Optimizing the cost of vaccine deliveries – a model-costed determination of key levers that influence vaccine delivery costs in Kano, Nigeria.

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Presentation at the Health and Humanitarian Logistics Conference, Kigali
July 10-11, 2019

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Background

- The effectiveness of vaccine supply chains are often hindered by:
  - Inadequate cold chain and poor maintenance limiting vaccine availability at service points
  - Complex and ineffective distribution architecture causing frequent stock outs
  - Inadequate and ad-hoc funding for vaccine transportation across all levels
  - Faulty vaccine forecasting and allocation which did not adequately reflect demand
  - Weak data management systems resulting in ineffective management decision making
  - Lack of proper supportive supervision due to funding limitations and capacity gaps
- Supply chain managers' ability to bridge the gaps are however constrained by dearth of information on resource requirement, effectiveness potential and risks involved.
- This presentation focuses on bridging the knowledge gaps in resource requirement specifically financial resources

SOURCE: Kano RI Program Diagnostics

Kano state, Nigeria presented a unique opportunity to model the financial resources needed to optimize supply chains across different contexts

Map of Kano state

- Number of zones = 6
- Number of LGAs = 44
- Number of wards = 484

Kano at a glance

Population	▪ 13.8 Million (2018)
GDP per capita[1]	▪ $1,288 USD
No. of children>1[2]	▪ 0.55 Million
Infant mortality rate[3]	▪ 112 deaths per 1,000 children
Immunization coverage rate[4]	▪ BCG: 61.2% ▪ Penta3: 45.9% ▪ Fully immunised: 19.4%
Healthcare facilities	▪ 1,222 PHCs; 1,142 providing RI services

Why was Kano selected for this study?

Kano State had experience implementing different vaccine delivery approaches with variations in:

Number of vaccine storage nodes

- The state refined its vaccine delivery from a **traditional system** of delivering vaccines to a **streamlined system**

Responsibility for vaccine distribution

- The state utilized both **outsourced** and **insourced** vaccine distribution

Delivery frequency

- The state utilized both **biweekly** and **monthly** delivery systems

Scale of operation

- Kano state operated insourced deliveries for **2 (of 6)** of its **zones**, the other **4 zones** were outsourced to third-party logisticians

The revamp of the Kano vaccine supply chain was initiated with the institution of a tripartite memorandum of understanding to strengthen routine immunization systems between the Kano State Government, Bill & Melinda Gates Foundation, and Dangote Foundation in November, 2012

SOURCE: 1. Canback Dangtel C-GIDD, 2. DHIS2 (2018) 3. MICS 2016-2017; 4. Nigeria Demographic and Health Survey, 2018

This study seeks to bridge the knowledge gaps in managing the cost of vaccine deliveries

Goal of the study

To bridge the knowledge gaps in vaccine supply chain by identifying levers and trade-offs available to supply chain managers in managing the cost of vaccine deliveries

The specific objectives are to:

1. Identify the levers that inform the cost of vaccine deliveries, given Kano state, Nigeria's context

2. Determine the trade-offs available to decision makers in low resource settings to minimize vaccine delivery cost from regional cold stores to service delivery points.

Source: Team analysis

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Retrospective review of Kano's program data helped to identify and model the levers that influence the cost of vaccine deliveries

Objective	▪ To identify levers that inform the cost of vaccine deliveries in Kano, Nigeria ▪ To determine trade-offs available to decision makers to minimize vaccine delivery cost
Context	▪ Kano State, Nigeria
Quantitative data	▪ Cost data was obtained from Kano state's expenditure report on vaccines from cold stores to target health facilities using different vaccine delivery approaches and market survey - Capital costs were amortized to reflect annual costs
Qualitative data	▪ Targeted key informant interviews and focus group discussions with relevant stakeholders using structured questionnaires

Source: Team analysis

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We identified five distinct levers that influence the overall costs of vaccine delivery

1 Number of delivery layers

- Number of storage points between the state cold store and the health facilities, inclusive
- The delivery layer informs the cost of travel and storage
- We modelled the 4 possible delivery layers identified in Kano:
  - ***S-Z-L-F*** (Vaccine push from state to zonal/satellite to LGA then to Apex facilities
  - ***S-Z-F*** (Like ***S-Z-L-F***, bypassing the LGA
  - ***S-L-F*** (Like ***S-Z-L-F***, bypassing the zone
  - ***S-F*** (Like ***S-Z-L-F***, bypassing the zone and LGA

