Improving reproductive health supply chain design through rapid and flexible cost modeling

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Agenda

1. **Overview** (10 min)
   What questions can the tool help address?
2. **Technical Details** (10 min)
   How to make the tool rapid and easier to use?
3. **Validating Accuracy** (5 min)
   Do results match those of other methods?
4. **Demonstration** (20 min)
   What does using the tool look like in practice?
5. **Questions & Answers** (15 min)

Problem: Supply chains (SCs) are key to health program success, but identifying efficient SC designs is a complex and expensive process

Challenge 1: Lack of SC cost data for strategic decision-making.

- Detailed costing analyses require significant time and resources
- Programs often lack reference points to understand what SC activities ***should*** cost.

Challenge 2: Difficulty evaluating ***potential*** design improvements.

- Cost studies and SC data systems typically provide snapshot of ***current*** SC design
- Software to model the impact of future SC design changes can be resource intensive and require specialized skills

Problem: Supply chains (SCs) are key to health program success, but identifying efficient SC designs is a complex and expensive process

*UNICEF estimates a budget of **$250,000 to $500,000**[3] over 3-6 months for one country to analyze potential SC re-design options.*

Data collection and modeling are the primary cost contributors.

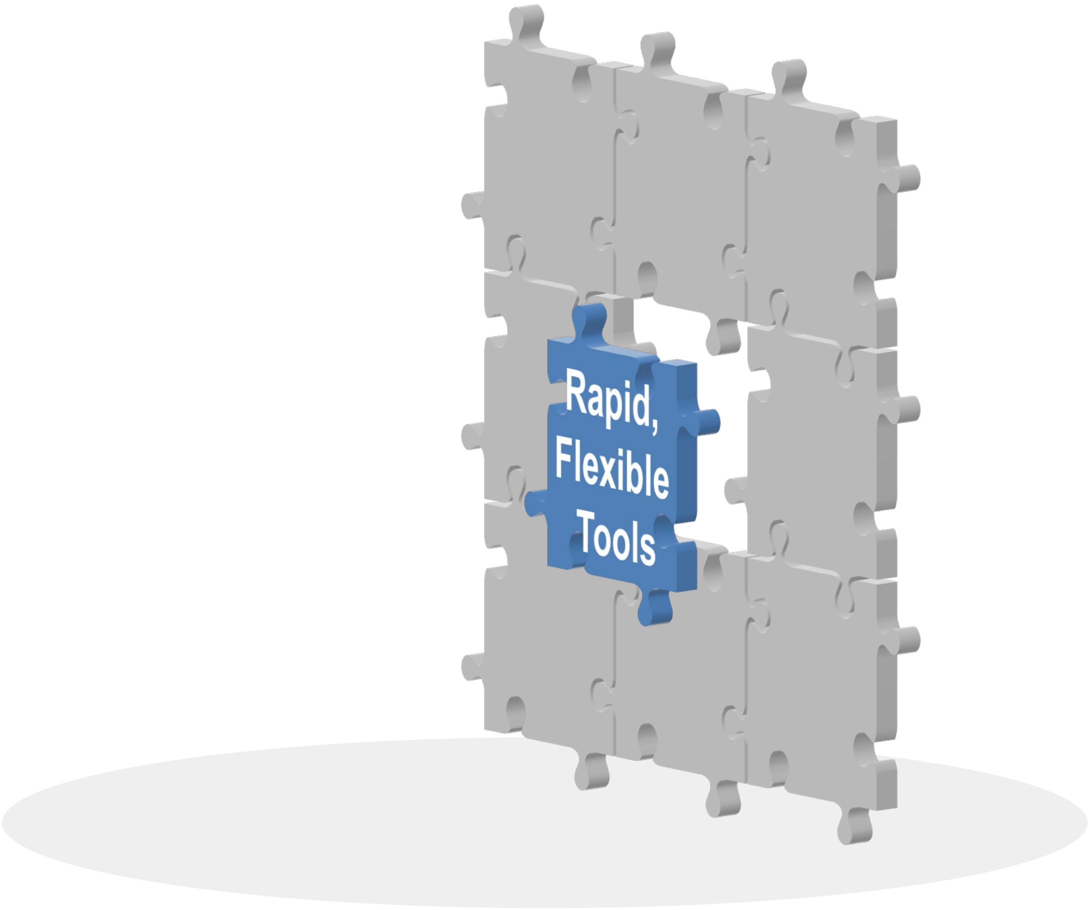
3. UNICEF, 2017: "System Design Summit Final Report". Presentation to Immunization Supply Chain System Design Working Group. Accra, Ghana.

