USING MODELING AND ANALYSIS TO DRIVE BETTER STRATEGIC SUPPLY CHAIN DECISION-MAKING

HEALTH & HUMANITARIAN LOGISTICS CONFERENCE

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Technology and investment are driving rapid improvements to supply chain data infrastructure

Electronic Logistics Management Information Systems (eLMIS) improving velocity and visibility of supply chain data

Mobile Health technology improving reach and visibility into patient demand

Logistics Management Units (LMUs) and **Visibility & Analytics Networks (VANs)** consolidating supply chain analysis and decisionmaking

These data improvements can change the way we approach strategic supply chain decision-making

Supply chain data used frequently to improve day-to-day **operational** decisions

- Tracking facility consumption
- Determining order quantities
- Allocating budget and resources
- Detecting products/facilities at high risk for stock-out

Can we also use data to inform strategic questions of **supply chain design?**

- How to design a cost effective supply chain for a specific geographic/political context?
- How to navigate decision-making in diverse stakeholder environments?
- How to incorporate continuous and ongoing feedback into supply chain design

To capitalize on this opportunity we need a critical mass of practitioners and a robust body of tools and approaches

Key Session takeaways:

- **Concrete examples** from the global health community of data use in strategic decision-making
- New **tools & approaches** to support data-driven decisions
- An **interactive discussion** on key opportunities and research gaps

Overall Session Flow:

1	Background & Context
2	Part I: Modeling as an approach to data-driven strategic decisions (LLamasoft)
3	Part II: Managing tradeoffs and stakeholder priorities in strategic decisions (WDI)
4	Part III: Moving towards a data-use culture (VillageReach)
5	Concluding group discussion

PART I:
USING MODELING TO INFORM STRATEGIC DECISION-MAKING

DID SOMEONE DESIGN YOUR SUPPLY CHAIN, OR DID IT DESIGN ITSELF?

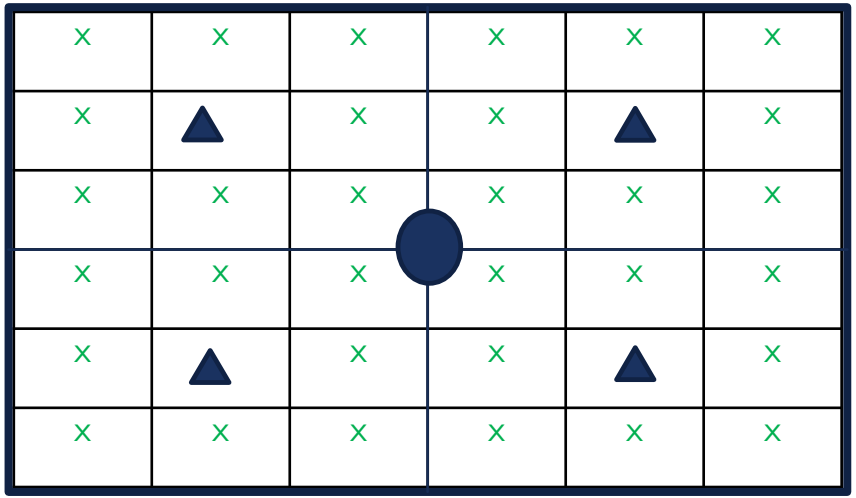
IS THIS SYSTEM EFFICIENT?

- What is the purpose of this system?
- Does the current design serve that purpose?
- What types of changes could be made?
- What are the implications of these changes?
- Is it a design issue or an execution issue?
- How do you measure the efficiency?

IN-COUNTRY DELIVERY SYSTEM

Central → Provincial → District

- Country or Region with
  - Central Stocking Location
  - Administrative regional locations
  - District Level Deliveries
- All product flows



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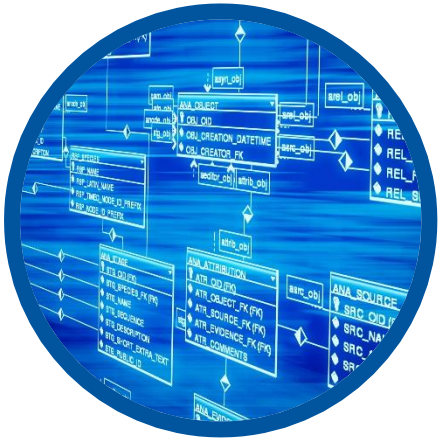
Supply Chain Design and Planning

