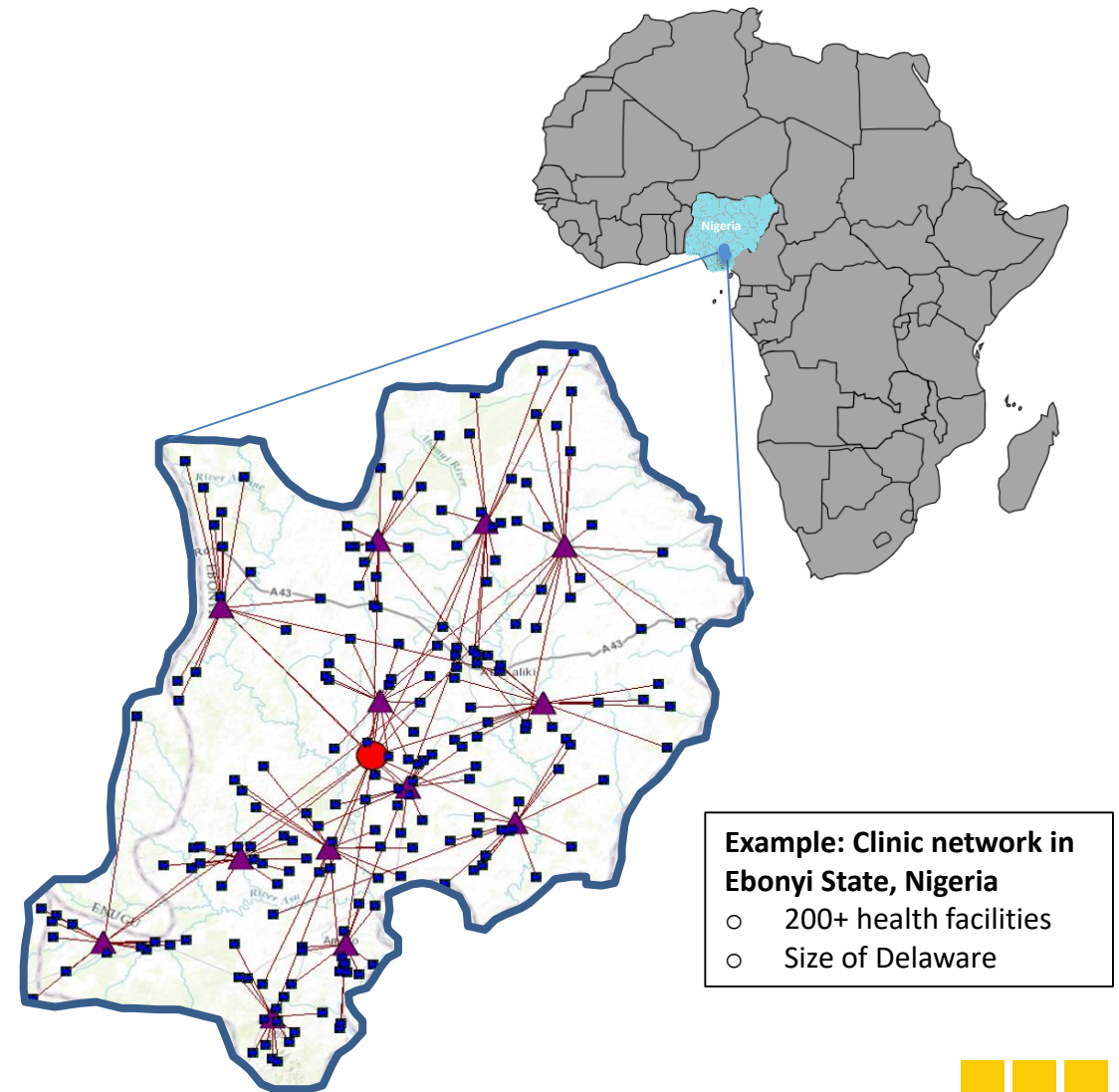


3a. Modeling to identify efficient and effective supply chain designs



First Step: Can we model different supply chain designs to understand what factors drive performance?

- Real world - some health supply chains perform much better than others.
 - Overall 57% average availability, but some systems are much higher (90+%)
- How much is their performance related to their underlying design?
- If we can model supply chains and replicate their performance, perhaps we can show how to improve supply chains in new countries/contexts



Approach: Simulation modeling using LLamasoft's Supply Chain Guru

Why partner with LLamasoft?

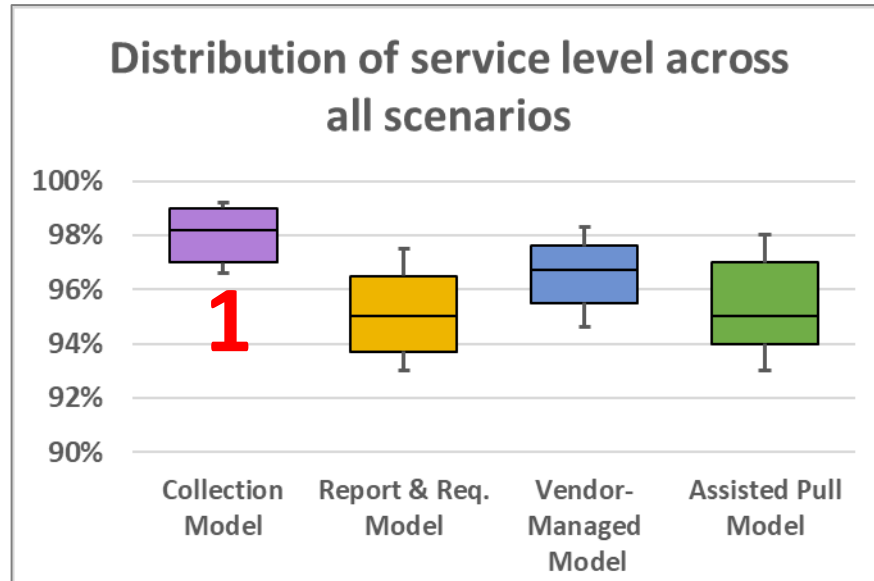
- **Locally based:** Headquarters in Ann Arbor
- **Global experience:** Have consulted for other global health & agriculture orgs
- **Powerful software:** Used by Unilever, Intel, Nike, Starbucks, Walmart, and other major corporations

How did we structure the simulation model?

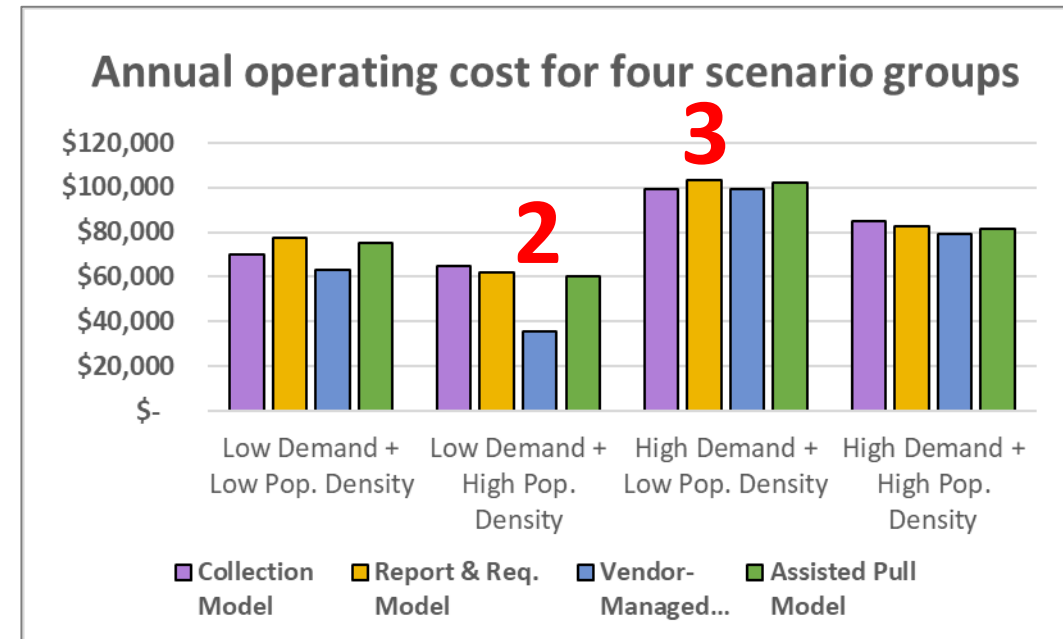
- **Started with Ebonyi State, Nigeria clinic network:** Basic network info: clinic locations, distances, demand
- **Built out 4 basic supply chain design variations:** Differing # tiers, travel patterns, timing of ordering vs. delivery
- **Incorporated country-to-country differences:** Varying demand, network density, truck size, reorder frequency
- **Modeled uncertainty and imperfect process control:** Demand/supply variability; Order reporting & processing errors



Results: Interesting insights on each design's relative performance under different operating contexts...



