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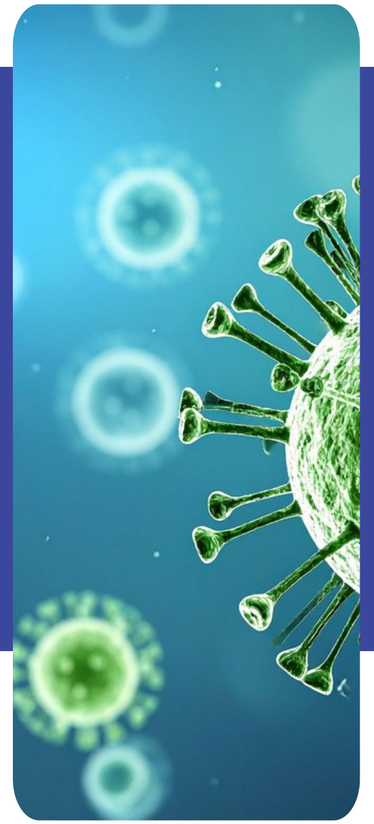
Cost effectiveness analysis for strengthening outbreak response in priority sub-counties

Dr. Matabel Odin Odiaga[1], Dr. Kanana Kimonye[2], Dr Kadondi Kasera[3]

[1] Namibia University of Science and Technology (NUST), Windhoek, Namibia
[2]Kenya National Public Health Institute (KNPHI), Nairobi, Kenya
[3]Tackling Deadly Diseases in Africa Programme 2 (TDDAP2), Nairobi, Kenya



Thematic Area: Technological Advancements In Public Health

UK International Development
Partnership | Progress | Prosperity

Background

- Cholera remains recurrent (**every 5-7 years**) in Kenya, concentrated in vulnerable hotspots with poor WASH access, mobility, and climate risks.
- Recurrent outbreaks led to the development of the National Multisectoral Cholera Elimination Plan **(NMCEP) 2022-2030** now guided by **PAMI report 2024---- Goal**: to control cholera outbreaks by 2030
- PAMI (2024) identifies **107 cholera hotspot sub-counties** (40% of Kenya's population) based on incidence, persistence, mortality, and testing coverage with the objective of improving surveillance (**targeted interventions, early detection & response, efficient resource allocation)**
- Cholera surveillance in PAMI sub-counties relies on transporting samples to labs, but current ad-hoc, inconsistent transport systems cause delays, variable costs, and risks to sample integrity.
- Despite its critical role, there is limited evidence on the **cost-effectiveness** and **sustainability** of alternative transport models, particularly under outbreak conditions.

Objectives

Overall Objective

Identify the most sustainable & cost-effective cholera sample transport model to achieve timely laboratory confirmation in priority sub-counties in Kenya.

- Document existing transport pathways
- Estimate current costs

Map & Cost Current System

- Identify sustainable transport models
- Estimate comparative costs

Model Alternative Options

- Compare alternatives vs. current system

Assess Cost-Effectiveness

- Evidence-based integration into NMCEP/PAMI objectives

Provide Policy Recommendations

Primary Outcome

Cost per sample successfully transported and accepted for testing by the laboratory within 24hours

Methodology

Study Design and Data

- **Cost effectiveness analysis (CEA)**
- **Data:** Primary and secondary data on costs and outcomes
- **Unit of Analysis**: Cholera sample referral pathway

Dispatch → Transport → Laboratory receipt

Perspective & Time Horizon

Healthcare system perspective
10-year horizon
3% discount rate
Base year: 2025

Comparators(Transport Strategies)

- ❑ **Current hub-and-spoke system (ad hoc)**
- ❑ **Public Private Partnerships (PPP)**
- ❑ **Integrated specimen referral system (ISRS)**
- ❑ **Dedicated transport**

Population & Setting (incl. Stratification)