2 Number of health facilities

- Number of destination health facilities
- The number informs the capital cost investment required and the capital cost per health facilities
- Deliveries were made to 390 health facilities in Kano state
  - We used the data to model the cost of delivering to 25 to 400 health facilities

3 Frequency of vaccine deliveries

- Scheduled time lag between deliveries per health facilities
- The frequency informs the capital investment
- The changes were to optimize the overall program costs

4 Transportation type

- Type of automobile used for vaccine distribution
- Different automobile options require different number of units at varying prices
- We modelled vaccine deliveries using:
  - Trucks
  - Trucks and tricycles
  - Trucks and motorcycle

5 Responsibility for vaccine distribution

- Refers to the parties that bear the responsibility of distributing vaccines to health facilities
- We modelled the both systems deployed in Kano:
  - State-led deliveries (insourced)
  - Third party logisticians

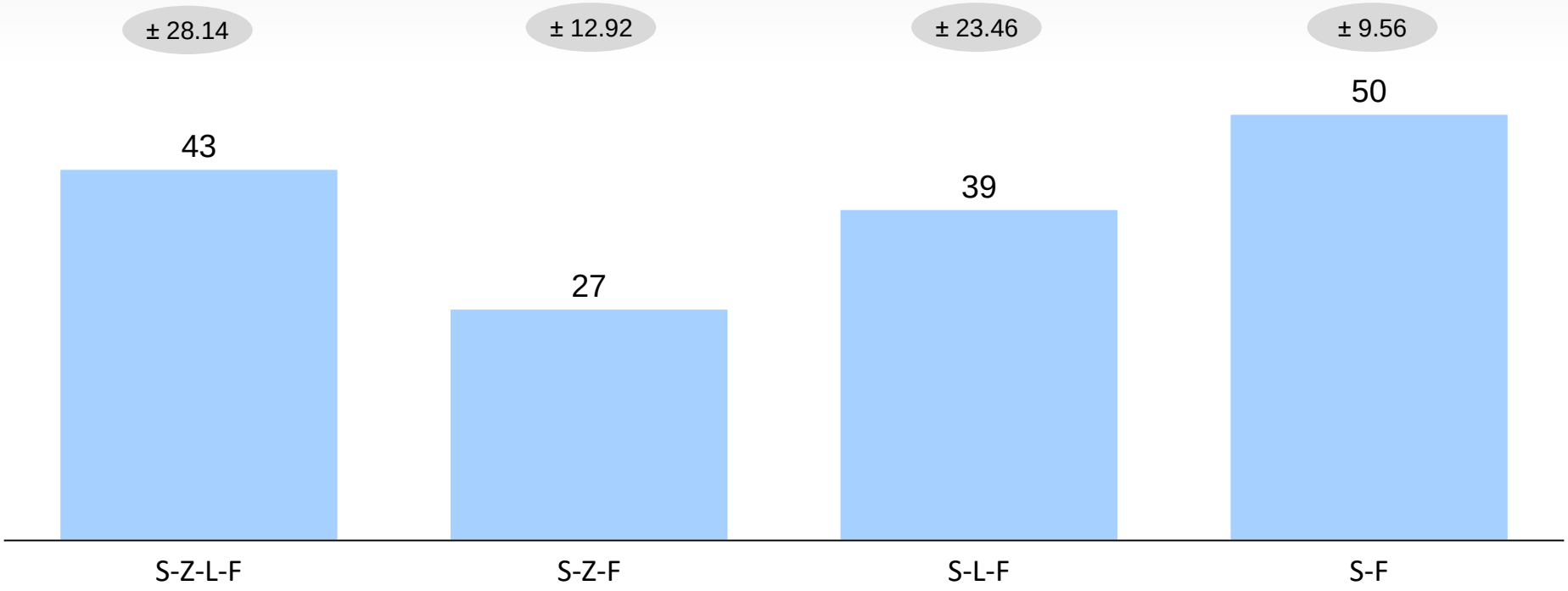
- Modelling the identified levers resulted in **9,216 different options** for vaccine deliveries
- The options informed the analysis of trade-offs available to decision makers to minimize vaccine delivery cost

Source: Team analysis

The three layered (-S-Z-F) architecture was shown to be the cheapest delivery model

xx Standard deviation

Comparison of unit costs of vaccine delivery across different delivery layers for deliveries made to 400 health facilities at a bi-weekly delivery frequency *(USD)*



