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

Michael Krautmann
Research Manager – Healthcare Initiative
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 List\(^1\)
- 25% of all low-income country patients were unable to access needed medicines at a recent visit\(^2\)

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Why is this? Lack of infrastructure physically preventing distribution?

Bad Roads??

Lack of electricity??

Not enough drones??

The Future of Healthcare is Out for Delivery

Zipline, which delivers lifesaving medical supplies by drone, now valued at $1.2 billion
No! Lack of infrastructure is absolutely a serious barrier, but people and companies already find numerous ways to overcome this barrier.

**Bad Roads?**

**Lack of electricity?**

**More drones needed?**
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
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.
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)
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

Example: Clinic network in Ebonyi State, Nigeria
- 200+ health facilities
- Size of Delaware
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?

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

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

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<th>Informing design and investment decisions</th>
<th>Targeting advocacy and implementation</th>
<th>Monitoring performance over time</th>
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<tr>
<td>• Identify which types of improvements would have the greatest impact on stakeholder support for a project</td>
<td>• Highlight organizations most and least likely to support a decision, allowing more targeted use of time &amp; resources for advocacy</td>
<td>• Identify priority metrics for central-level monitoring &amp; evaluation dashboards</td>
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<tr>
<td>• More accurately define the needs/requirements of a “best-case solution”</td>
<td>• Enables a phased implementation strategy -- initial roll-out to those regions and program areas where support and/or performance is strongest</td>
<td>• Create executive-level performance snapshot using composite performance metric(s)</td>
</tr>
<tr>
<td>• Clearly identify the tradeoffs associated with different supply chain design options</td>
<td></td>
<td>• Separating critical changes in performance metrics from those that are less-prioritized</td>
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Streamlining financial flows
The "Last Mile" - small towns and communities

- International
  - Manufacturers
  - Manufacurer’s national subsidiary
  - Importers and Wholesalers

- National
  - Distributors
  - Sub-Wholesalers
  - Private subscribers

- Regional
  - Regional Medical Stores
  - District Medical stores and District Hospitals

- District
  - Pharmacies
  - Second-tier pharmacies and chemical sellers

- The patient

- Non-governmental organizations (NGOs)
  - NGO international warehouse
  - NGO national warehouse
  - NGO Regional Warehouse
  - NGO Health Clinic

- Immunization
- HIV/AIDS
- Essential Meds
- Family Planning
- Malaria
- Labs
Fragmented funding complicates system execution in numerous ways:

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

**Reporting Rate:** Percent of order forms submitted on-time

- Mporo: 65%
- Chilubi: 70%
- Kasama: 72%
- Kaputa: 74%
- Luwingu: 74%
- Chinshila: 79%
- Nakonde: 81%
- Mpulungu: 81%
- Mbuluzi: 85%
- Mibala: 86%
- Iseka: 90%
- Mungu: 93%

**Accuracy:** Percent of submitted forms that are Error-Free

- Luwingu: 22%
- Kasama: 26%
- Nakonde: 36%
- Mpulungu: 40%
- Iseka: 42%
- Mibala: 43%
- Luwingu: 51%
- Kasama: 52%
- Chilubi: 53%
- Chinshila: 53%
- Mporo: 58%
- Mungu: 65%

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?

<table>
<thead>
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<th>Challenges</th>
<th>Health Supply Chain Examples</th>
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<tbody>
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<td><strong>1. Getting Started</strong></td>
<td>• Conducting a “full” supply chain re-design analysis costs up to $500,000 and takes up to 6 months (for data collection, software &amp; consulting fees, etc.)</td>
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<tr>
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<td>• Most regional &amp; local leaders never have this kind of budget; National leaders must plan far in advance.</td>
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<td>• <strong>Result</strong>: Very few health leaders conduct any kind of supply chain design analysis</td>
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<tr>
<td><strong>2. Sustaining Momentum</strong></td>
<td>• Health workshop results in good ideas for reform, but momentum peters out once participants return to their day jobs</td>
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<td></td>
<td>• A pilot project is successful, but organizational turnover or newer projects impede full scale-up</td>
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<td>• <strong>Result</strong>: Many good initiatives don’t realize their full potential</td>
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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)
...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?