WDI and VillageReach created a rapid modeling tool to address barriers to conducting SC design/cost analyses

Many potential use cases where high-level, directional insights are useful, but where time and resources are limited for detailed analysis:

- **Streamlining** initial stages of SC redesign process
- **Addressing** questions in real-time during a workshop setting
- **Validating** donor budgets or logistics provider bids
- **Advocating** for SC funding or improvements

By addressing these use cases we hope to **expand opportunities** to identify and implement innovative supply chain design changes.



The user creates a supply chain scenario, and the tool ***estimates*** operating cost and efficiency of that scenario

1

	Scenario 1
Estimated Annual Operating Cost:	$ 1,552,216

	Scenario 1
Total Volume (m^3) Delivered to Health Facilities :	2,005

	Scenario 1
Total Value of Procured Commodities	$ 12,300,000

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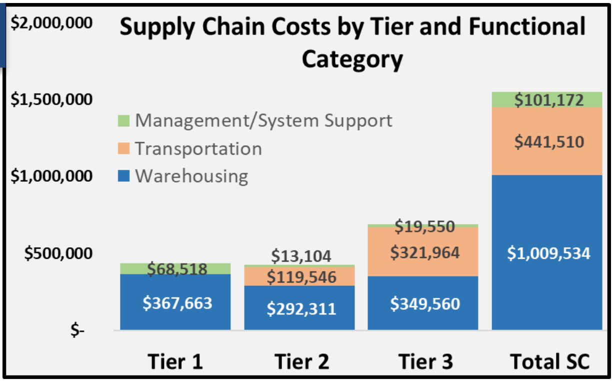

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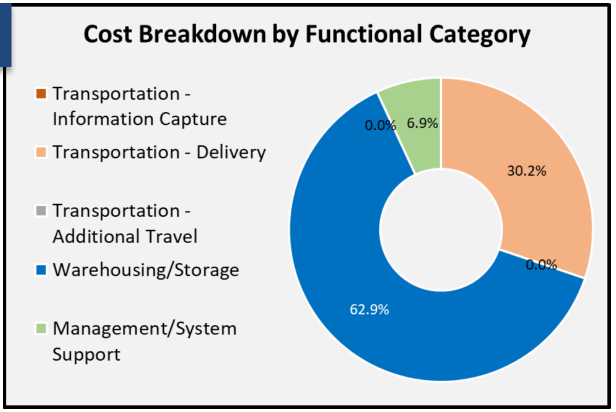

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Utilization of Available Resources

	Tier 1	Tier 2	Tier 3
Delivery Vehicle Utilization	--	62%	88%
Ordering Vehicle Utilization	--	--	--
Ambient Temp. Storage Capacity Utilization	91%	86%	82%
Cold chain storage capacity utilization	32%	30%	5%

What can these estimates tell us?

1. How much overall funding the supply chain requires to operate (approx.)
2. Which **locations** (*national, regional, facility*) require the most funding
3. Which **functions** (*storage, transport, management*) require the most funding
4. Are we using existing storage, vehicles, and labor **efficiently**? Do we have too many or too few of these resources?