Three Key Building Blocks

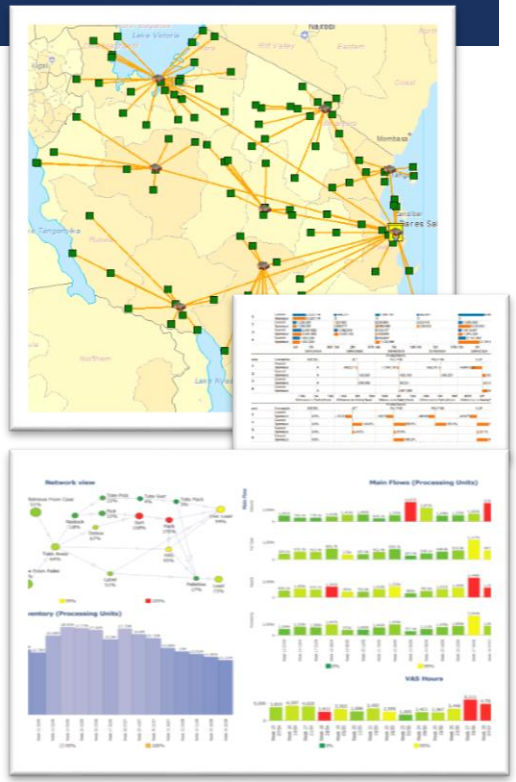
Data Integration
& Management



Modeling,
Optimization & What-if
Analysis

Visualization, Analytics
& Collaboration

SUPPLY CHAIN DESIGN AND MODELING



Supply Chain Design

- Create models to represent the structure and policies of the existing supply chain
- Use advance analytics to find a better or more appropriate future state
- Continuously run what-if scenarios to test new strategies and to react to changing market conditions

modeling [mod-l-ing]

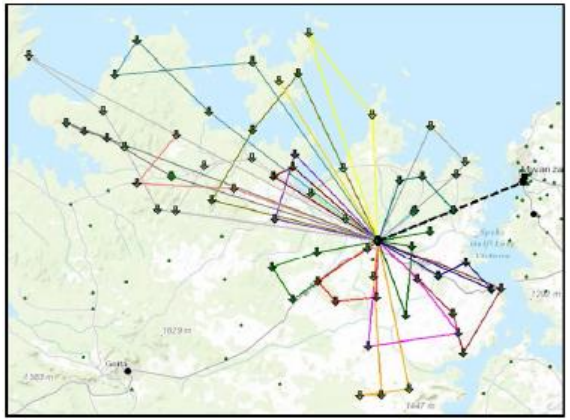
- *the representation, often mathematical, of a process, concept, or operation of a system, often implemented by a computer program*

Supply Chain Modeling

- To digitally represent the structure and policies of the physical supply chain operations
- Use advance analytics to find a better or more appropriate future state
  - Network Optimization
  - Inventory Optimization
  - Demand Analysis
  - Product Flow-path Optimization
  - Vehicle Route Optimization
  - Enterprise Simulation
- Continuously run what-if scenarios to test new strategies and react to changing market conditions or operational constraints

WHY USE MODELING?

- Virtual test-bed for new systems and new policies
- Ask “What-if” questions and understand trade-offs between various options
- Assess longer-term viability of the options
- Assess the end-to-end supply chain, and not just single elements of the network
- Solve complex problems beyond spreadsheets
- Data-driven aid to policy-makers



SUPPLY CHAIN DESIGN METRICS

RISK

- Supply Disruption
- Transportation Variability
- Demand Volatility
- Supply Volatility
- Sensitivity to Costs
- Natural Disasters, Structural/ Geographic
- Geopolitical Change

Service

- On Time Delivery
- Fill Rate
- Service Time (True Route Based)

Financials

- Fixed and Variable Operating Costs
- Transport, Warehousing, Inventory
- Admin costs

Supply Chain

- Facility and Equipment Footprint
- Inventory & Capacity
- Complexity

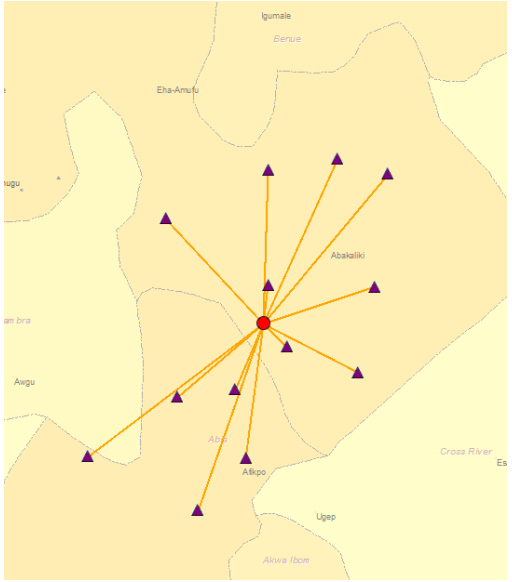
Sustainability

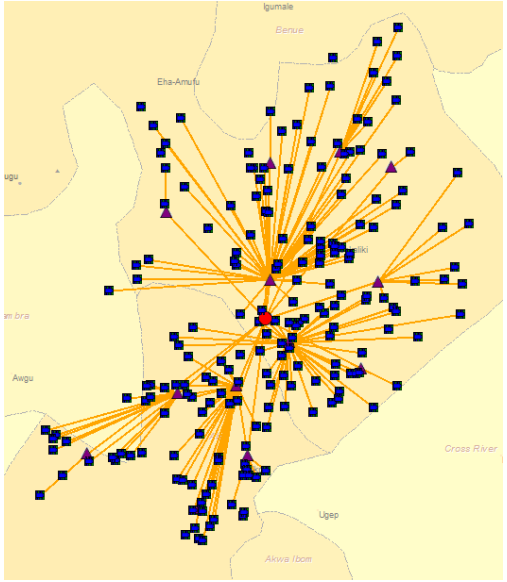
- Long-term robustness
- Security/Reliability

