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

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Identifying effective and efficient supply chain (SC) designs can be a complex and resource-intensive process

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

- Detailed costing analyses often require extensive time and resource investments
- Lack of widely available reference data to understand what certain SC activities should cost.

Challenge 2: Difficulty analyzing potential SC design improvements

- Typical cost studies and LMIS systems provide snapshot of current SC design
- Software to explore the impact of different SC design changes can be resource-intensive and require specialized skills

Identifying effective and efficient supply chain (SC) designs can be a complex and resource-intensive process

*Estimates by UNICEF place the cost at **$250,000 to $500,000**[1] over 3-6 months for one country to analyze potential SC re-design options.*

Data collection and modeling are the primary cost contributors.

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

Opportunity for rapid and flexible tools to address data and design challenges

Example instances where directional insights are valuable but limited resources for detailed analysis:

- **Advocating** for SC funding or improvements
- **Streamlining** early-stage SC design analyses
- **Demonstrating** cost impact of SC decisions
- **Validating** donor budgets or bids from private logistics companies

Addressing these use cases could **reduce barriers** to conducting SC design analyses and **expand opportunities** to implement innovative design changes.

WDI and VillageReach addressing this opportunity with new tool to model operating costs of SC design scenarios

Overview of tool & modeling approach:

Modeling a single supply chain design in Excel:

1. System Inputs
Define the scenario to be modeled – the supply chain design and overall country context

2. Back-end Modeling
Estimate the activities and resources needed to execute the SC design in the specified country context

3. Cost Outputs
Calculate the expected annual cost of the resources and activities that are needed

4. Scenarios
Repeat analysis with different sets of inputs to test different design or country context options

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Inputs:

Three Types of Data Inputs:

- Overall system Information:
- Unit Cost data:
- SC Design Policies:

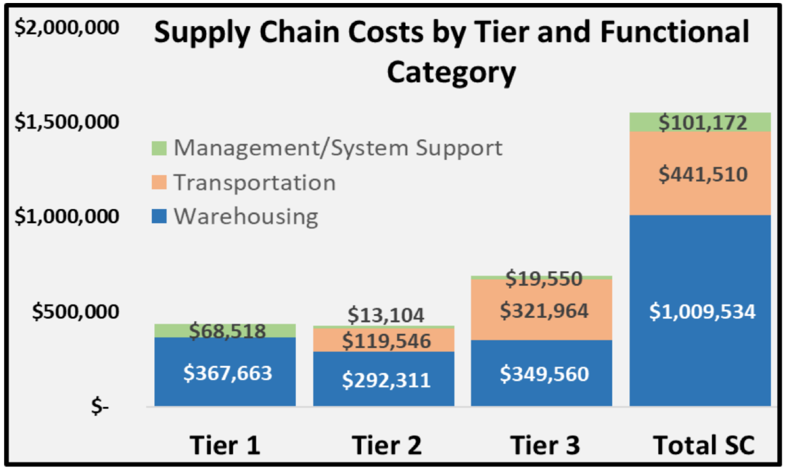
Focus on data inputs that are easier for central-level stakeholders to estimate

1. General System Information	Enter your own value if known	Value used in Model
Data Source for General Information	Data Template1	
Currency Conversion Factor		1
Number of SC Levels or Tiers		3

5. Supply Chain System Information	Tier 1		Tier 2	
	Enter your own value if known	Value used in Model	Enter your own value if known	Value used in Model
5.1. Overall Network & Policy				
Total Land Area (km^2) of this tier	36,459	36,459	36,459	36,459
Number of facilities at this tier	275	275	275	275
Number of order periods per year	6	6	6	6
Average Distance (km) between facilities		23.7		23.7
Average Distance (km) to nearest supplier		74.2		74.2
Circuity factor (Road vs. straightline		1.45		1.45
Expiry/Wastage Rate from previous tier		5.0%		5.0%

Ex.: Partial data inputs for overall system network information

WDI and VillageReach addressing this opportunity with new tool to model operating costs of SC design scenarios



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%

Outputs:

Aligned with common global health SC costing methodologies

Costs categorized based on:

- Supply Chain Function
- Cost Category
- Tier/level in the supply chain

How to improve speed and flexibility of tool?
Easily-assessible proxy data to leverage existing SC knowledge

WDI/VillageReach building set of reference (proxy) data from existing global health SC costing studies.

Two ways to use proxy data:

1. Load directly into model via preformatted templates

2. Use as reference point for estimating a missing data point

Example screenshots from Inputs Page: *Addressing data gaps via proxy data*

1. General System Information	Enter your own value if known	Value used in Model
Data Source for General Information	DataTemplate1	
Currency Conversion Factor		
Number of SC Levels or Tiers		

DataTemplate1
DataTemplate2
DataTemplate3

Select template to use as baseline data source

5. Supply Chain System Information	Tier 1	
	Enter your own value if known	Value used in Model
5.1. Overall Network & Policy		
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Override proxy values where user has better data

Rely on proxy data where user's data is lacking

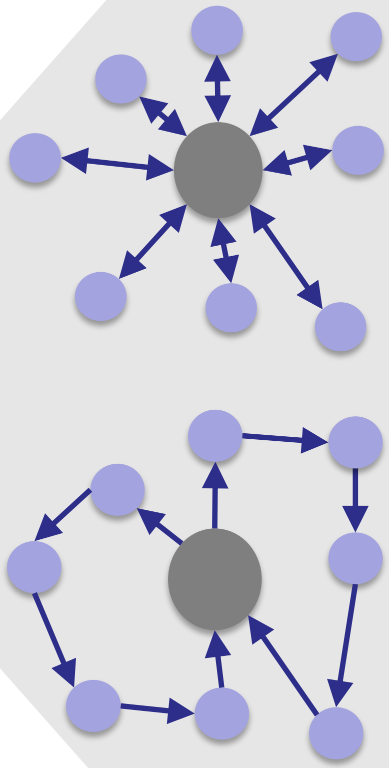
How to improve speed and flexibility of tool?