The tool lets users quickly create and compare multiple scenarios/options

		Baseline	Scenarios		
		Current System	More Frequent Deliveries	Eliminate District-level Tier	Use IPM-style last mile distribution
Key Input Factors	*Land Area*	100,000 sq. km.	100,000 sq. km.	100,000 sq. km.	100,000 sq. km.
	# Health Facilities	1,000	1,000	1,000	1,000
	# SC Tiers	4	4	**3**	4
	# Order Periods/yr	4	**12**	4	4
	Last Mile Distribution	Point-to-Point (facility staff travel to district)	Point-to-Point (facility staff travel to district)	Point-to-Point (facility staff travel to district)	**Route-Based from District**
	Type and # of vehicles	Health Facility vehicles; 50% motorcycles, 50% Land Cruisers	Health Facility vehicles; 50% motorcycles, 50% Land Cruisers	Health Facility vehicles; 50% motorcycles, 50% Land Cruisers	**District Vehicles (15 Land Cruisers)**
	Fuel Price per liter	$1.50	$1.50	$1.50	$1.50
	MOH Salaries	Nurse: $3.00/hr District Supervisor: $6.00/hr Warehouse worker: $5.00/hr	Nurse: $3.00/hr District Supervisor: $6.00/hr Warehouse worker: $5.00/hr	Nurse: $3.00/hr District Supervisor: $6.00/hr Warehouse worker: $5.00/hr	Nurse: $3.00/hr District Supervisor: $6.00/hr Warehouse worker: $5.00/hr
Operating Cost / year		**$1.3m**	**$1.5m**	**$1.1m**	**$1.3m**

- Copy and paste worksheets to create new scenarios
- Change specific SC design or country context input values
- Changes are instantly reflected in output costs and statistics

The outputs from this tool could help inform several technical and advocacy questions

Supply Chain Financing

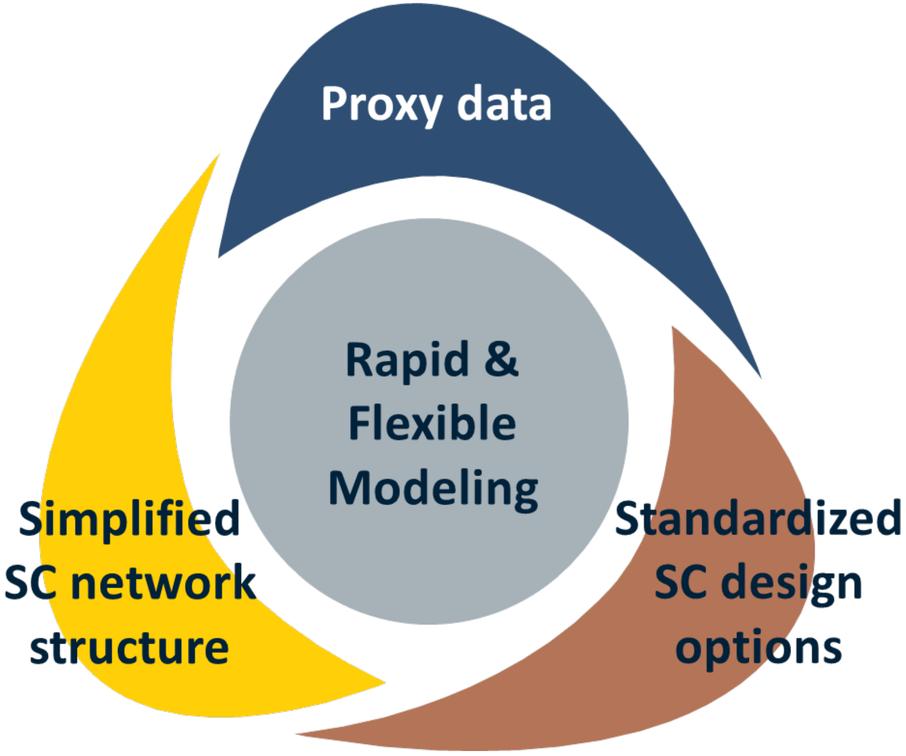
- How much funding should be allocated to supply chain activities each year?
- Which supply chain activities are the biggest drivers of cost? Where/with whom do these activities take place?
- Where are the largest current funding gaps, i.e., the people/places with the biggest mismatch between SC activities and SC funding?