IN-COUNTRY DELIVERY SYSTEM

Central → Provincial → District

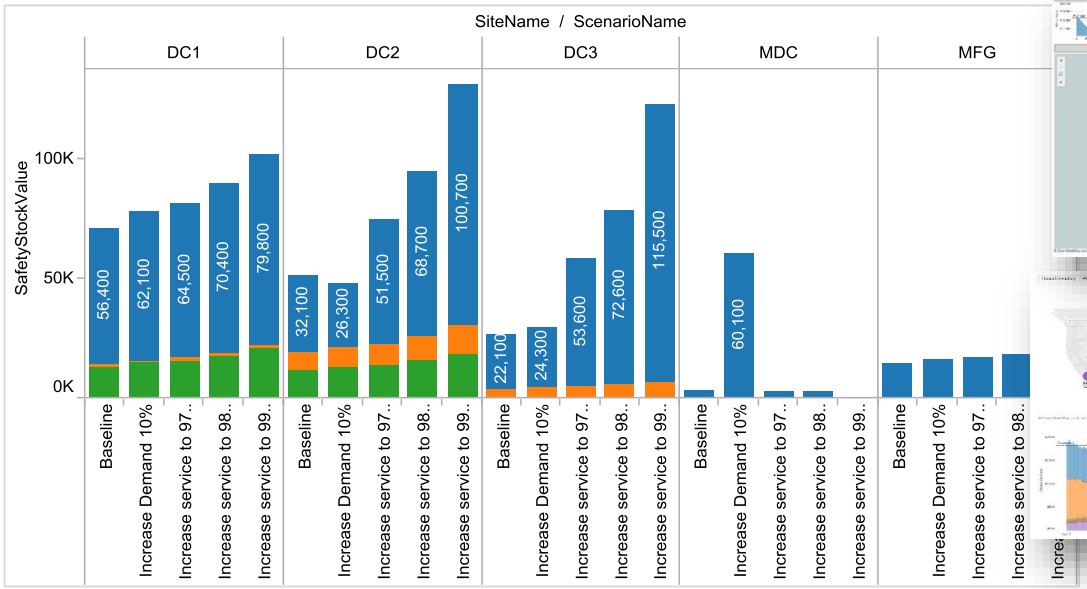
- Country or Region with
  - Central Stocking Location (1)
  - Administrative regional locations (13)
  - District Level Deliveries (204)
- All product flows

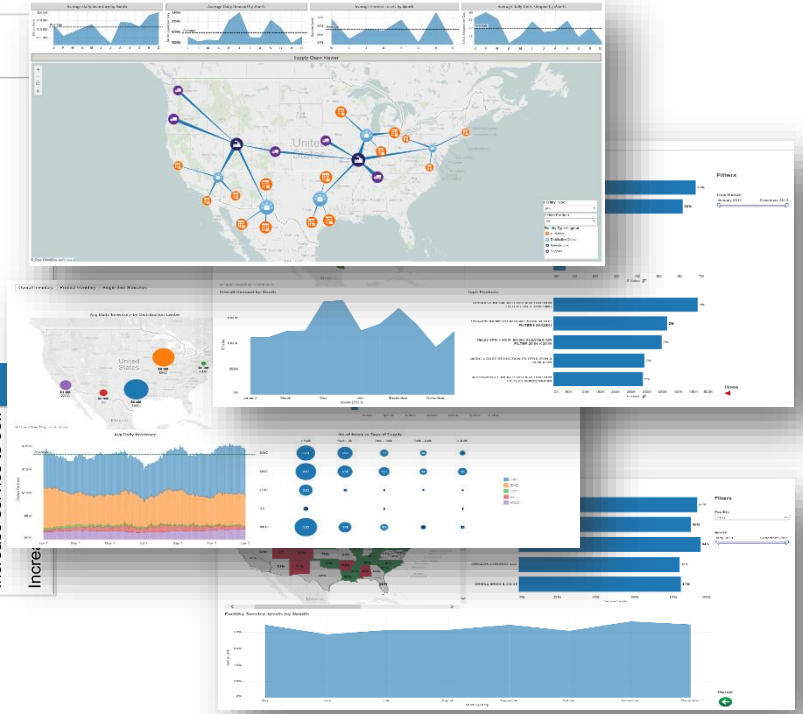




GROUP DISCUSSION

DETAILED OUTPUTS TO DIG INTO TRADE-OFFS





NOT THE END OF THE CONVERSATION

- Designing a supply chain is a multi-dimensional problem with many trade-offs
- Modeling is an iterative process and there lies value in continuous analysis
- *"Don't let the perfect be the enemy of the good."*
- Supply Chain Design provides insight and direction, not a specific answer!

PART II:
MANAGING TRADEOFFS AND STAKEHOLDER PRIORITIES IN STRATEGIC DECISIONS

Group Discussion:
Capturing complexity, tradeoffs, and priorities in supply chain decisionmaking

Questions:

- Which SC model is best?
- What tradeoffs were involved in that decision?
- 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	**VS**	**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

ROLE #1: SECRETARY GENERAL TO THE MINISTER OF HEALTH

Before you discuss the merits of each supply chain option, please take into account the following perspectives:

- As the Ministry of Health your mandate spans the entire health system. Supply chain is a critical priority, but is one of many critical priorities that must be juggled in order to maximize healthcare quality with limited resources:
  - Improving quality of treatment services, and expanding access in poor and remote communities
  - Training new nurses, doctors, pharmacists, and health managers, and managing the interests of their national professional cadres.
  - Managing a large collection of outside organizations who are working within your health system and have their own goals and objectives

  Therefore it is important that any interventions or novel approaches – supply chain or otherwise – are designed with these other priorities in mind, and are attuned to the Ministry's vision for how the overall health system is managed.