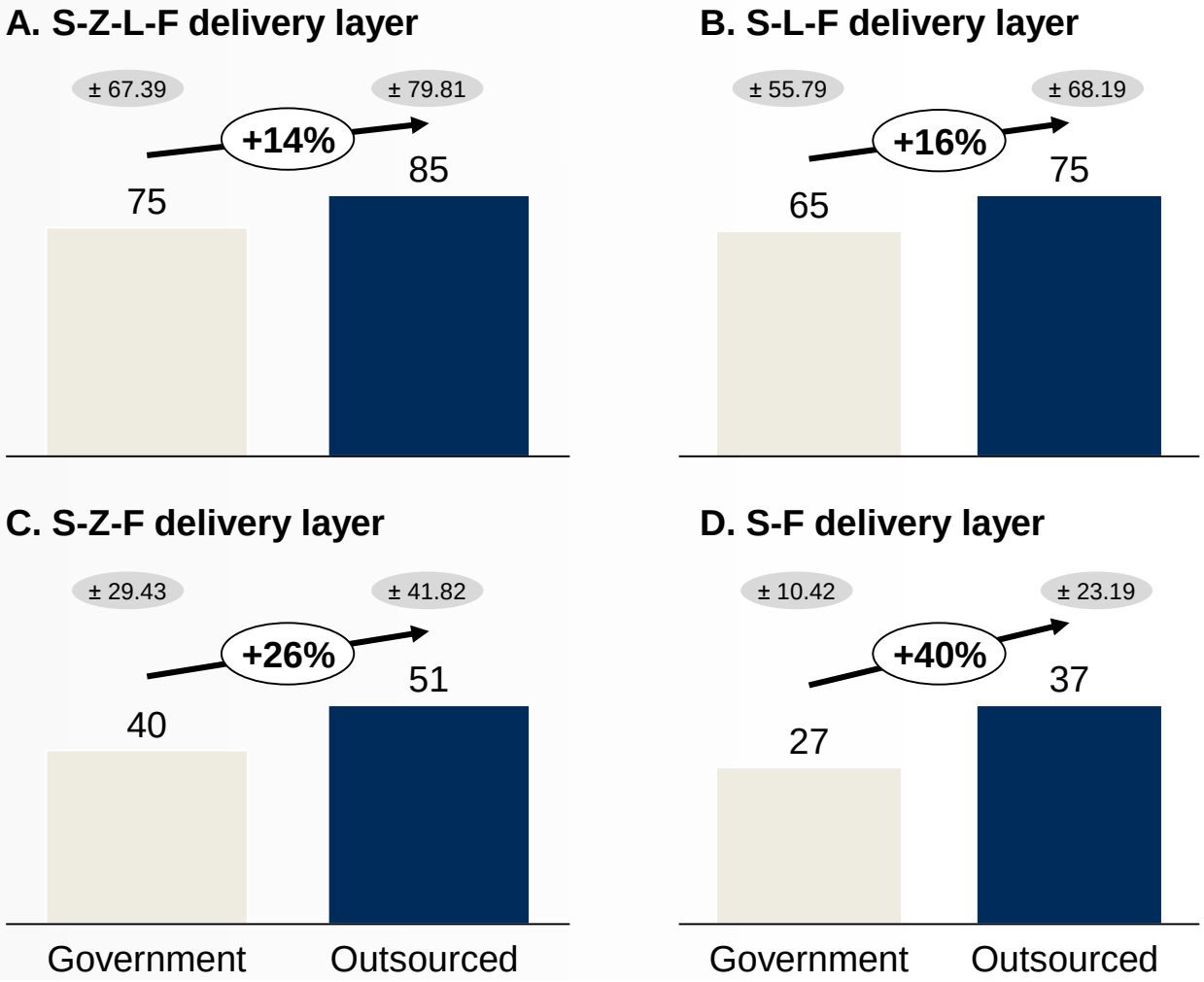
Altogether, vaccine delivery cost is reduced by an average of 10-38% (p>0.05) for streamlining vaccine delivery from the four layered model to three layered models

Source: Team analysis

The outsourced model was shown to be more expensive than government-run distribution

xx Standard deviation

Comparison of cost of government-run versus outsourced vaccine deliveries to HFs using trucks at a bi-weekly frequency[1] *(USD)*