1. Collection model has highest service level in model, but often very low in real-world systems.



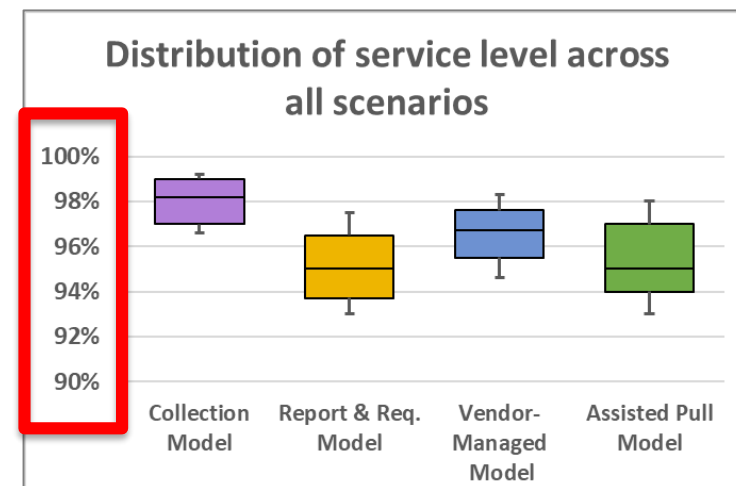
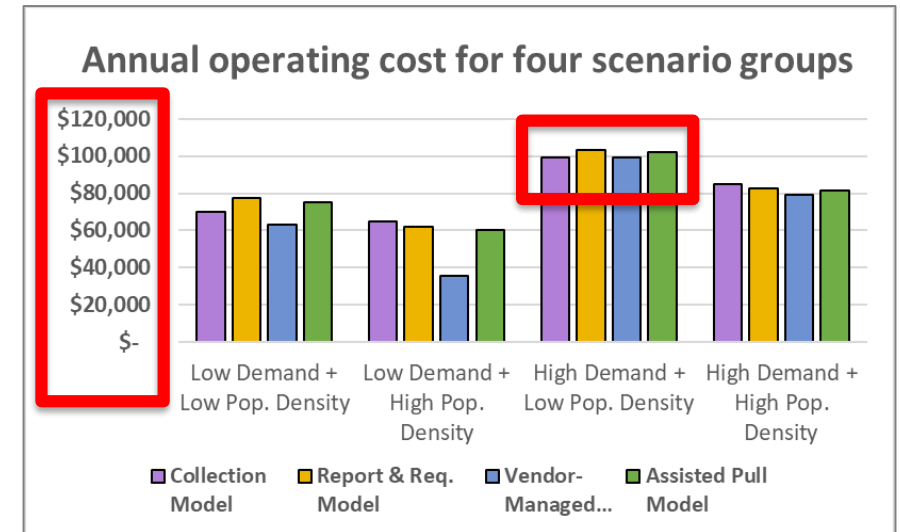
2. VMI model most cost-efficient despite perception of being expensive. Advantage when visiting lots of closely-spaced clinics with one truck-full of inventory

3. Potential for hybrid strategies? Collection for low-density areas, VMI for high-density?



...but one key issue: In the simulation model, ALL the designs performed well in ALL the scenarios

- Simulated designs all performed at a very high level given normal variability & process error rates
 - Service levels mostly ~95+%
 - Costs lower overall on a per-cubic-meter basis
 - Narrow cost range for most scenarios
- Performance doesn't drop as variability (demand & lead time) and order error rate increase.
 - Only way to sink performance: major process breakdowns, e.g. consistently not submitting or delivering orders
- Implication: Beyond a certain threshold, stockouts likely driven by lack of consistent execution, rather than the nature of the design itself



Each of the supply chain designs was *capable* of performing well, but modeling couldn't explain why real-life versions struggle to realize that potential.

For that, we must focus on the broader *system* – the financing, management, and strategic environment – in which a supply chain operates.

How does that system enable & incentivize people to carry out supply chain processes? How can it be improved?



3b: Enabling and incentivizing supply chain performance through a broader systems focus



Four overarching “systems” lessons from WDI’s work (for health supply chain but probably also for many other systems)

1. The system must be designed around people’s goals and priorities. Don’t assume that other people share your same goals and priorities.
2. Money drives complexity in many systems; streamlining financial flows is often the best place to start improving a system’s design
3. Complexity invites diffusion of accountability and control; make sure that every part of the system has an “owner” who is incentivized by actionable metrics
4. Decisions and actions often require MORE effort but LESS data than people think; give leaders resources to make quick decisions and see them through



Designing around stakeholder priorities



Which of these supply chain pilot models would you move forward with?

Discussion Questions:

- Which supply chain model is best?
- What tradeoffs does that decision require?
- Which metrics did you prioritize most?

| | Pilot model A | Pilot model B |
|---------------------------------------|--|--|
| Total Cost | \$950,000 / year | \$1,600,000 / year |
| Efficiency | \$625 / cubic meter delivered | \$975 / cubic meter delivered |
| Sustainability | 90% of costs funded by internal gov't revenues | 50% of costs funded by internal gov't revenues |
| Alignment w/ National Health Strategy | 8.4 out of 10 on internal evaluation study | 3.6 out of 10 on internal evaluation study |
| Num. of commodities supported | 175 (all commodities except cold-chain) | 175 (all commodities except cold-chain) |
| Data Quality | 70% average reporting rate | 95% average reporting rate |
| Inventory Availability | 75% average product availability | 96% average product availability |

VS



Consider the question from multiple perspectives...does your answer change?

Minister of Health:

- Underfunded; money a key concern
- Outside donor funding unpredictable
- Multiple groups with entrenched interests and political influence
- Many competing health priorities

Chief-of-party for a donor organization:

- Mission = improving health outcomes
- Can raise additional funding if able to demonstrate impact
- Interested in novel approaches –
“Be Disruptive!” “Fail Fast!”