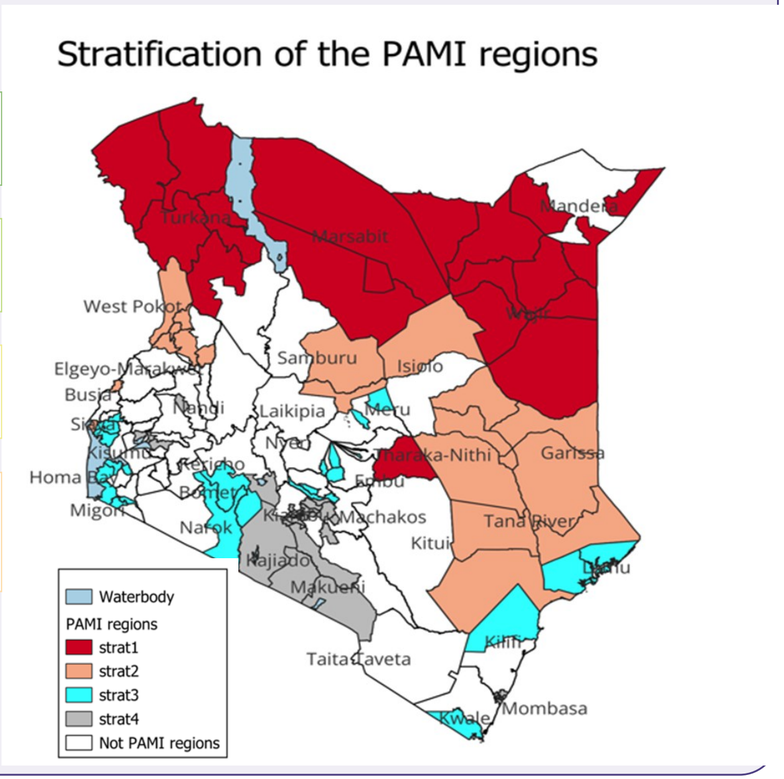
- **107 PAMI-identified cholera hotspot sub-counties, ~10,000 health facilities, 45 country referral hospitals**
- **Stratification** by geographical context, transport accessibility and complexity

Stratum 1 (21)
ASAL+Rural+High transport constraint+Crossborder

Stratum 2 (16)
ASAL+semi-rural+moderate transport access+ crossborder

Stratum 3 (28)
Non-ASAL+ rural + moderate transport constraint

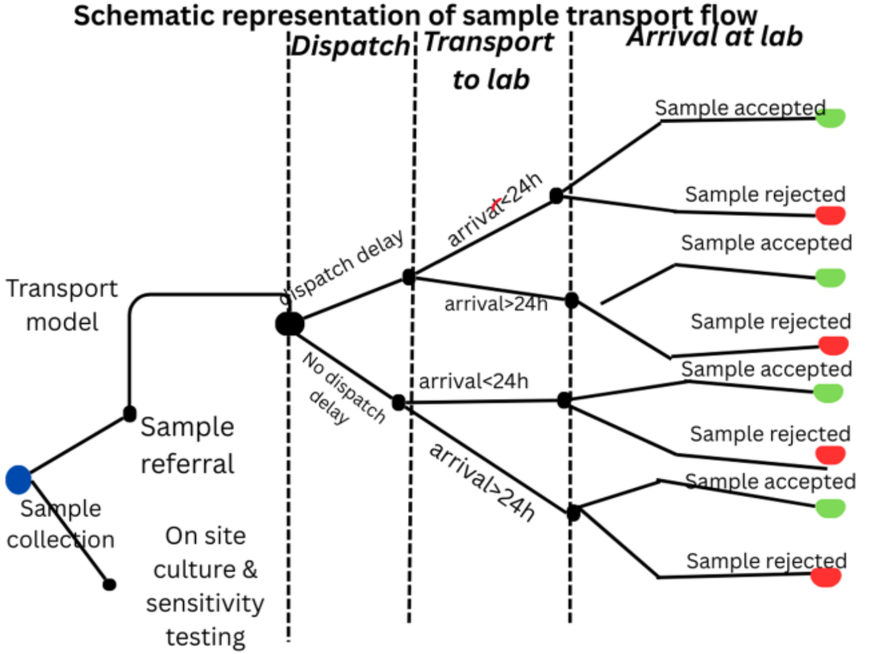
Stratum 4 (42)
Non ASAL+urban+ fast transport+ not crossborder