- Budget management is a critical challenge. Outside donors support many programs, but often they face significant year-to-year uncertainty in their funding levels. Your budget must cover anything that they do not – infrastructure, operating costs, salaries, basic medicines, etc.

  Furthermore your organization is beholden to the political process; annual budgets are determined via legislative appropriation and may sometimes be cut 10% or 20% below what you feel is needed. Thus it is easiest to incorporate and plan for interventions that are highly cost effective, with reliable and sustainable funding sources.

As you are discussing each supply chain option, please consider the following questions:

- How do the above perspectives affect the way you view the two supply chain options? What supply chain metrics or qualities are most important to achieving this organization's mission? Which supply chain best reflects those priorities?

- How do you think these views are similar or different from those of other stakeholder organizations?

- From your own personal experience, are there any important perspectives that are missing from the above description? Are there any metrics/categories omitted from the analysis that would be important to this organization?

For group discussion on Slide 19

ROLE #2: COUNTRY CHIEF-OF-PARTY TO LARGE PARTNER ORGANIZATION

Before you discuss the merits of each supply chain option, please take into account the following perspectives

- Budgets are almost always tight, but amongst the various stakeholders your organization likely has the most budgetary flexibility to test novel approaches or support systems that are particularly effective. If you are able to demonstrate a clear improvement to public health or access to medicines, then it is likely that you could justify additional funding for that approach.
- That said, much of your organization's leadership and primary funders reside outside your country, in locations like Geneva or Washington DC. They are knowledgeable to some extent about the challenges and complexities that exist within your country, but in order to convince them of the value of a particular intervention, you must be able to clearly demonstrate with evidence/data the impact that intervention will have
- Your organization must also compete for donor funding with other organizations, many of whom (claim to) offer similar sets of expertise. This creates some demand for innovation - to beat out competitor organizations & consortiums, you must demonstrate a novel, innovative approach that will improve upon the current situation in a significant way. While you recognize the need for solutions that are well-tailored to existing health systems and processes, you also are likely to see a need to drive change to the system. In Silicon Valley parlance, "Be disruptive" and "fail fast".

As you are discussing each supply chain option, please consider the following questions:

- How do the above perspectives affect the way you view the two supply chain options? What supply chain metrics or qualities are most important to achieving this organization's mission? Which supply chain best reflects those priorities?
- How do you think these views are similar or different from those of other stakeholder organizations?
- From your own personal experience, are there any important perspectives that are missing from the above description? Are there any metrics/categories omitted from the analysis that would be important to this organization?

For group discussion on Slide 19

ROLE #3: NURSE IN-CHARGE AT A PRIMARY HEALTH CENTER

Before you discuss the merits of each supply chain option, please take into account the following perspectives

- You are first and foremost a clinician - your primary interest is providing medical care to patients, and that's the area in which you received your training. You understand and recognize the importance of supply chain and health system management, but
- At times your life seems like a mountain of paperwork. At the facility level, most health and logistics data is entered by hand – patient registers, health management information reports, summary statistic calculations, program-specific reports for HIV, malaria, immunizations, etc. etc. Logistics management forms are one of many, and anything that your leadership can do to reduce your reporting burden would be a welcome relief.
- Funding availability is frequently a challenge. Often there are no specific line-items in your budget for managing day-to-day supply chain operations, even if those duties are technically in your job description. This means you are often covering for supply chain operations out of program/outreach activity budgets, and means that cash flow is an ongoing challenge.