- Costing for both models were computed with the **exemption of the costs of storage**
- The data shows that **using the government-run option reduces vaccine delivery cost** by an average of 18% ($p>0.05$) as opposed the outsourced transportation
- Disaggregating the unit delivery cost showed a higher **cost of labor and communication** in the outsourced transportation system
- **Associated costs** of technical assistance often required by states for in-sourced delivery **not considered**

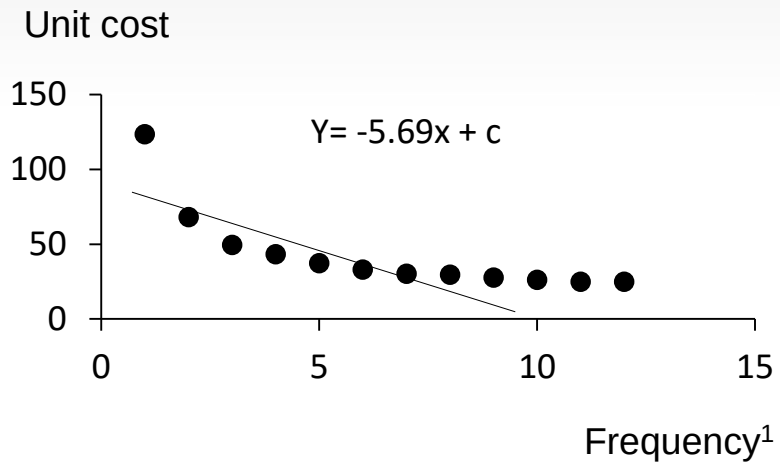
1. All differences were insignificant at the $p<0.05$ level, with the exception of the *–S-F* layer

Source: Team analysis

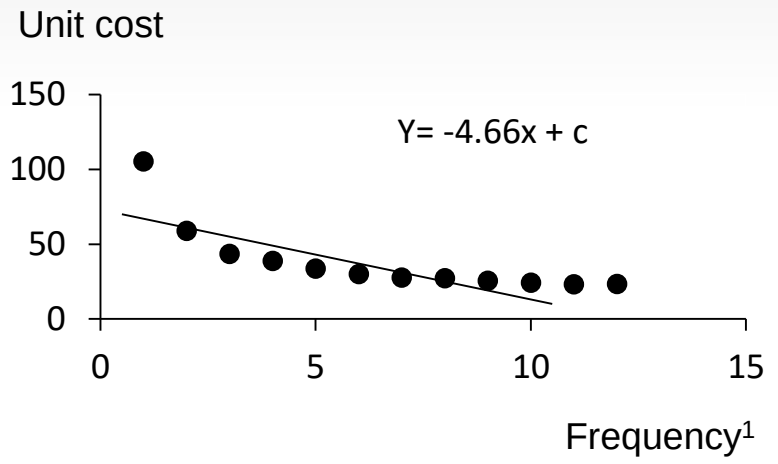
Increasing frequency of vaccine deliveries each quarter using the government-run approach will further reduce the unit cost per delivery

Comparison of the unit cost of government-run deliveries to 400 health facilities using trucks *(USD)*