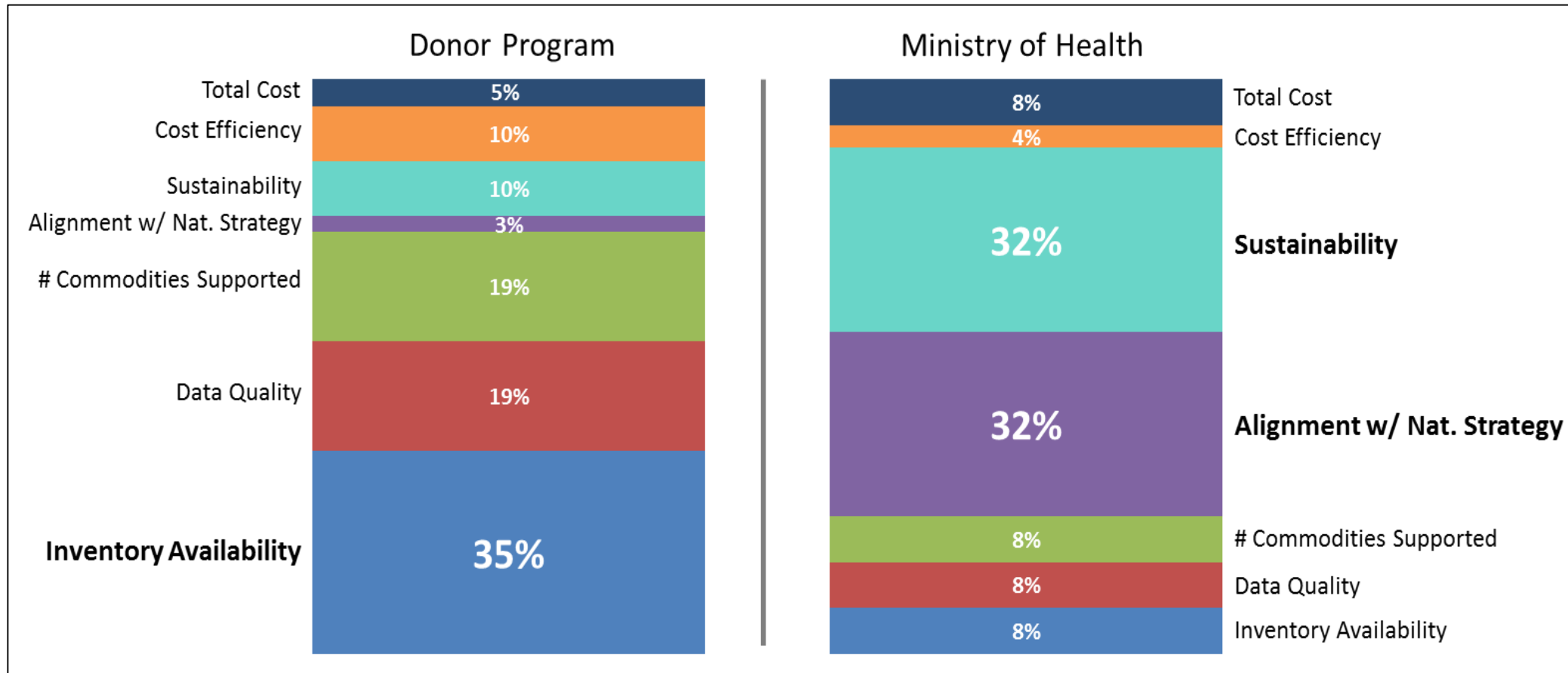
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VS



Real-world example: Stakeholders agree they want to “improve supply chain performance”, but disagree on what that means and how to achieve it

Analytic Hierarchy Process (AHP) tool results – Differences in SC performance priorities



Making stakeholder objectives and priorities explicit up front can streamline project design and decisionmaking in many ways

Informing design and investment decisions

- Identify which types of improvements would have the greatest impact on stakeholder support for a project
- More accurately define the needs/requirements of a “best-case solution”
- Clearly identify the tradeoffs associated with different supply chain design options

Targeting advocacy and implementation

- Highlight organizations most and least likely to support a decision, allowing more targeted use of time & resources for advocacy
- Enables a phased implementation strategy -- initial roll-out to those regions and program areas where support and/or performance is strongest

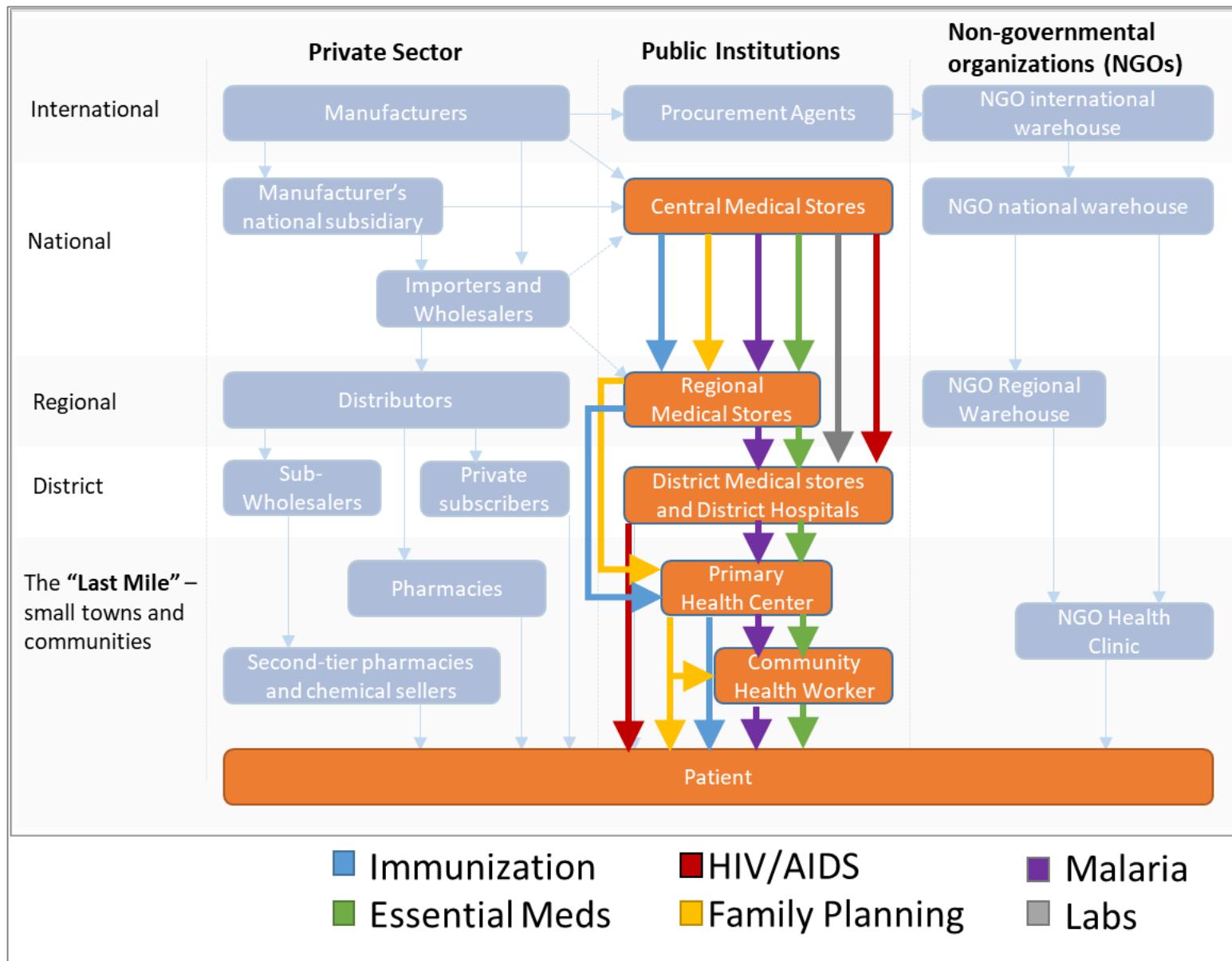
Monitoring performance over time

- Identify priority metrics for central-level monitoring & evaluation dashboards
- Create executive-level performance snapshot using composite performance metric(s)
- Separating critical changes in performance metrics from those that are less-prioritized