Standardized design "levers" to replicate most SC 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 health SC designs



Point-to-point travel

- Distribution from central to regional medical stores
- Facility staff travel to submit orders and/or collect their facility's products

Route-based travel

- Mobile warehouse-style models (e.g. Informed Push)
- Centrally-managed ordering and/or delivery (e.g. Assisted Pull, Direct Delivery)

How to improve speed and flexibility of tool?

Assumptions to simplify how SCs are represented in model

Key model assumptions

- All facilities assumed identical within a given SC tier:
  - Average distance from supplier
  - Average demand per period
- Model captures supply chain designs as they ***should*** ideally operate; cannot capture differences in implementation quality
- Model assumes stable operating conditions; does not capture transition or start-up costs when switching to a new SC design

Pros/Cons of assumptions

Cons (Tradeoffs):

- Potential for bias if geography or demand patterns highly variable or unusual
- Represents "best-case" estimate of costs; no inefficiency or variability

Pros (Advantages):

- Lower data requirement
- Computationally efficient
- Inaccuracies likely consistent for most scenarios in a given study

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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

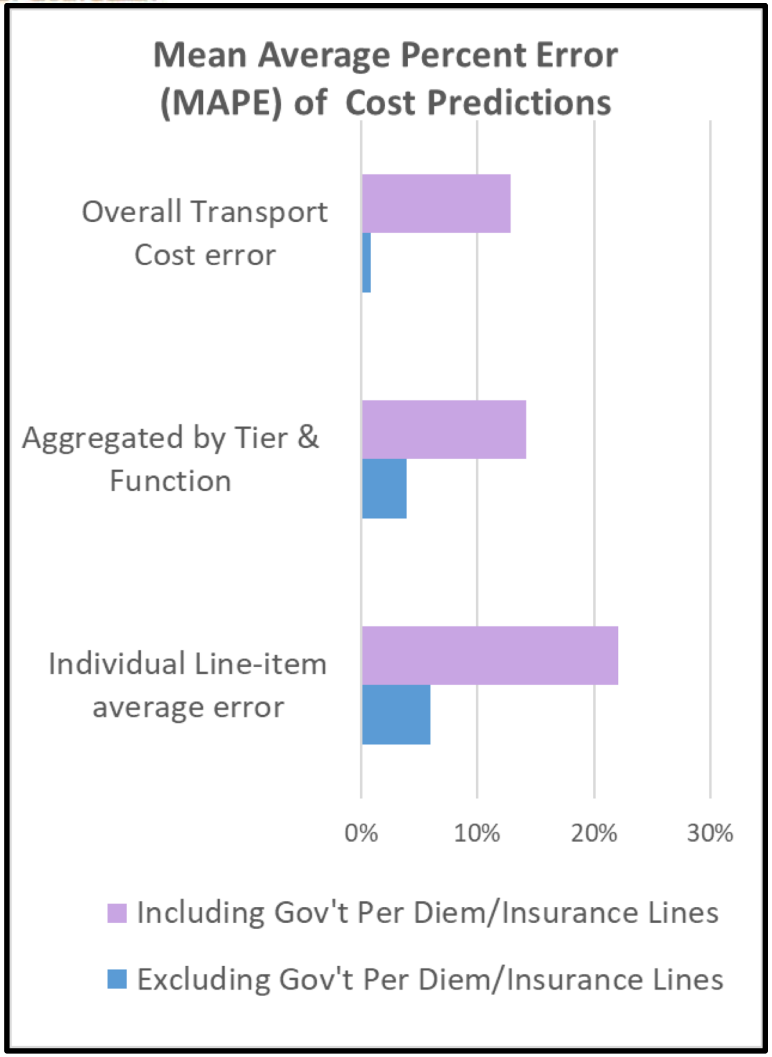
KEY QUESTIONS

- 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 dataset* – 2015 Zimbabwe Assisted Pull System (ZAPS) pilot evaluation
- 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 and takeaways from initial validation exercise



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

- Additional validation testing will clarify results in several ways:
  - Develop a larger sample & more robust picture of overall tool accuracy
  - Test correlation of accuracy correlation with specific factors. Better or worse for specific country, SC, or cost types?
  - Once several data sets are compiled, can begin to also test storage/mgmt. costs

Next steps for refining, testing, & disseminating tool

- Compiling additional data on health supply chain costs
  - Full costing study datasets for use as proxy data templates
  - Individual data points (e.g. warehousing costs, supply chain demand volume) as reference points for estimating input values

- Identifying opportunities for testing tool in live decision-making context:
  - Cross River/Kano (potential collaboration with VillageReach and Merck for Mothers): analyzing potential design options for improving reproductive health supply chains

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