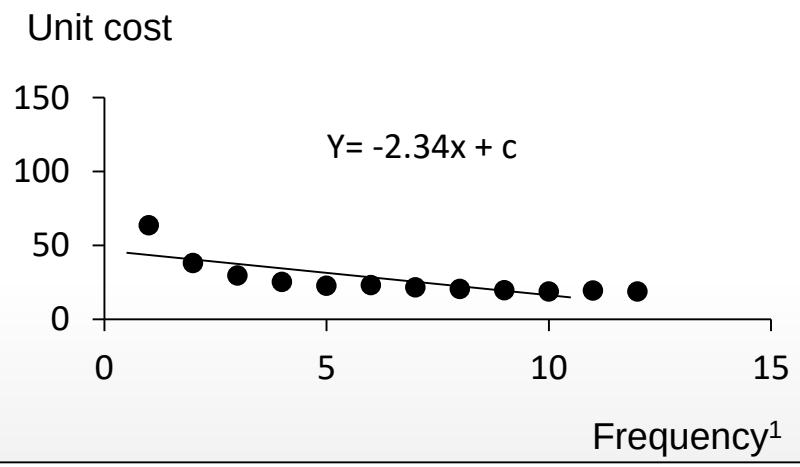
A. S-Z-L-F delivery layer



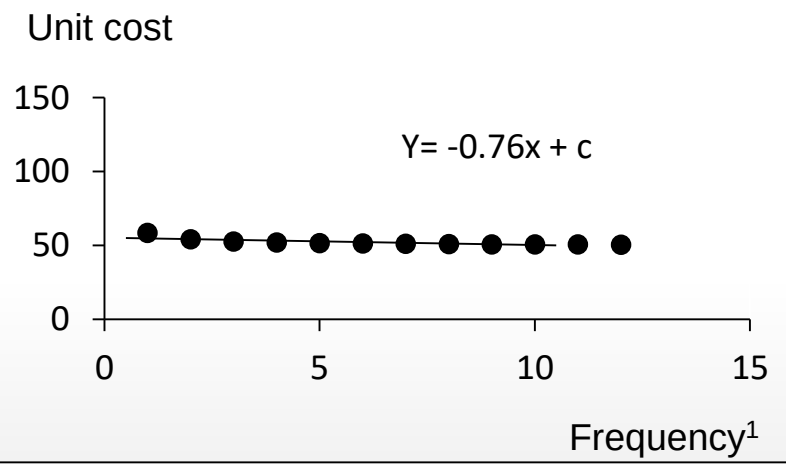
C. S-L-F delivery layer



B. S-Z-F delivery layer



D. S-F delivery layer



1. Frequencies are per quarter

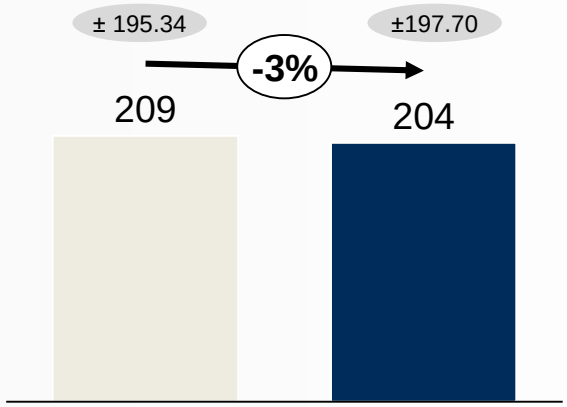
Source: Team analysis

Including weekend deliveries in the delivery cycle reduced the unit cost per delivery

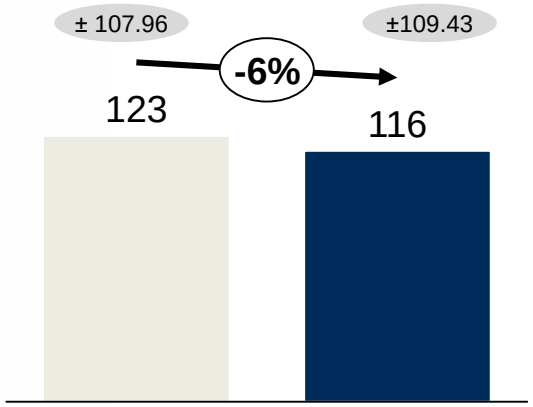
XX Standard deviation

Comparison of the unit costs of vaccine deliveries across the 4 delivery layers for biweekly deliveries to health facilities using trucks[1] *(USD)*