Streamlining financial flows

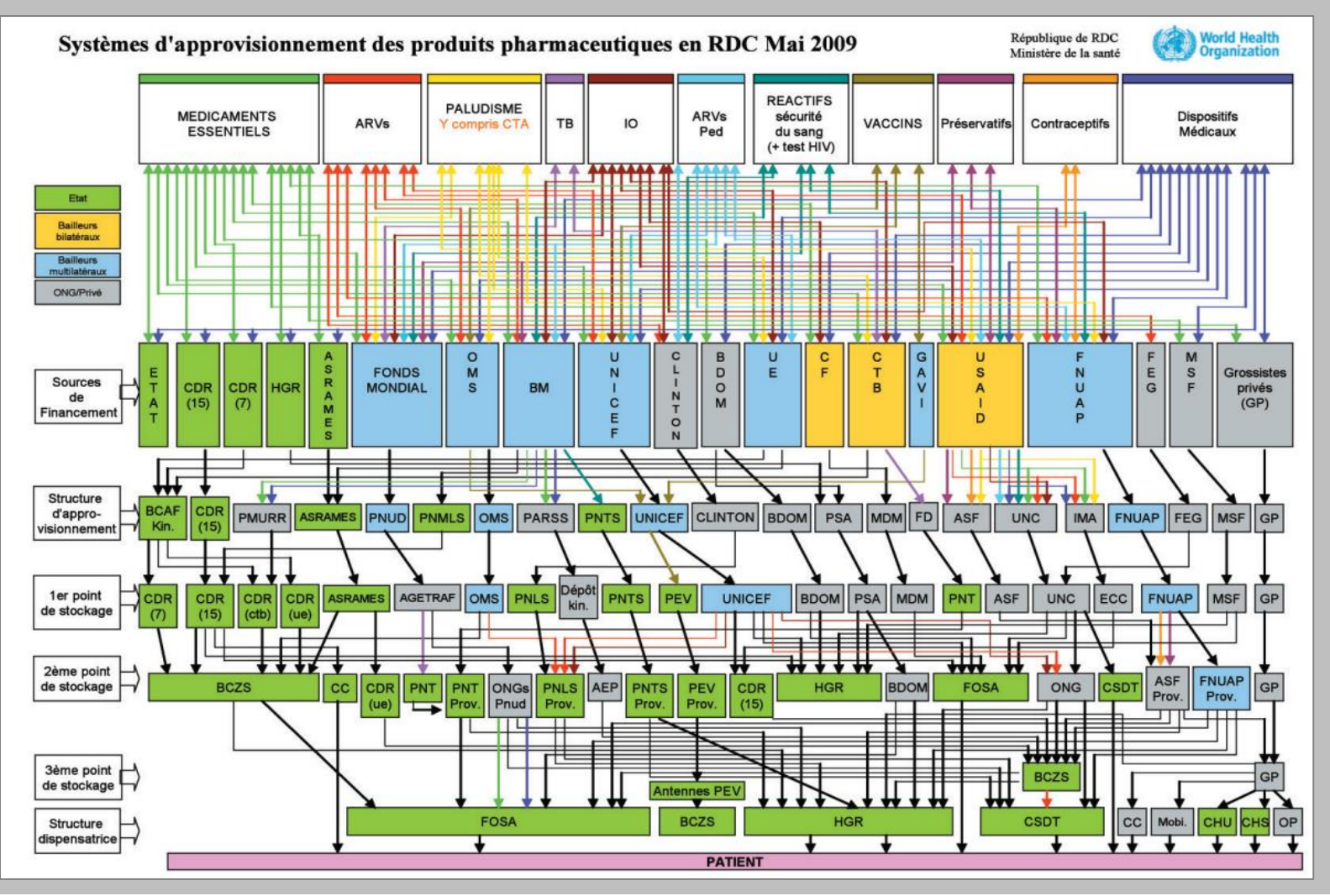
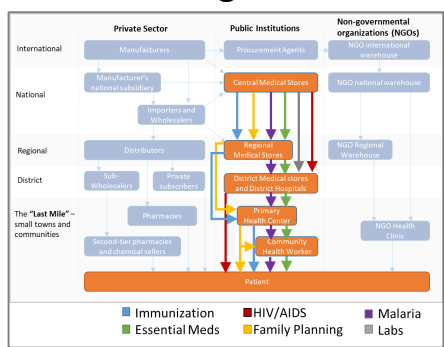




Fragmented funding complicates system execution in numerous ways:

Actual Diagram – Democratic Republic of the Congo (DRC) - 2009

Illustrative diagram



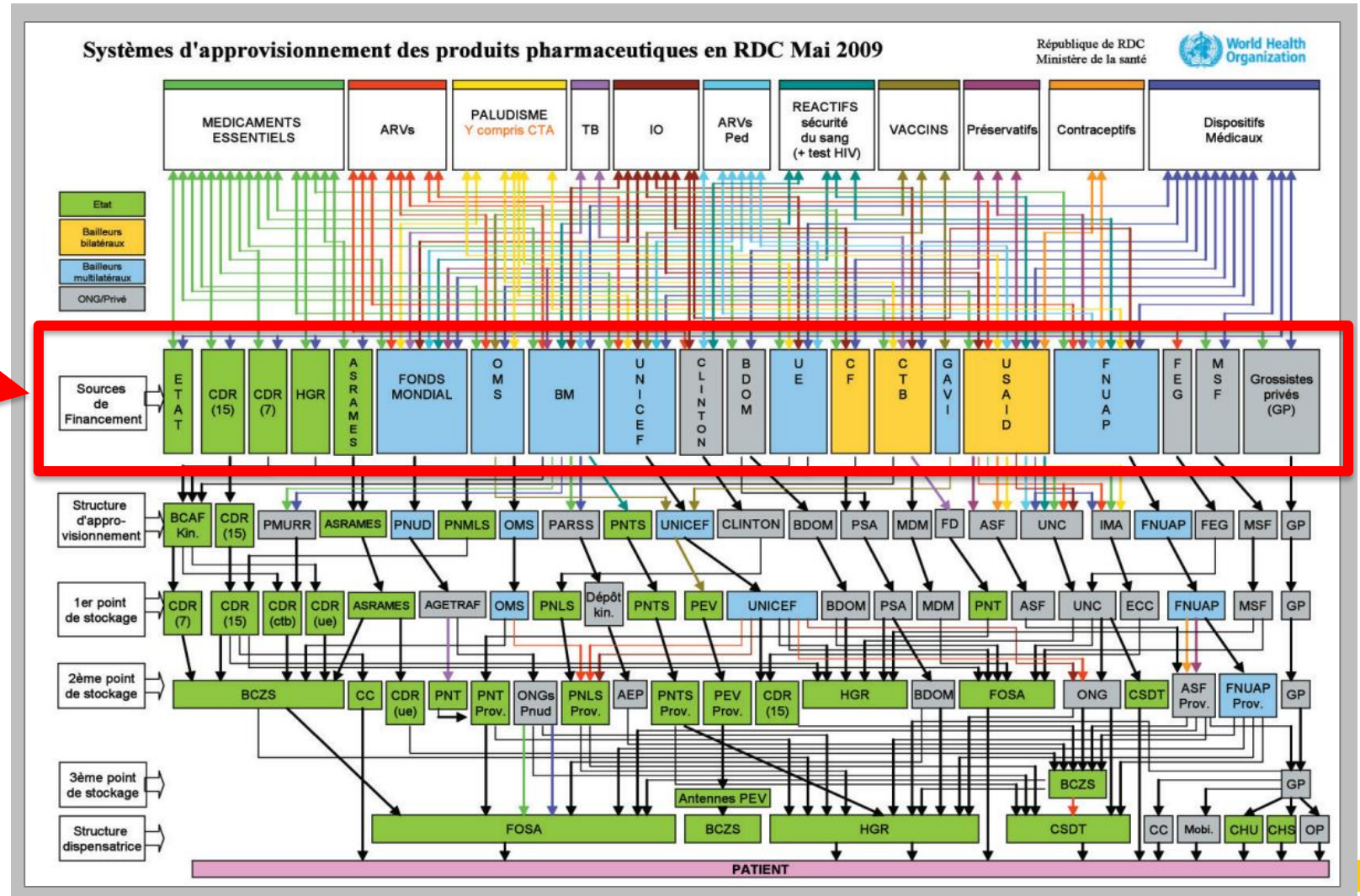
Fragmented funding complicates system execution in numerous ways:

1. Budgeting Challenges

Two challenging characteristics of current financing situation:

1. Earmarked funding
2. Differing funding timelines

How to estimate funding needs from one source when you don't know how much you're getting from the others, or what it can be used for?