Supply Chain Design

- How much program funding could potentially be freed up by implementing a more efficient supply chain design?
- What types of supply chain design changes have the biggest impact on overall cost and efficiency?

TECHNICAL DETAILS

Three primary tool features enable rapid, high-level cost estimates across a wide range of country and SC design scenarios



- **Proxy data** from other health SC cost studies provide benchmarks and enable quick estimation of missing data inputs
- **Standardized menu of SC design options** provide flexibility to model diverse global health distributions strategies
- **Simplified SC network structure** reduces data requirements and enable real-time calculation and updating of results

1. **Proxy and reference data** in pre-formatted templates enable quick estimation of missing data points

Two ways to use proxy data:

1. Load directly into model
   - Pre-formatted templates with data from existing global health SC costing studies
   - Load template data set and customize fields where better data are available
2. As reference point for estimating less common input values, such as:
   - Circuity Factor (Ratio of road distance to straight-line map distance in a network)
   - Overall demand volume in cubic meters
   - Warehousing construction/utilities prices

		Tier 1 *(Highest Level e.g. Central Medical Store)*		**Tier 2**	
		Enter your own value if known	**Value used in Model**	**Enter your own value if known**	**Value used in Model**
Select Proxy Data Template to populat		**Data Template #1**		**Data Template #1**	
Total Land Area (km^2) covered by facilities in each supply chain tier		390757	390,757	36459	36,459
Number of facilities at each supply chain tier		1	1	345	345
Average number of order periods per year per product		4	4	4	4
Average distance (km) between adjacent facilities at each tier			0		18.7
Average travel speed (km/hr) between adjacent facilities at each tier			80		25
Assumed expiry/wastage rate (% of product coming into a warehouse that does not leave due to expiry/wastage/pilferage/etc)			5%		10%
Inventory Policy	Minimum desired stock level per commodity (# order periods of stock)		2		1
	Maximum desired stock level per commodity (# order periods of stock)		4		2
Labor	Profession of person who typically picks and processes inventory in warehouse (Select from	Warehouse Floor worker - Midlevel	Warehouse Floor worker - Midlevel		Nurse / Facility In-Charge

Select template to use as base data source

Override proxy data where better information exists (e.g. country size, # clinics)

Rely on proxy data where country/SC-specific data points are lacking (e.g. travel speeds, expiry rate)

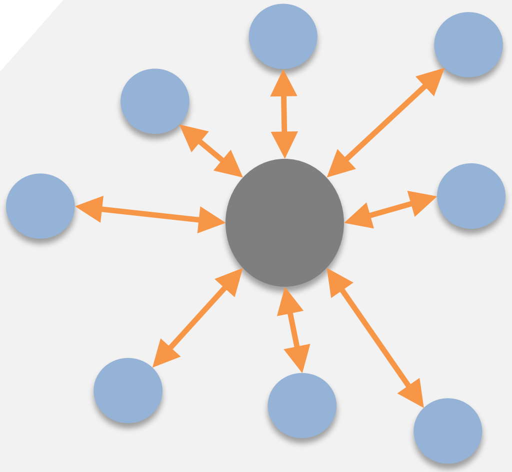
Screenshot example: Filling data gaps using proxy data template

2. **Standardized SC design choices** provide flexibility to model most current global health distribution strategies

User can adjust several design parameters to replicate their program's SC design:

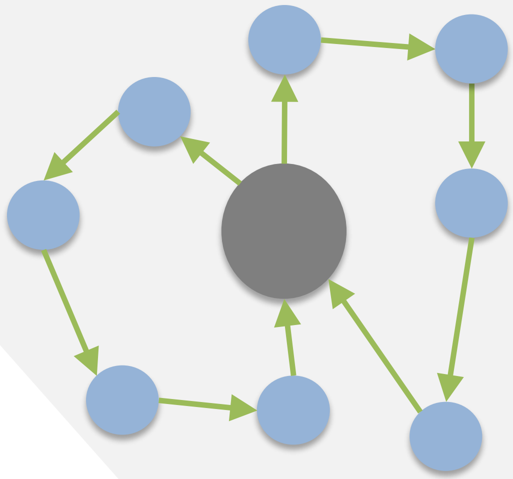
- Number of SC tiers (levels) that manage storage & distribution
- Frequency of delivery / length of order period
- Inventory policy / safety stock levels
- Ordering & delivery travel patterns
- Types of vehicles
- Timing of ordering & delivery (i.e. separate vs. simultaneous)
- Roles and responsibilities for storage, data capture, and delivery functions

Deep-dive example: Travel patterns in global health SC designs



Point-to-point travel

- Distribution from central to regional warehouses across most systems
- Systems where SDP staff are responsible for ordering or delivering their facility's products (e.g. many HIV/AIDS SCs, cost recovery-based models in francophone West Africa)



Route-based travel

- Mobile warehouse-style models (e.g. Informed Push, Direct Logistics System)
- Centrally-managed ordering and/or delivery (e.g. Assisted Pull in Zimbabwe, Info Capture & Direct Delivery in Nigeria, Direct Delivery in Tanzania)

3.1 Simplified representation of SC network considers overall facility averages rather than individual facility differences

	Real-life systems:	***Model Assumes:***
Facility Size	Some facilities larger than others, experience higher product demand levels	All facilities within a tier have the same demand, equal to the per-facility average
Distance Between Facilities	Some facilities more isolated than others (i.e. farther from supplier and other facilities)	Facilities within a tier are evenly distributed throughout the geographic area
Demand Over Time	Demand varies from one order period to the next, depending on a number of factors	Same demand for every order period, equal to overall average per-period demand

Tradeoffs of this modeling approach:

- ***Potential for bias*** if actual geography or demand distribution is unusual or highly variable (though bias likely consistent across most scenarios)
- **Represents "best-case" estimate** of costs, since variability and uncertainty are often a driver of inefficiency in supply chain operations

Advantages of this modeling approach:

- ***Lower data requirement***: Don't need details on individual facilities & orders
- ***Computationally efficient***: Don't need to calculate hundreds/thousands of individual movements and activities, facilitating quicker multi-scenario analysis

3.2 Additional simplifying assumptions: Model assumes a supply chain under stable operating conditions, with good implementation quality

Good implementation quality:

- Model captures how a supply chain design ***should*** behave under ideal implementation conditions
- In real world, implemented system may be less efficient than original design
  - Adherence to operating procedures
  - Scheduling transportation
  - Managing warehouse products & capacity
- Model incorporates *limited* types of inefficiency (e.g. product expiry/wastage; additional travel)

Stable operating conditions:

- Model estimates ***long-term annual cost*** to operate a system of the specified design
- Does NOT include initial transition/start-up costs, e.g. *developing new training materials and SOPs*
- Model assumes that any design changes happen instantly. It does NOT capture any temporary transitions

VALIDATING TOOL ACCURACY

How to test the impact of these assumptions on model accuracy? Answer: validation exercise

OBJECTIVE

Understand potential accuracy of modeling tool in order to 1) deploy it most effectively and 2) identify opportunities for improving modeling approach