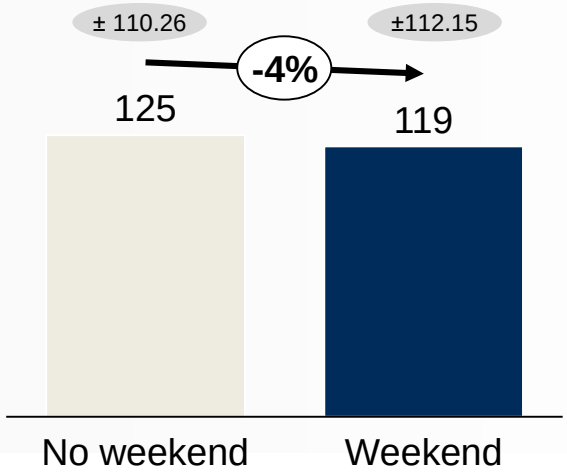
A. S-Z-L-F delivery layer



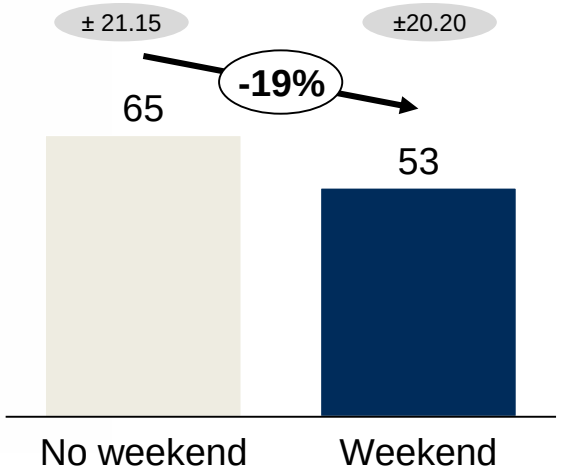
B. S-L-F delivery layer



C. S-Z-F delivery layer



D. S-F delivery layer



The unit costs of vaccine deliveries reduces across all delivery layers by 3% to 19%, depending on the delivery layers, if weekend deliveries are introduced

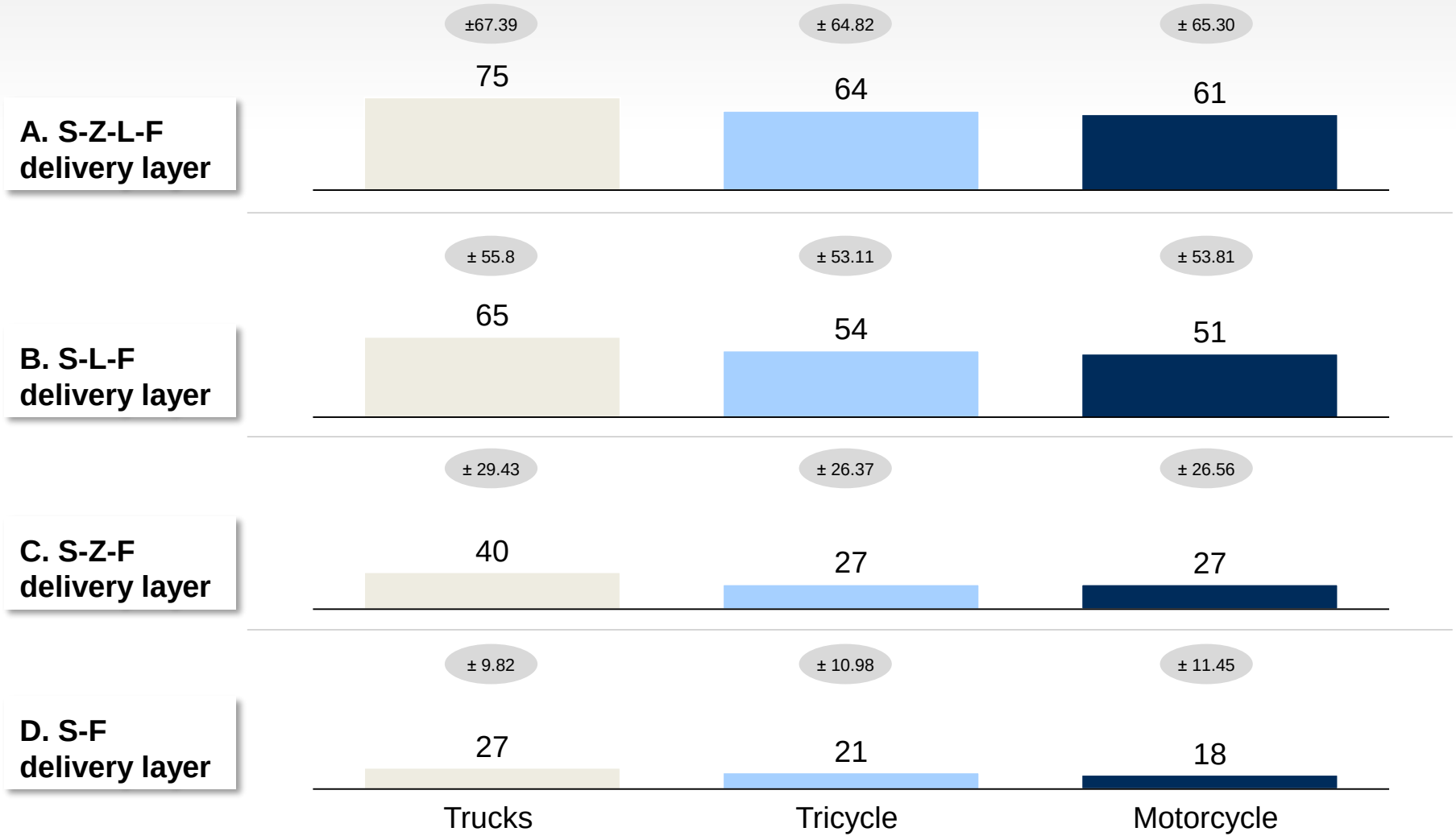
1. All differences were insignificant at the p<0.05 level, with the exception of the *–S-F-* layer