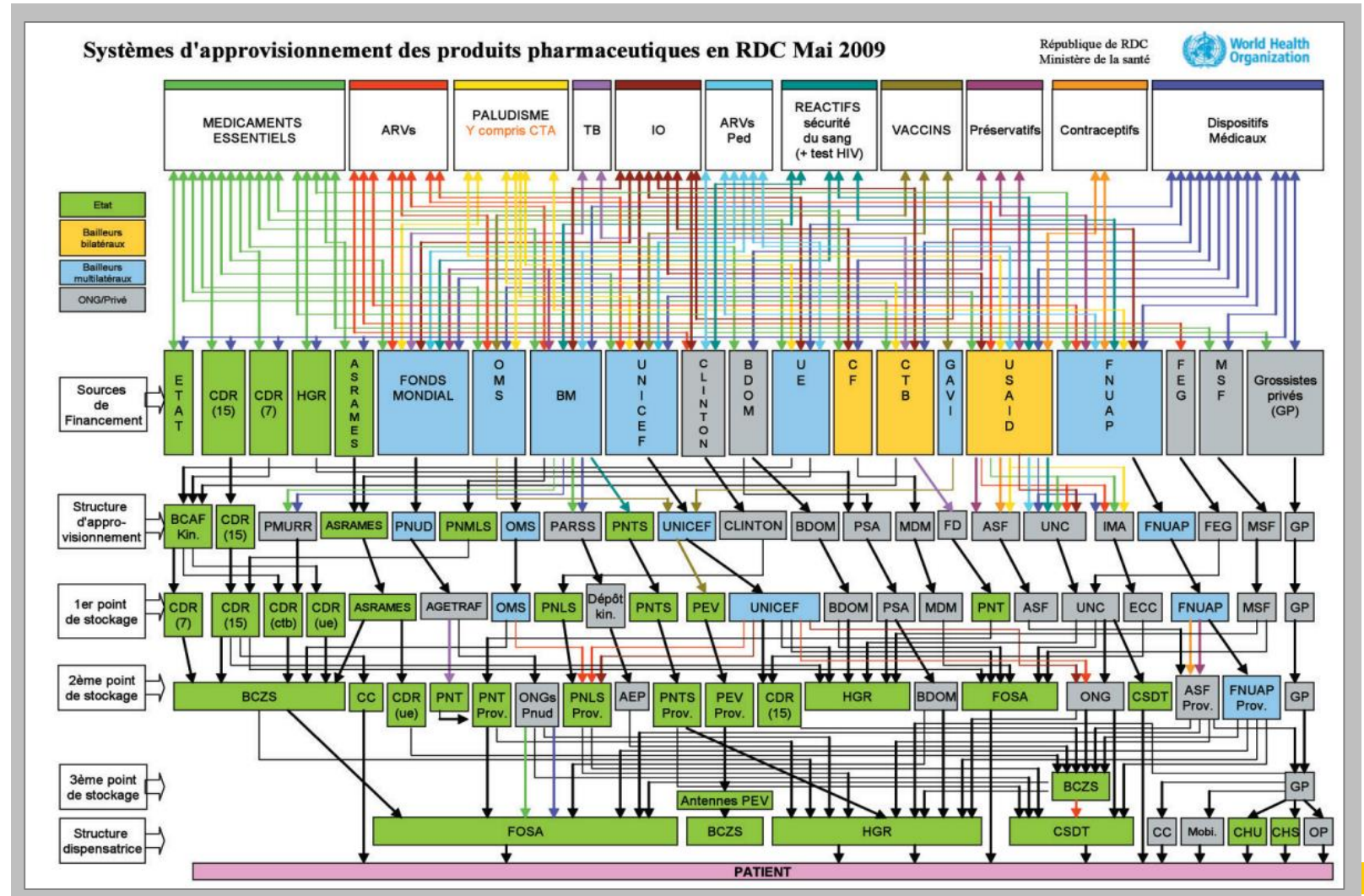
Fragmented funding complicates system execution in numerous ways:

2. Coordination Challenges

Three or more organizations often handling single product from port of entry to patient.

More organizations involved = more potential points of failure

Who is ultimately accountable for ensuring availability at a clinic?



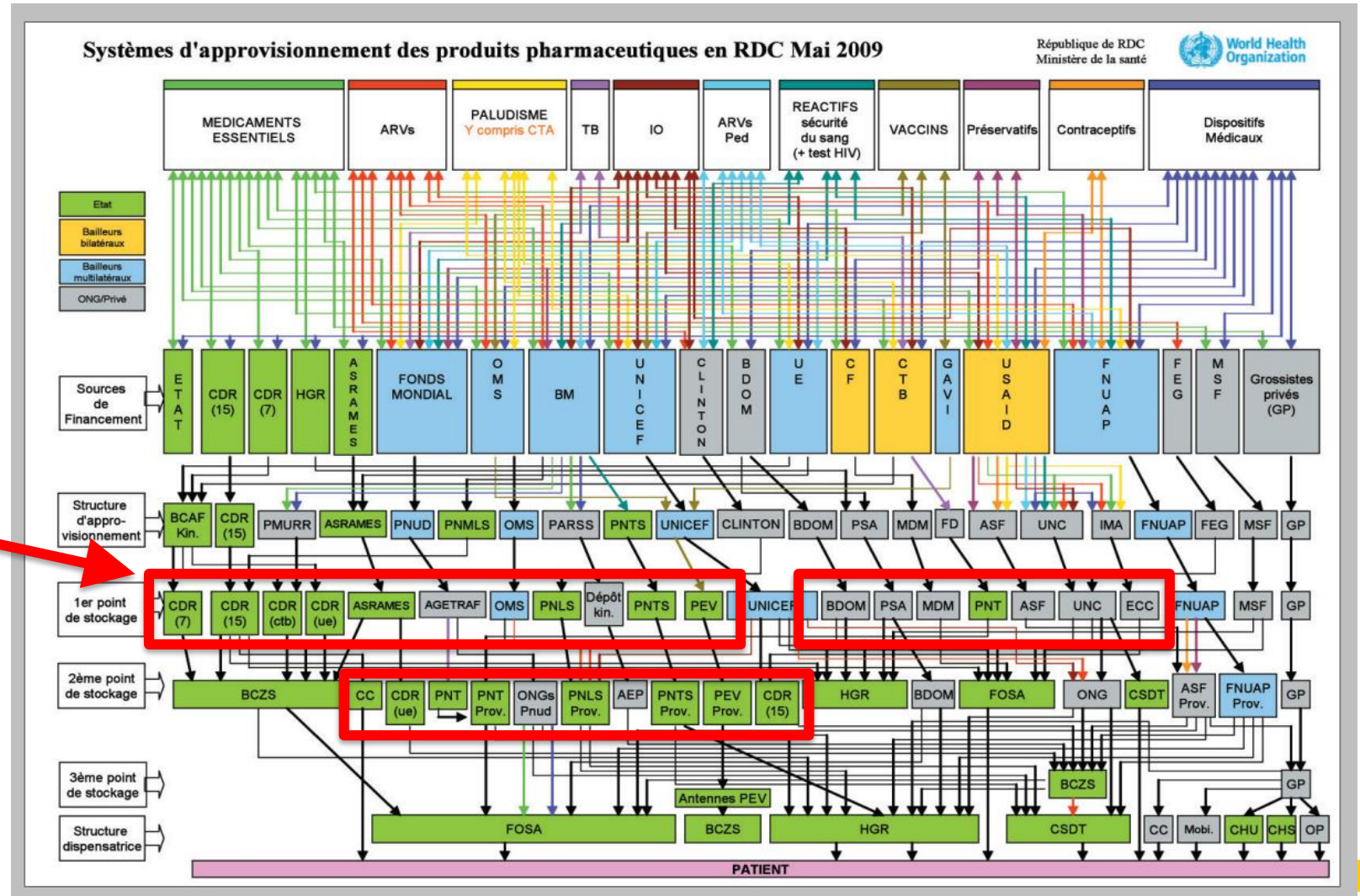
Fragmented funding complicates system execution in numerous ways:

3. Efficiency Challenges

Many boxes on the chart *refer to the same physical location*.