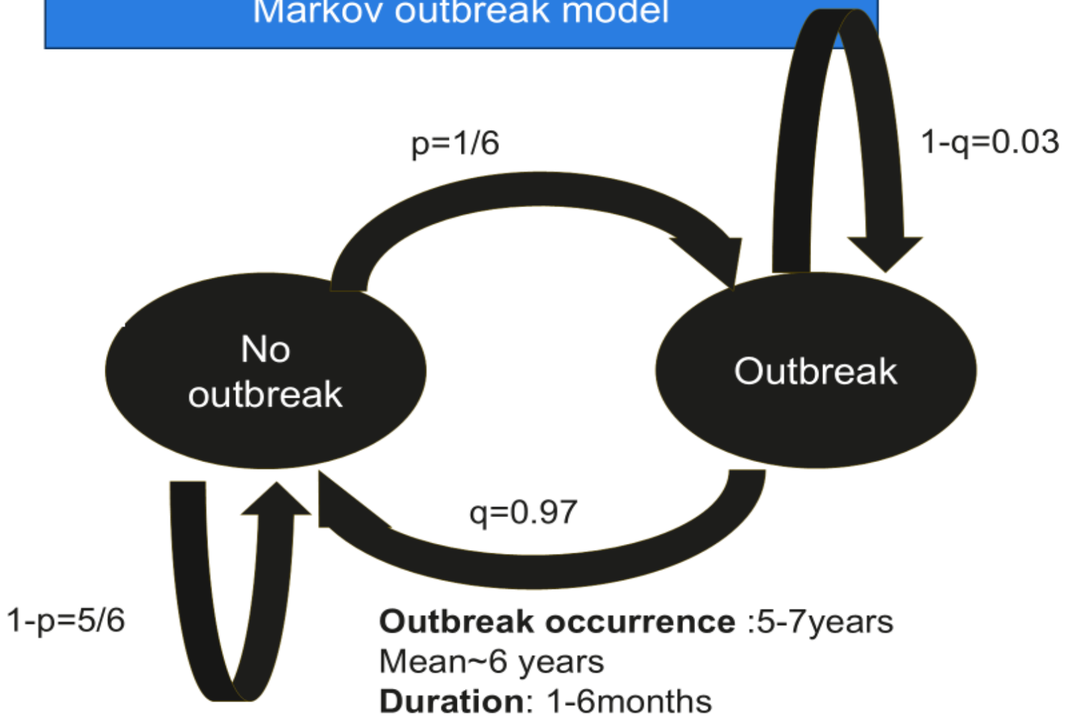
Methodology

Modelling approach

Decision tree framework



Markov outbreak model



Outbreak occurrence :5-7years
Mean~6 years
Duration: 1-6months

Mean~0.29years; Duration ~exp(0.29)

Base Case CEA Results:

ICER

1. ISRS (KES 4,149.78)

2. PPP (KES 7.380.17)

3. Dedicated (KES 611,221.56)

Observed county cholera budgets
Range: Not allocated– ~600,000 per sub-county

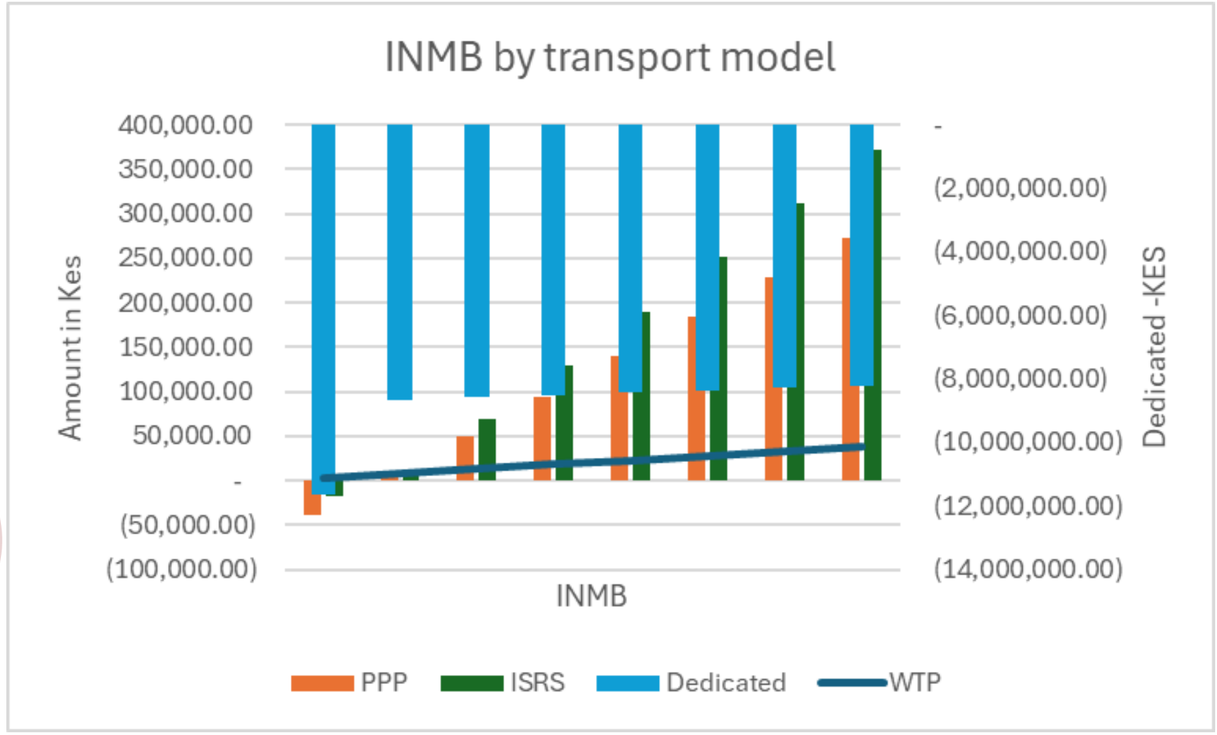
Nairobi: ~KES 10M (17 sub-counties)
Narok/Turkana ~KES 2.5M
Tana River ~KES 30,000
Samburu ~ KES 70,000