Source: Team analysis

Substituting trucks with motorcycles or tricycles in vaccine delivery to health facilities reduced unit cost of vaccine deliveries

xx Standard deviation

Comparison of the unit cost of vaccine delivery using different automobile options[1] *(USD)*



1. All differences were insignificant at the p<0.05 level, with the exception of comparison between trucks-tricycles and trucks-motorcycles for the *–S-F* model
2. Trucks – deliveries made with trucks only, Tricycle – deliveries made with trucks and tricycles, Motorcycle – deliveries made with trucks and motorcycles

Source: Team analysis

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Supply chain managers can toggle the identified levers to minimize their cost of vaccine deliveries…

Insights

1. Streamlining delivery layers from 4 to 3 was shown to have the greatest impact in reducing the unit cost of delivery and should be the primary consideration for supply chain managers seeking cost optimization
   - The –S-Z-F model has proven to be the most cost-effective option for vaccine delivery to a high number of target facilities as against the four models
   - Unit cost of deliveries increased when the delivery layer was further streamlined to 2 (S-F)

2. Typically, increasing frequency of delivery will typically have the same effect as increasing the number of health facilities by a factor of the increase in delivery frequency, while keeping the inter health facility distance constant

3. Increasing the available number of days per delivery cycle to include weekends, reduces the cost per delivery on the average; as more health facilities can now be covered with available fleet of vehicles

4. Cheaper automobile options (including motorcycles and tricycles) may be used to substitute trucks to make vaccine deliveries between LGAs or zones to the health facilities, to reduce the vaccine delivery cost

5. Outsourcing the transportation of vaccines to a 3PL increases the delivery cost due to the efficiency and innovations that private organizations typically introduce

Source: Team analysis

…However, they must also take cognizance of factors that may constrain their cost minimization objectives

Factors that may constrain cost optimization objectives

1. The potentials for real cost minimization may be constrained by the fact that permanent government staff are required to run the cold stores and their disengagement is highly unlikely

2. Opportunities for reducing delivery costs through weekend vaccine delivery may not exist where health facilities are closed on weekends

3. Non-suitability of cheaper automobile options in difficult terrain

4. Increased likelihood of vaccine wastage owing to delivery of a higher volume of vaccines aimed at reducing delivery frequency

Source: Team analysis

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Conclusion

- The following **5 decision points** may be considered by supply chain managers, to minimize vaccine delivery cost per facility per time:
  - **Streamlining** the vaccine supply chain architecture
  - Increasing the **number of target health facilities**
  - Increasing the vaccine delivery **frequency**
  - Including **weekends** in the vaccine delivery cycles
  - **Substituting vaccine delivery trucks** with cheaper automobile options such as motorcycles and tricycles, to reduce the cost of vaccine deliveries per target health facility per time.
- Managers and policy makers must consider supply chain settings-specific context (such as terrain and vaccine utilization behaviors at service delivery points), and take account of their own broader context, to make decisions on vaccine delivery options

Source: Team analysis

Thank you

Back-up Slides

We modelled the levers to observe the variations in unit cost of vaccine deliveries

Levers	Model	Interval	# of possible variations
A Number of health facilities	25 HFs → 400 HFs	25 HFs	16
B Frequency of vaccine deliveries	1/quarter → 12/quarter	Weekly *(with considerations for weekend deliveries vs no weekend)*	24
C Transportation type[1]	Trucks, Tricycle, MotorC	N/A	3
D Number of delivery layers	State, Zone, LGA, Facility	N/A	4
E Responsibility for vaccine delivery	Insourced and Outsourced	N/A	2

9,216 possible Combinations

1. Trucks – deliveries made with trucks only, Tricycle – deliveries made with trucks and tricycles, Motorcycle – deliveries made with trucks and motorcycles

Source: Team analysis