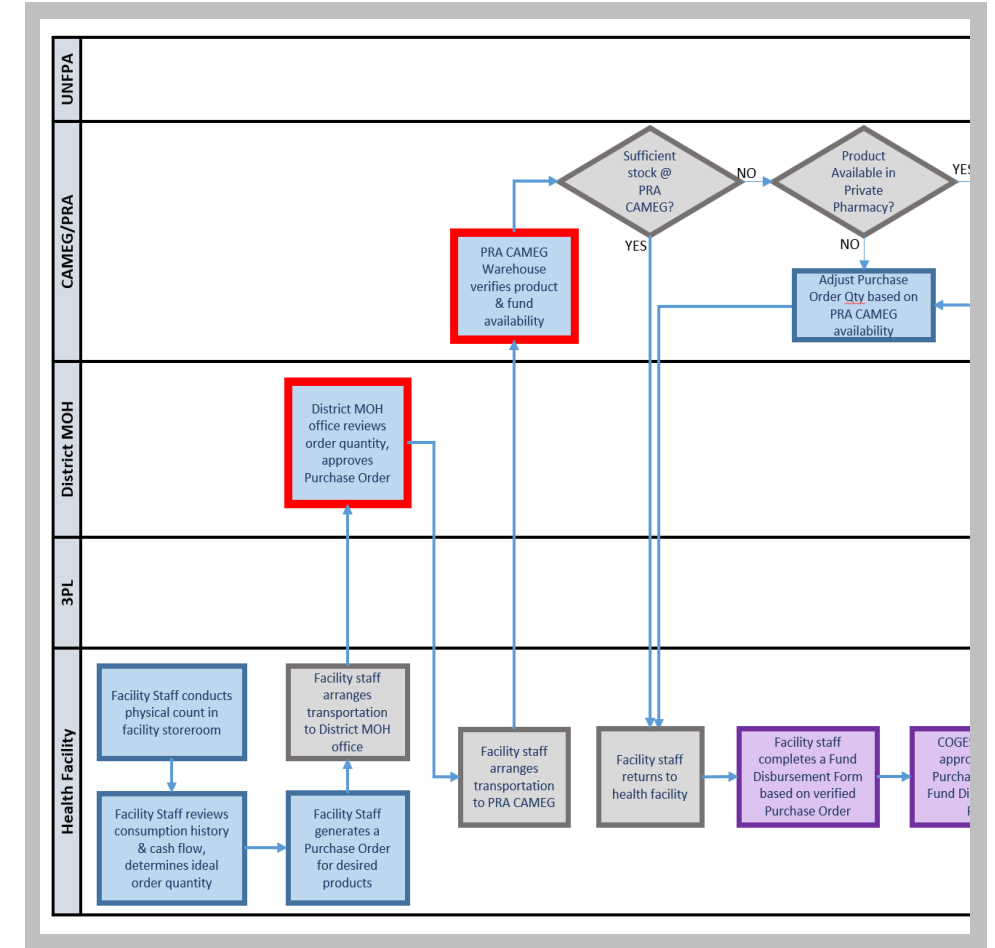
Each location juggling multiple processes to move commodities through essentially the same path.

How to operate efficiently when managing parallel systems?



How to streamline financial flows? Mapping, advocacy, and integration

- Process mapping a great tool for highlighting opportunities to merge similar funding decisions & processes
 - Often hard to realize how complicated the system actually is on the ground
- Financial integration requires someone to reduce control over their own money.
You must convince them it is worthwhile!
- In many cases the best way to catalyze action is to clearly highlight the problem
 - E.g., the diagram from the previous slides
 - **“Find the figure that tells the story”**



Designing for accountability



As systems become more complex, they often become harder to govern and administer effectively

A delivery process that involves more steps and more stakeholders:

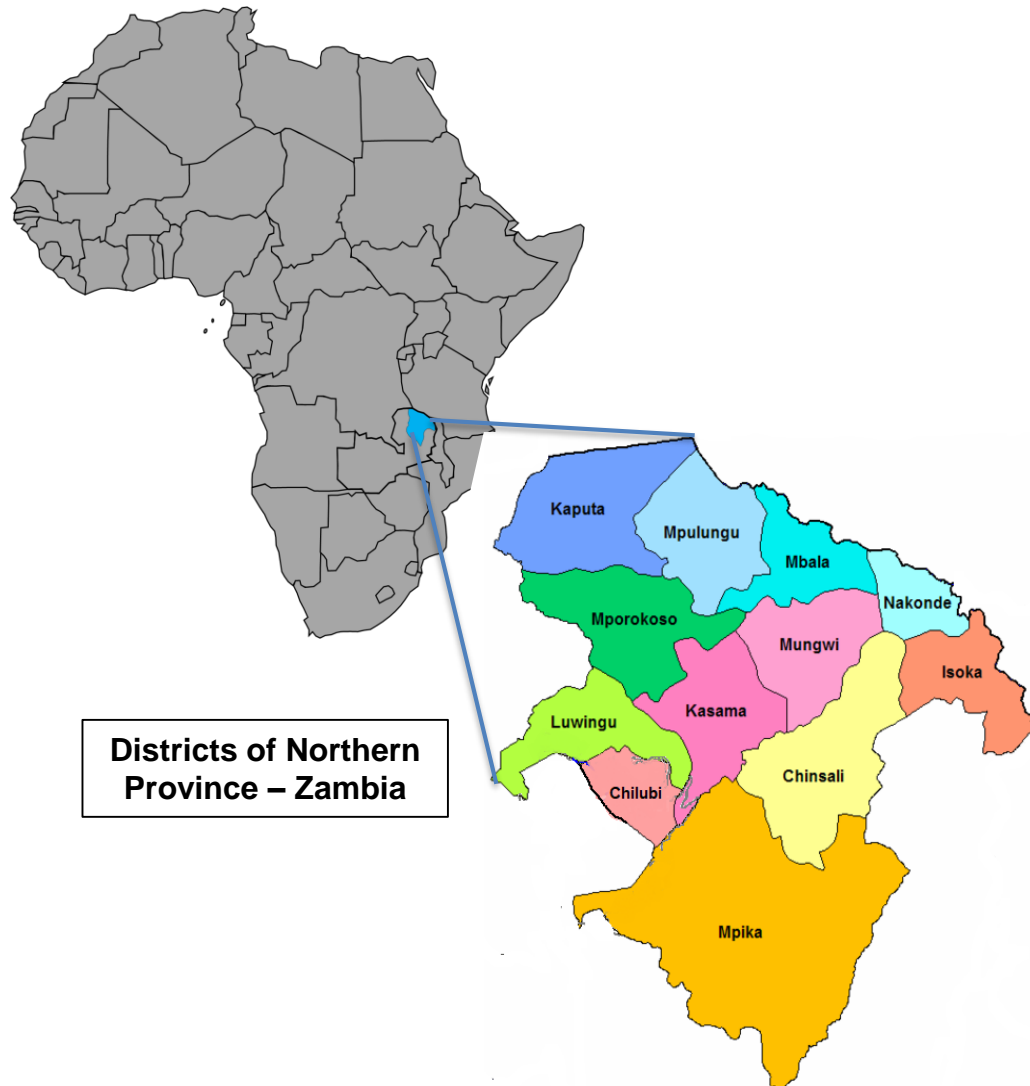
Requires more monitoring, supervision, and data collection to ensure process adherence

Obscures incentives and makes it harder to ensure everyone's incentives are aligned around the same goal

Diffuses accountability, enabling stakeholders to more easily pass off and avoid responsibility for a particular outcome