Outbreak sample volumes: 5 – 300 samples

📌 Implied WTP per additional timely

WTP Threshold Estimation

Incremental Net Monetary Benefit



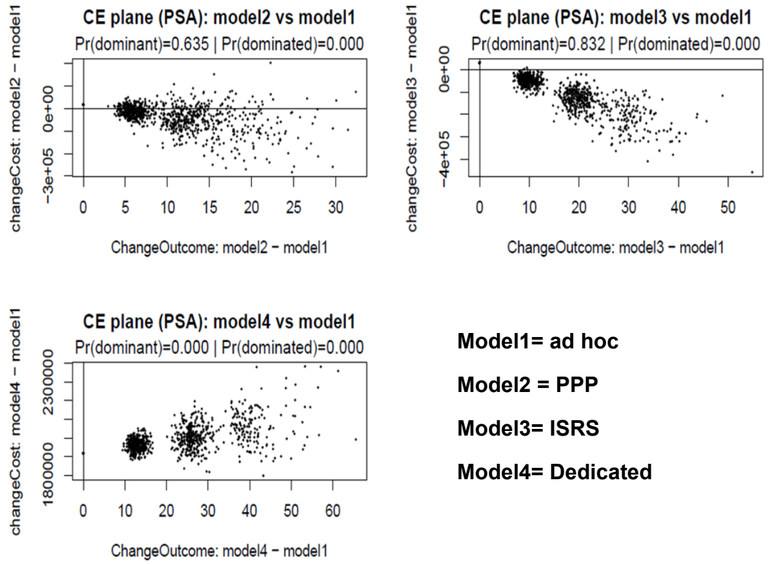
- **ISRS achieves more timely successful confirmations than both the current system and PPP at a lower incremental cost per additional referral.**
- **Dedicated is very expensive per additional referral**.

At Very Low WTP (KES 3,000); PPP → Negative INMB;
SiTEB → Negative INMB➡ Current system preferred

From KES 8,000 Upwards; PPP → Positive INMB
SiTEB → Highest INMB across all thresholds
Dedicated → Negative INMB at all thresholds