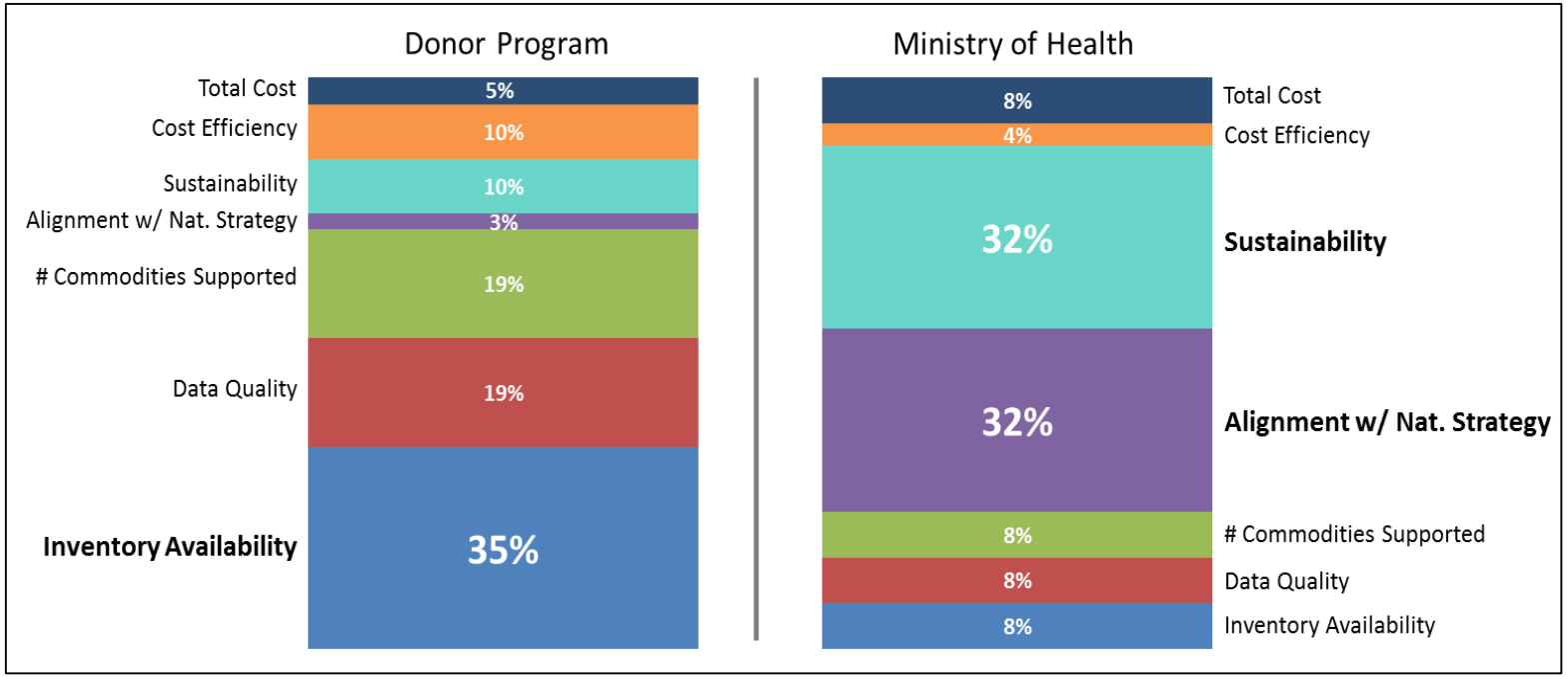
As you are discussing each supply chain option, please consider the following questions:

- What types of performance are you looking for from your supply chain? Do you feel that one of these supply chains better addresses the perspective of someone who works day-in and day-out at the last mile?
- Do you feel that your supply chain priorities are adequately captured in the seven metrics listed? Are there other important aspects of supply chain performance that are important to on-the-ground supply chain workers?
- What do you think categories like "sustainability", "data quality", and "alignment with the national health system" mean to someone like a nurse in-charge? IN what ways do you think those interpretations differ from those of a central-level or international stakeholder?