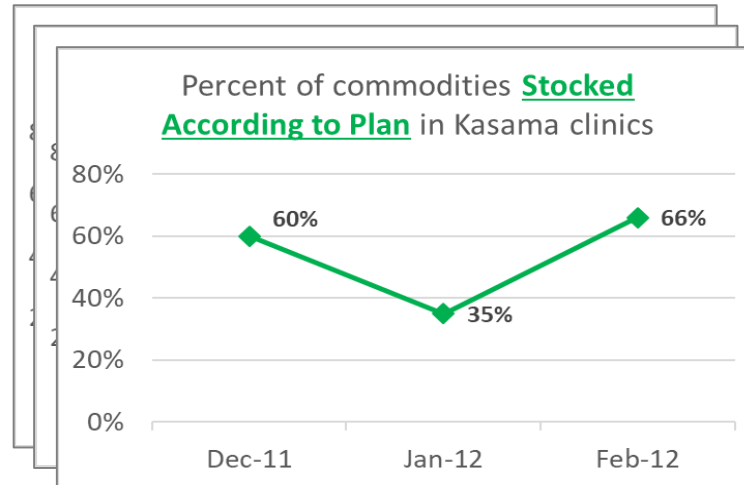
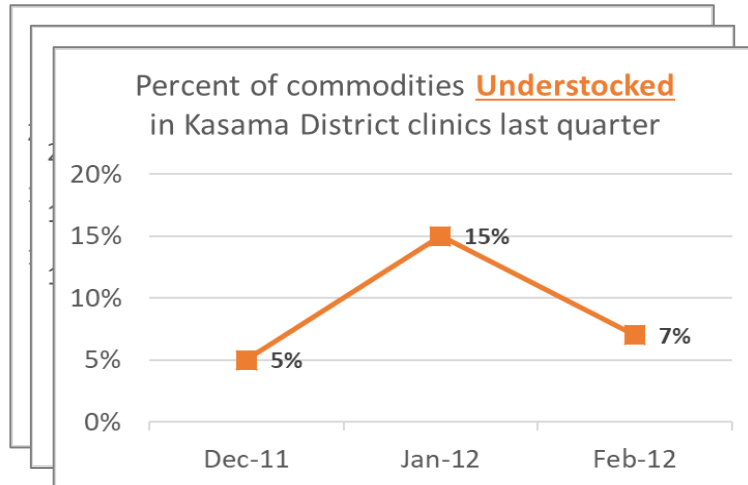
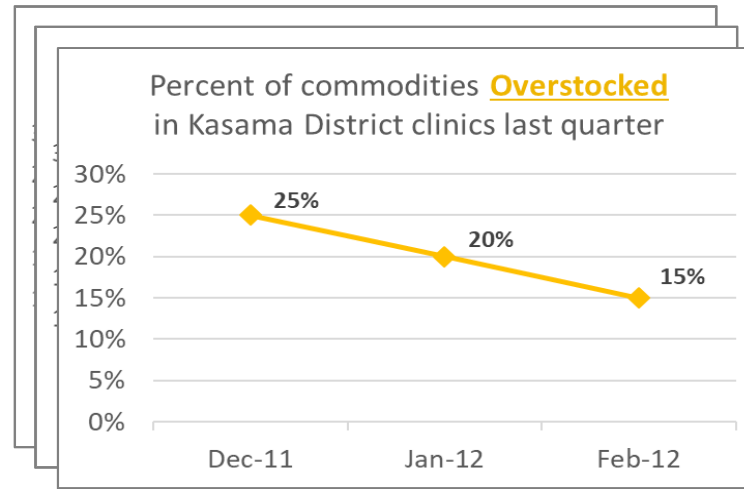
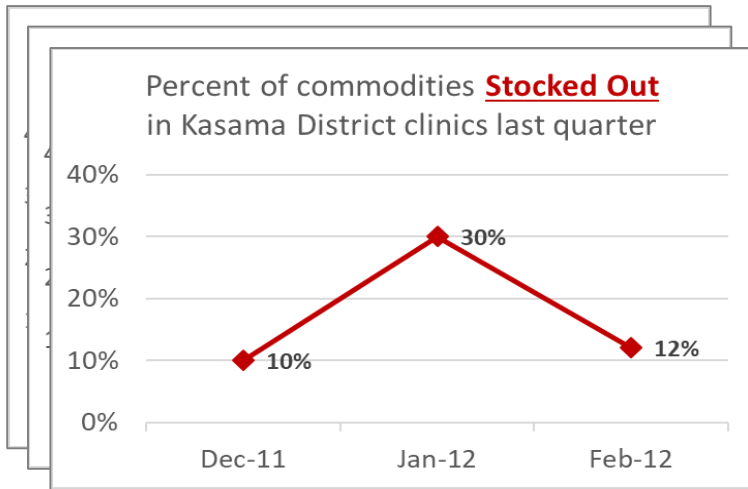
Real-world example: Trying to incentivize district-level health leaders to focus on improving supply chain outcomes



- **Setting:** Quarterly management workshop with 12 District Chief Medical Officers
- **Approach:** Show each DCMO their clinics' supply chain performance, using outcome metrics given to us by our funder:
 - Stockout Rates for all commodities
 - Over/understock rates
 - Percent of commodities “Stocked according to plan”
- 4 metrics x 12 districts = 48 graphs total
 - District-specific handouts for each DCMO
 - Also discussed as a group



Using our own organization's success metrics was ineffective at measuring and incentivizing local health leaders' performance



How did the conversation go?

- “My clinics only stocked out because the central warehouse messed up their orders! You should be yelling at those guys instead!”
- “If I do poorly on the stockout metric, I automatically look bad on two of the other metrics too!”
- “This meeting always takes a really long time!”



Instead we needed to design metrics that accurately reflected supply chain performance at the local level

Identify core supply chain task(s) directly within District control

Zambia DCMOs have one overarching supply chain responsibility:

Provide timely and accurate clinic order data to the central warehouse

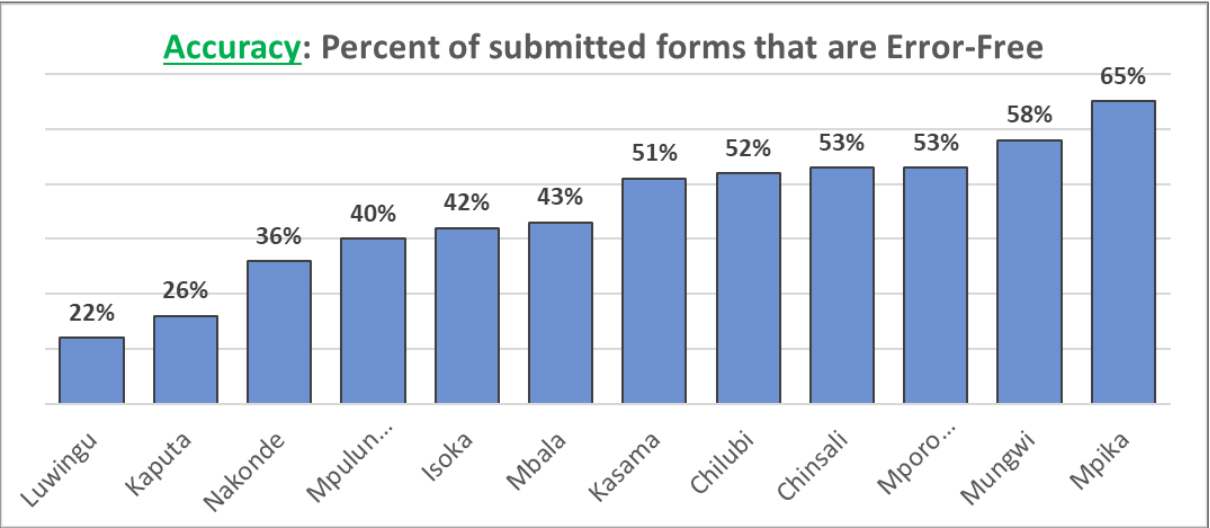
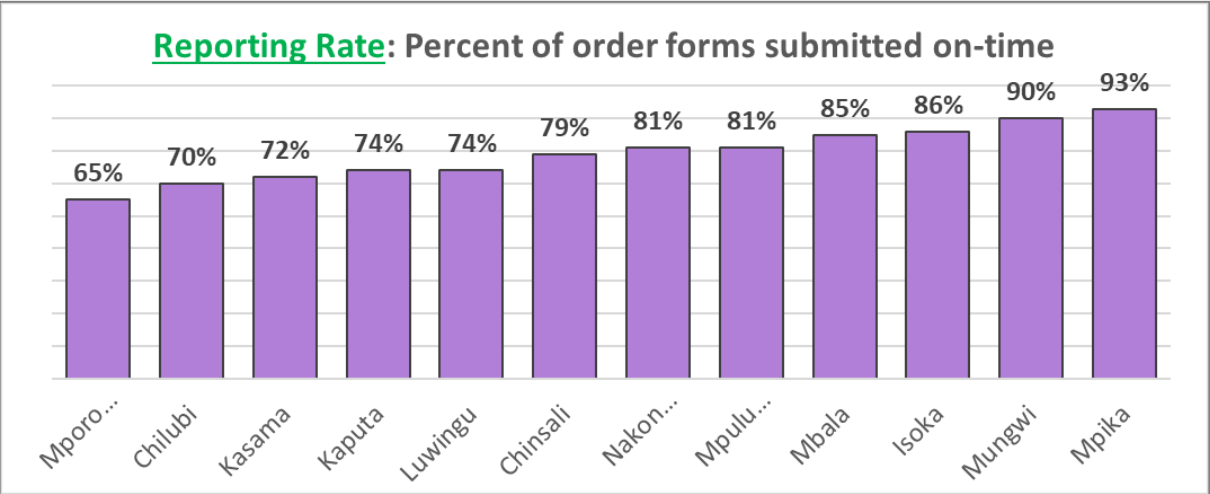
In order to expect timely and accurate deliveries from the central warehouses, they must provide timely and accurate data

Define metrics and visualizations to show performance on those tasks

- DCMO responsibility captured with two metrics:
 - **Clinic Reporting Rate:** Percentage of all clinic order forms submitted on-time
 - **Clinic Reporting Accuracy:** Percentage of all submitted order forms that are error-free
- Each metric best displayed with all districts on a single graph
 - To show variation in district performance
 - To take advantage of peer pressure



Showing district leaders metrics that were tailored to their own sphere of control helped generate informative dialogue and incentivize action



How did the conversation go this time?