KEY QUESTIONS

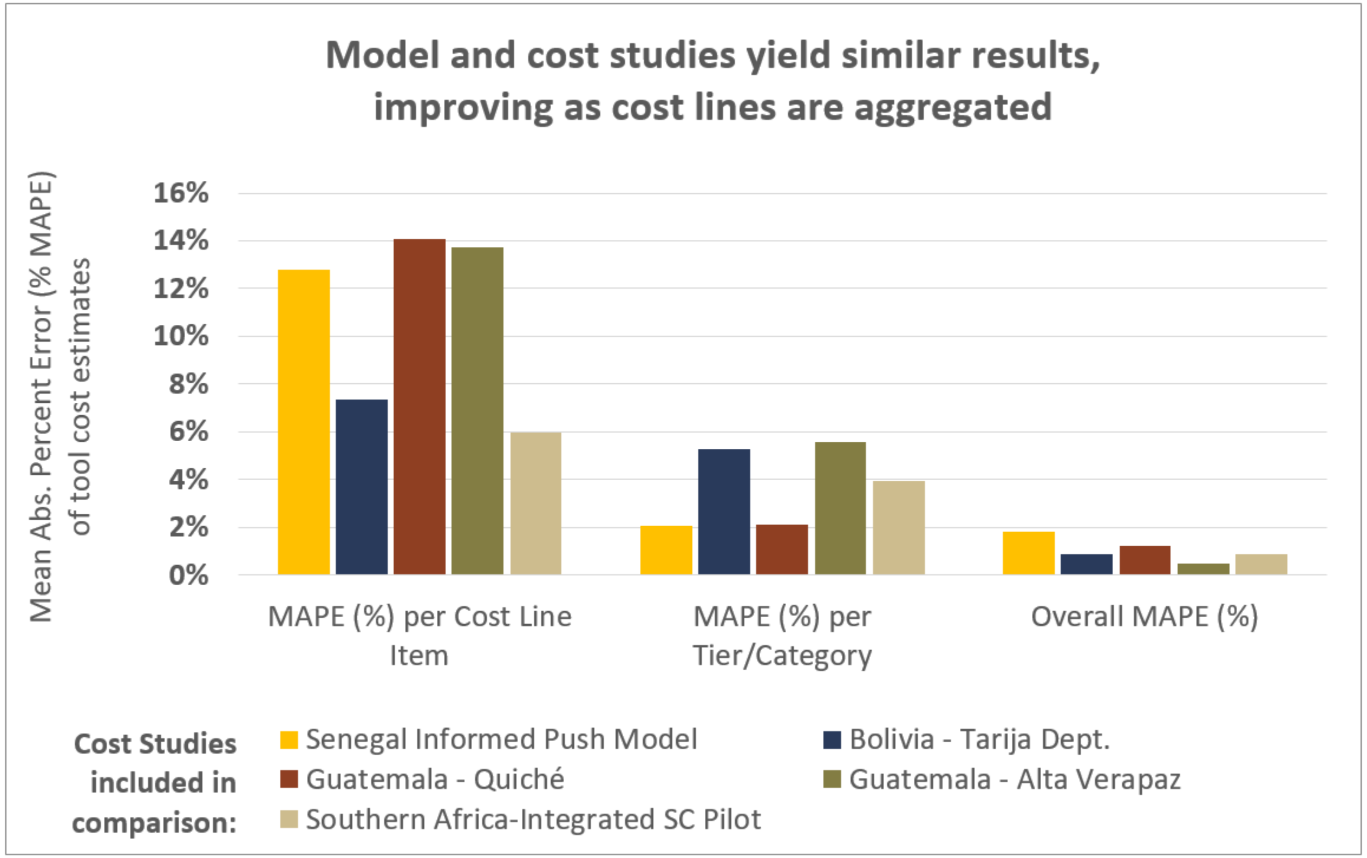
- How accurate can the model results be under ideal conditions?
- How does that accuracy level change as supply chain data quality deteriorates?