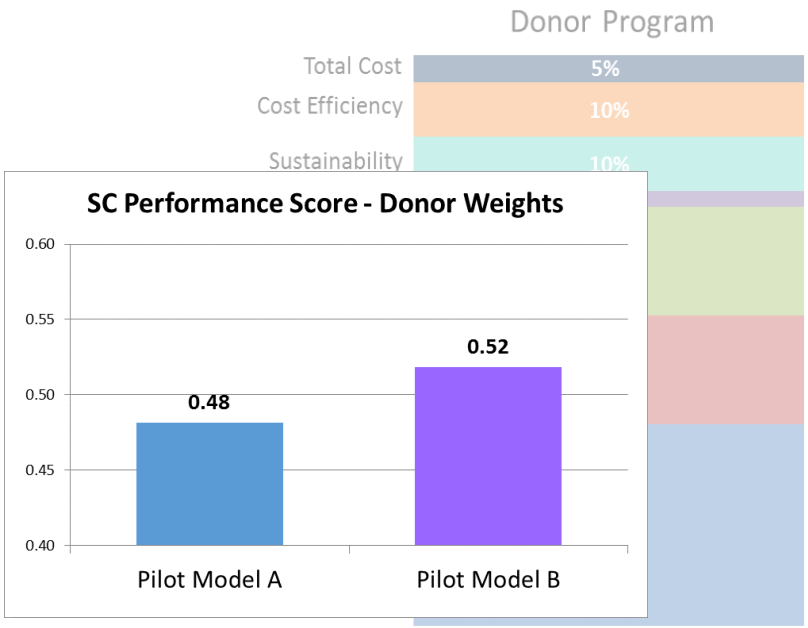
For group discussion on Slide 19

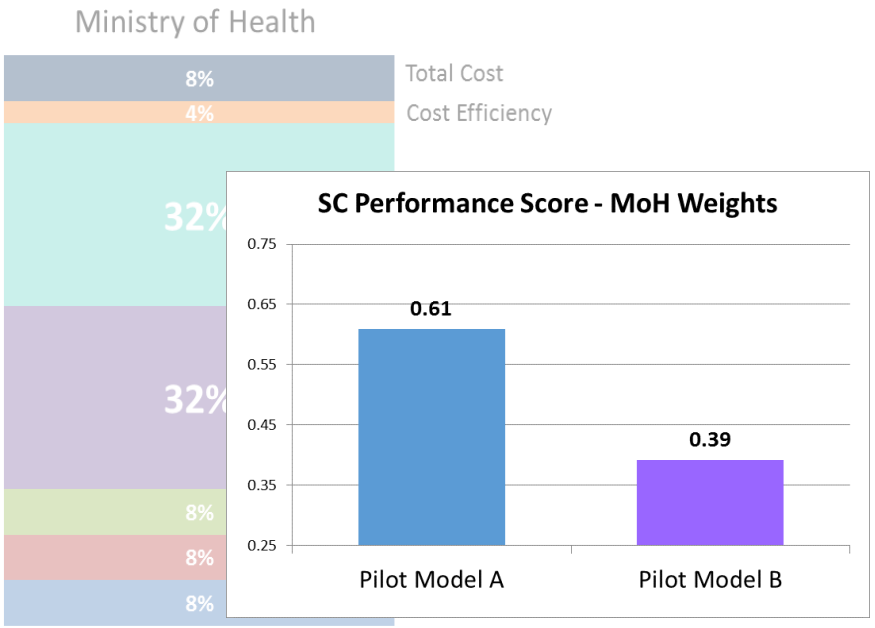
A real-world example: Stakeholders often differ in their supply chain policy priorities…

Stakeholder Policy Priority Weights for 7 Supply Chain Performance Dimensions



…and these differences affect which system is viewed as 'best'





How to manage complex SC decision-making?
Research says first step is to make tradeoffs and priorities more explicit

A general framework for quantifying complex SC decisions

100 %	Composite performance score

Weight	Category	Metric(s)
20%	Total Cost	• Total logistics & transport cost • Facility worker LOE cost
10%	Efficiency	• Cost per cubic meter • Utilization of vehicles/capacity
30%	Sustainability	• % of costs internally funded
20%	Alignment w/ National Health System	• Assessment / Evaluation aimed at measuring process alignment
5%	# Commodities Supported	• # products managed by system • Annual total m^3 delivered
5%	Data Quality	• Reporting rate or accuracy • Central forecasting accuracy
10%	Inventory Availability	• % of products in-stock at visit

NOTE: Percentages and metrics are illustrative only

- **Weights** can be tailored to match individual stakeholder's preference
- **Categories & metrics** can be tailored to match available data
- Single **composite performance score** to enable easy comparison & decisionmaking

WDI-developed tools incorporate tradeoffs and priorities into formal SC analysis…

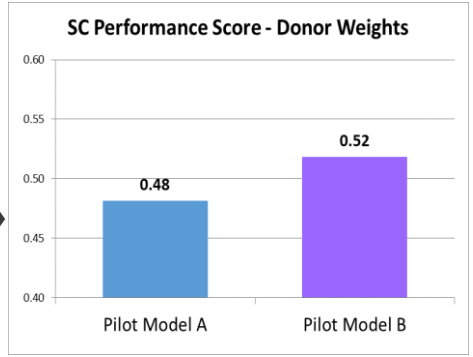
1. **Survey Tool** uses Analytic Hierarchy Process (AHP) to calculate quantitative weights in structured manner:
   - Force-ranking categories from most- to least-important
   - Pairwise comparisons to determine strength of preference

2. **Automated Excel tool** calculates composite performance based on quantitative weights and raw data inputs

3. **Process Document** provides practical implementation guide and case studies to assist user in identifying decision context and gathering/analyzing data

Based on the rankings you provided above, please rate the relative magnitude of each ranking. The higher ranked dimension is how much more important than the lower-ranked one?				Equal / Tie	SLIGHTLY More Important	MUCH more important	EXTREMELY more important
#1	Product Availability	vs.	#2 Scope of Activities & Outputs	X			
#2	Scope of Activities & Outputs	vs.	#3 Data Quality & Visibility				X
#3	Data Quality & Visibility	vs.	#4 Process Quality		X		

		Pilot Model A	Pilot Model B
Total Cost	min	$ 950,000	$ 1,600,000
Cost Efficiency	min	625.00	975.00
Sustainability	max	90%	50%
Alignment w/ National Health	max	8.4	3.6
Number of Commodities	max	175	175
Data Quality	max	70.00%	95.00%
Inventory Availability	max	60%	96%



…and can improve strategic supply chain decisions in a number of ways

Guiding investment decisions

- Clearly identify the tradeoffs associated with different supply chain design options
- Highlights organizations most likely to support a decision, allowing more targeted use of time & resources
- Analyze sensitivity of different supply chain designs to evolving performance & policy priorities

Targeted improvements to design & Implementation

Identifying solution paths that might not otherwise have been considered, e.g.:

- **Phased roll-out strategy?** initial roll-out to those regions / program areas where support and/or performance is strongest?
- **High-impact design improvements?** In which performance categories would improvement have the greatest impact on stakeholder support?