- “Wow, I didn’t realize we were making that many mistakes in our reporting!”
- “How are those districts performing the best of the group? They have the biggest area and the most facilities to cover...”
- “Last year I budgeted for two-way radios for my faraway facilities. That helped our reporting rates -- now they sometimes just call me and I submit their order form for them.”



Empowering decisions and action



“Bias for Action” – A core Amazon leadership principle; also critical for healthcare organizations seeking innovation and improvement

People working towards this principle (in global health, but also probably everywhere) often face two challenges:

1. **Getting started** - Deciding to take a specific action
2. **Sustaining momentum** – Seeing an action through when competing needs arise

“Speed matters in business. Many decisions and actions are reversible and do not need extensive study. We value calculated risk taking.”



What do these two challenges look like in LMIC health supply chains?

Challenges

Health Supply Chain Examples

1. Getting Started

- Conducting a “full” supply chain re-design analysis costs up to **\$500,000** and takes up to **6 months** (for data collection, software & consulting fees, etc.)
- Most regional & local leaders never have this kind of budget; National leaders must plan far in advance.
- **Result:** Very few health leaders conduct any kind of supply chain design analysis

2. Sustaining Momentum

- Health workshop results in good ideas for reform, but momentum peters out once participants return to their day jobs
- A pilot project is successful, but organizational turnover or newer projects impede full scale-up
- **Result:** Many good initiatives don't realize their full potential



How to address? First enable smaller and quicker decisions with rapid analysis & decisionmaking tools...

Getting Started is all about making a decision. Often you don't need a \$500k analysis to decide your first step.

WDI has developing several Excel-based rapid analysis tools to support supply chain decisionmaking, using

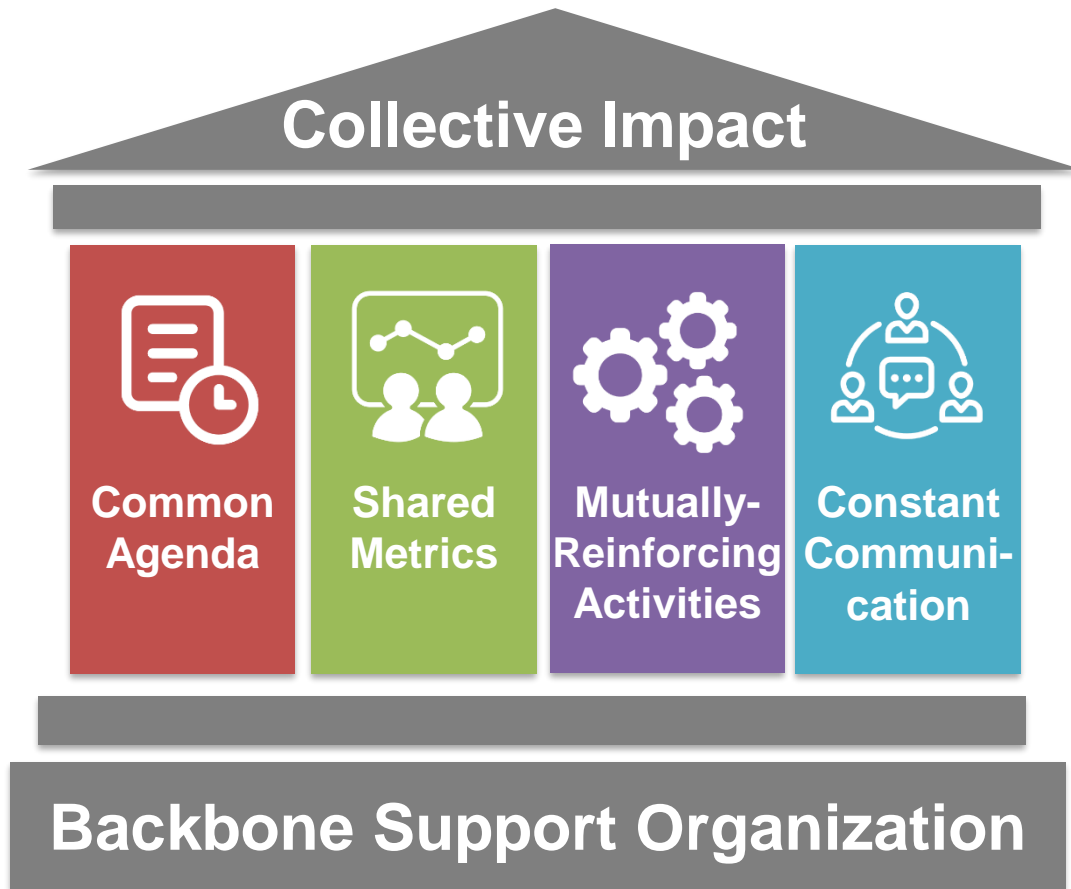
- Proxy data from other supply chains
- Simplified network/model design
- Back-of-the-envelope heuristics
- Qualitative logical analysis (see example)

Example: SC Strategy Alignment Tool

| | | Supply Chain Design Archetype | | | | |
|------------------------|--------------------------|-------------------------------|-----------------------|-----------------------|------------------------|---|
| | | 1. Collection Model | 2. Report & Req. | 3. VMI Model | 4. Assisted Pull Model | |
| Country Context Factor | Infrastructure | Incompatible | Incompatible | Incompatible | Incompatible | Synergistic Alignment Moderate Alignment Incompatible |
| | Management Systems | Moderate Alignment | Moderate Alignment | Synergistic Alignment | Synergistic Alignment | |
| | Financing Systems | Moderate Alignment | Incompatible | Incompatible | Incompatible | |
| | Political Climate | Synergistic Alignment | Synergistic Alignment | Moderate Alignment | Moderate Alignment | |
| | SC Network Structure | Moderate Alignment | Moderate Alignment | Synergistic Alignment | Synergistic Alignment | |
| | SC Process Quality | Incompatible | Moderate Alignment | Incompatible | Incompatible | |
| | National Health Strategy | Moderate Alignment | Synergistic Alignment | Moderate Alignment | Moderate Alignment | |
| | Technology | Moderate Alignment | Synergistic Alignment | Moderate Alignment | Synergistic Alignment | |
| | Topography | Moderate Alignment | Moderate Alignment | Synergistic Alignment | Synergistic Alignment | |



...Then sustain action by dedicating resources to “backbone support”



Initiatives lose momentum when people stop doing the legwork needed to drive collaboration and action:

- Setting group strategy & agenda
- Organizing meetings
- Tracking progress & sharing data
- Holding partners accountable

The **Collective Impact Framework** solves this problem by dedicating an organization/team/person specifically to that set of functions

Summary



Key Takeaway: Successful projects must balance technical solutions with an understanding of how the broader system enables and incentivized action

1. The system must be designed around people's goals and priorities, and those priorities are not always obvious
2. Money drives complexity in many systems; streamlining financial flows is often the best place to start improving a system's design
3. Complexity invites diffusion of accountability and control; make sure that every part of the system has an "owner" who is incentivized by actionable metrics
4. Decisions and actions often require MORE work but LESS data than people think; give leaders resources to make quick decisions and see them through



Questions?