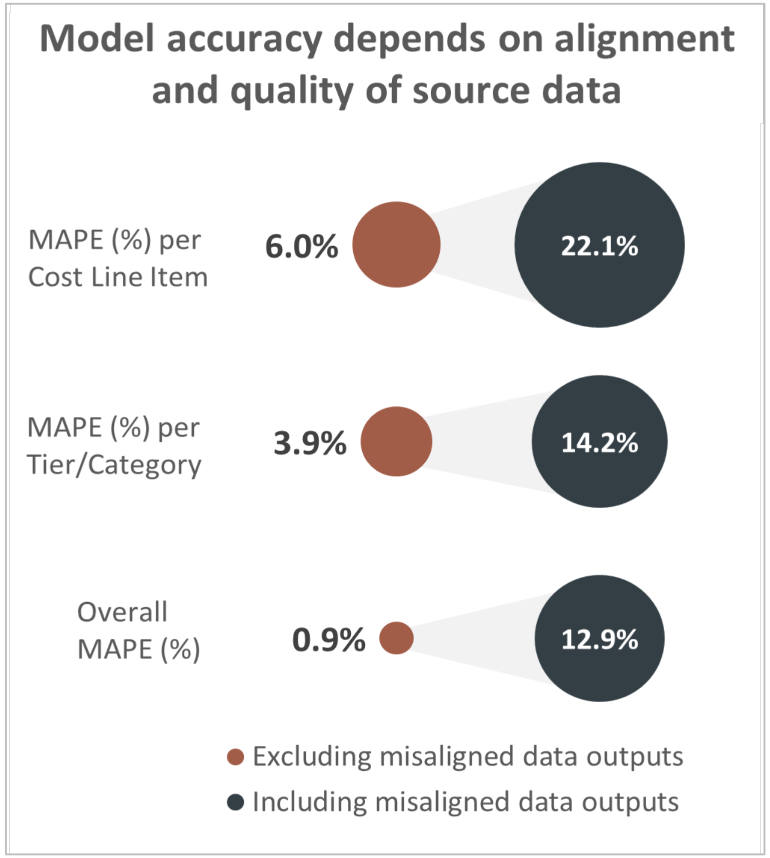
APPROACH

- Use existing SC costing study results as "gold standard" to validate model predictions
  - *Initial datasets* – Dataset from pilot Integrated SC in Southern African Country, Senegal Informed Push Model Scale-up Modeling; ForoLAC costing studies in Bolivia and Guatemala
  - Metric used is Mean absolute percent error (MAPE)

- For studies with greater clarity on data quality, split into two sub-studies based on quality of individual data points, and alignment with model calculation approach
  - *Best-case scenario* – Compare costs only where confident in quality/alignment
  - *Rapid scenario* – Compare all data points, even if misaligned with model

Results from initial validation exercises





Key takeaways from initial validation exercise

- Level of error generally aligned with initial expectations
  - Approach can be very accurate if data/implementation quality are high (1-6% MAPE).
  - Reliability decreases as input data accuracy deteriorates (12-22% MAPE)

- Many errors consistent across scenarios, minimizing impact on directional insights

- Additional validation testing could improve results in several ways:
  - Develop a larger sample & more robust picture of overall tool accuracy
  - Test accuracy correlation with specific factors
    - Does error get worse/better for specific types of countries or SC designs?
    - Does error get worse/better for specific cost line items?

TOOL DEMONSTRATION

Example problem and analysis plan for tool demonstration

Problem	You are a regional program manager in a Southern African country. You expect a large increase in demand for health products over the next five years, due shifting population and rollout of a social health insurance program.
Key Questions	1. Can the current supply chain handle that increase in demand? 2. If not, what are some efficient ways to address this increased demand?

Scenarios to Analyze

	Scenario Name	Scenario Description
1	Baseline	Current state supply chain. Every 3 months facilities submit orders and receive resupply shipments
2	Baseline + High Demand	Same supply chain structure as baseline; Overall supply chain demand increased to 1.5x baseline levels
3	Monthly Ordering + High Demand	Monthly resupply cycles instead of quarterly; Overall supply chain demand increased to 1.5x baseline levels
4	More Storage + High Demand	Maintain baseline quarterly resupply cycles; Overall SC demand increased to 1.5x baseline levels; Storage at all levels also increased to 1.5x baseline levels

DISCUSSION

Next steps and discussion

- Next Steps
  - Version 1.0 of the tool and resources are available online for download
    - https://www.villagereach.org/resources/
    - WDI and RHSC websites – coming soon!
  - Will also disseminate via email to RHSC working groups and IAPHL once a few formatting improvements have been finalized

- Questions? Email us at:
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