Monitoring performance over time

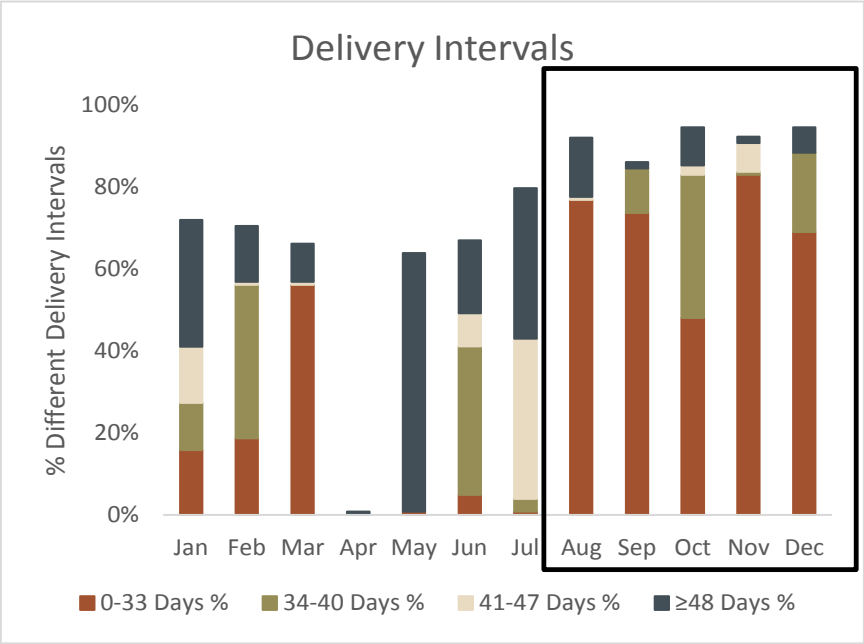
- Identify priority metrics to include in central-level supply chain monitoring & evaluation dashboards
- Create executive-level performance snapshot using composite performance metric(s)
- Separating critical changes in performance metrics from those that are less-prioritized

PART III:
MOVING TOWARDS A DATA USE CULTURE

MOZAMBIQUE CASE STUDY

Regular and structured data review to drive improvements

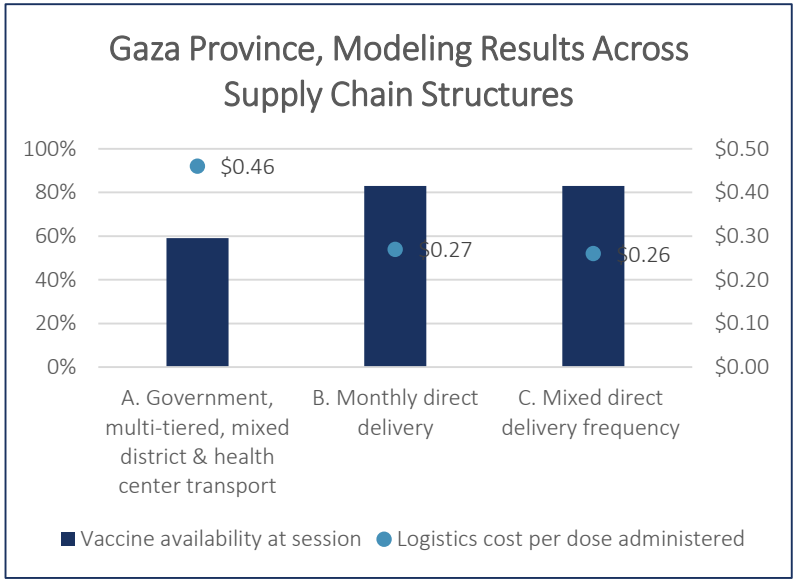
- The Mozambique OpenLMIS platform was introduced in June 2014, providing greater visibility into the performance of the vaccine supply chain down to the last mile.
- Monthly, structured review of data initiated with a performance management study in different provinces.
- Provincial leaders in Niassa province adopted data review practice and noted regular delays in distribution; further analysis identified the problem stemmed from delays in vehicle maintenance.
- **Decision**: the provincial government changed the maintenance schedule to ensure vehicles were ready for the established monthly distribution date; delivery frequency stabilized at less than 40 days from August on.



Broader strategic system design decisions made using modeling results

Alternative delivery frequency

- Modeling what-if scenarios in Gaza province (availability, logistics cost per dose) to identify potential improvements:
  - A: Multi-tier system using mixed transport from district and health facilities
  - B: Monthly direct delivery from province to health facilities C: Monthly direct delivery in one region of Gaza, two month direct delivery in hard-to-reach region
- **Decision:** the provincial government decided on Scenario C with delivery every two months based on cost-savings and reduced level of effort. Some challenges found with cold chain equipment.



**Modeling done by the HERMES Logistics Modeling team, a collaboration between the Pittsburgh Supercomputing Center at Carnegie Mellon University and Johns Hopkins Bloomberg School of Public Health.*

Key catalyzing factors to develop a data use culture

Data visibility

- OpenLMIS provided visibility to health facility level with better quality data
- Modeling results provided evidence for change to the system design

Structured review of data

- Structured data review process:
  - *Monthly review for operational logistics data*
  - *Strategic review of modeling results for system design decisions*
- Data analyzed within country context (feasibility, willingness to change, ease to implement, financial implications)

Commitment to higher performing supply chain

- Leaders saw an opportunity for improvement based on evidence, not just opinion
- Demonstrated drive for excellence

Enabling environment to enact change

- Global evidence of other countries using modeling and logistics data to drive improvements to supply chain
- Willingness to question the status quo and catalyze change

CLOSING SLIDES

- Success factors:
  - Data availability through modeling and logistics management information system
  - Data analytics with regular review
  - Commitment to improvement
  - Developing a data use culture