Results

Probability Sensitivity Analysis



Model1= ad hoc

Model2 = PPP

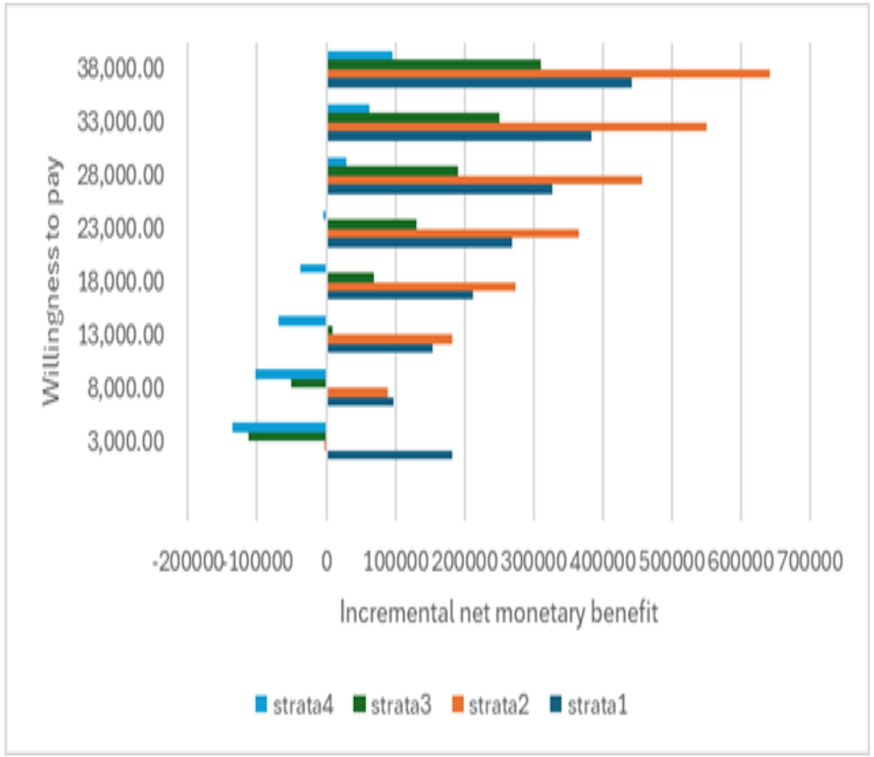
Model3= ISRS

Model4= Dedicated

- ISRS dominates ad hoc in over 83.2% of simulations (SE quadrant) – lower cost and higher effectiveness
- PSA confirms base ranking results

Equity Analysis

ISRS vs Ad hoc



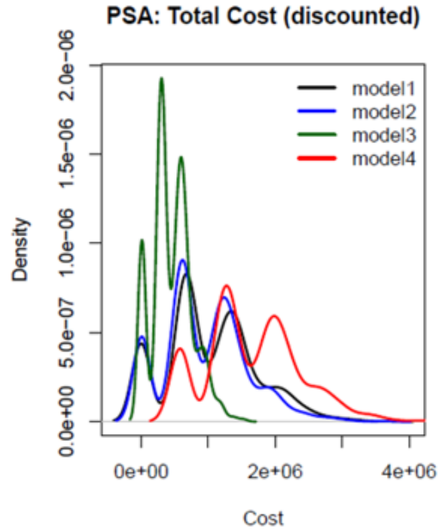
- Stratum 1 and 2 consistently have higher INMB across all WTP thresholds implies they experiences the largest economic gains with implementation of ISRS

Sustainability Analysis

Budget Impact Analysis

Model	Savings (Losses)
PPP	2,846
ISRS	8,949
Dedicated	(198,367)

Budget risk under uncertainty



- **Cost distributions show ISRS has lowest fiscal risk**

Discussion

- Across sensitivity analysis:
  - ✓ ISRS consistently generated positive net monetary benefit
  - ✓ Maintained affordability over extended planning horizons
  - ✓ Demonstrated low fiscal volatility under uncertainty
  - ✓ Delivered economic gains across all transport strata
- Integrated specimen referral systems improve timeliness and efficiency compared to ad hoc transport, PPP and dedicated transport.
- Largest economic gains occur in remote, high-complexity areas, where transport constraints are greatest. These findings suggest that lower-access areas (Strata 1 and 2) require proportionally greater transport investment..
- ISRS demonstrates financial feasibility and low budget risk, unlike dedicated transport models

Conclusion

- The results of the CEA indicate that **integrated specimen referral systems (ISRS)** provide the most cost-effective, equitable and fiscally sustainable strategy for strengthening cholera sample transport across priority sub-counties

- Cost-effectiveness gains are driven by coordination, shared infrastructure, and reduced delays

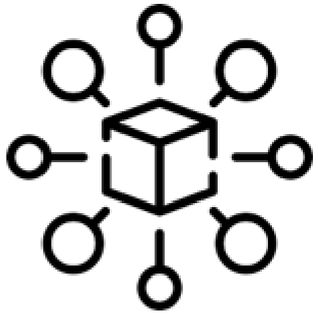
- Findings align with NMCEP and PAMI priorities → early detection & efficient resource use and supports transition from reactive to structured integrated transport systems.

- This will improve timely outbreak detection and response in PAMI areas

Policy Impact and Implications

Outbreak Preparedness

- Integrate cholera referral into existing specimen transport platforms
- Adopt PPP in urban sub counties as a transitional phase before ISRS scale up
- Dedicated transport can be adopted in extreme insecurity settings/ emergency contexts



Targeted Decentralization

- Can be considered in high-volume sub-counties-Stratum 1 and 2
- Be guided by minimum annual samples threshold

Budget & Planning

- Reallocate transport budgets toward integrated routing
- Shift from reactive outbreak spending to structured annual budgets/allocations

Resource Allocation

- Prioritize investment in Stratum 1 and Stratum 2 sub-counties-high INMB gains
- Moderate allocations in strata 3 and 4- leverage existing infrastructure

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