Closing Group Discussion

To stay at the cutting edge we know we must continue to improve at using data to inform strategic decisionmaking

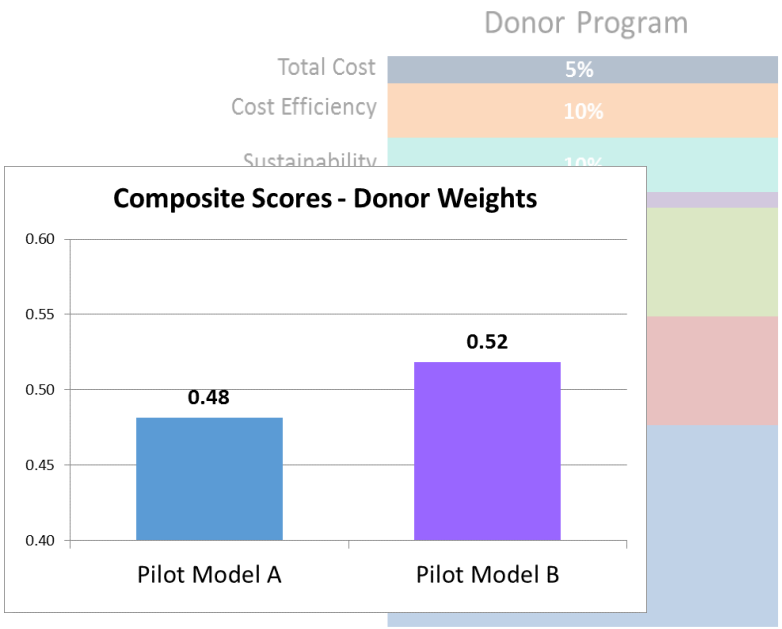
As a diverse group of experts and practitioners, your work and experiences provide critical insight to this discussion:

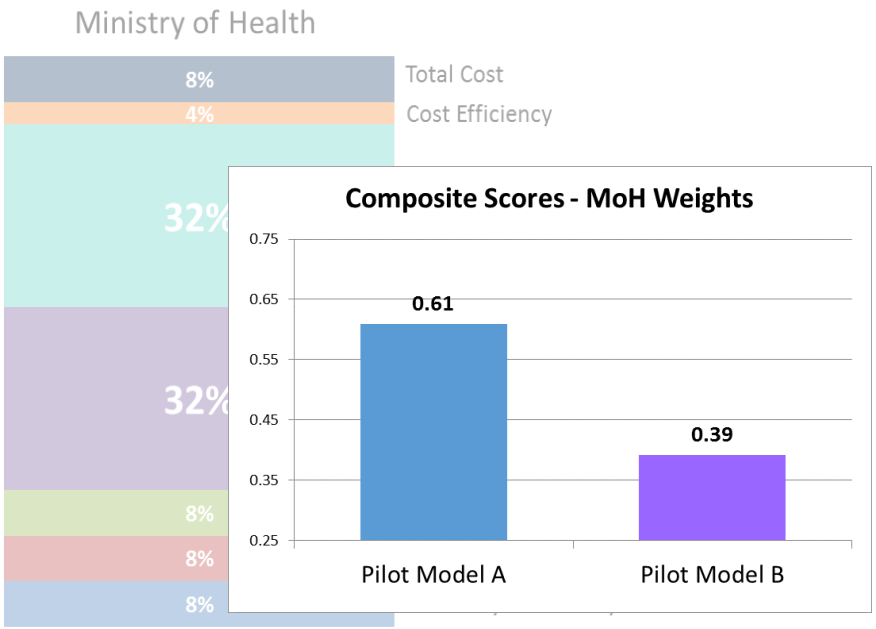
- What key challenges do you experience in using data more frequently?
- What do you see as the key research gaps – areas where better tools/methods would improve high-level SC design?

EXTRA SLIDES

Backup slides to give more detail / resources on each individual initiative discussed earlier

…and these differences affect which system is viewed as 'best'





WDI-developed tools help incorporate tradeoffs and priorities in SC decision-making

Quantifies Tradeoffs

Clearly identifies the tradeoffs required if the MOH were to move forward with

(i.e. 33% lower performance for FP & PMTCT commodities)

Segments key stakeholders

Highlights those stakeholders likely to support MOH decision, and those most likely to have concerns

This info allows MOH to target time & resources towards specific stakeholders when seeking buy-in

Highlights options moving forward

Potential paths that might not otherwise have been considered:

Two-step solution? Integrate ZADS, ZIPS & EMPS (83% of volume) first, then work to improve performance and gain FP/PMTCT stakeholder buy-in?

Adjust Integrated design? Could the performance of FP/PMTCT model offer any changes or improvements to the Integrated model?

100 %	Composite performance score

Weight	Category	Metric(s)
20%	Total Cost	• Total logistics & transport cost • Facility worker LOE cost
10%	Efficiency	• Cost per cubic meter
30%	Sustainability	• Average % Facilities out-of-stock at replenishment
20%	Alignment w/ National Health System	• Facility reporting rate (%) • Average facility order accuracy (%)
5%	# Commodities Supported	• Average time between order and delivery
5%	Data Quality	• Average % deliveries that are delayed by 1+ days
10%	Inventory Availability	• Average % deliveries that are delayed by 1+ days