Photo Credit: Gabriella Ailstock, VillageReach

Optimizing the Specimen Referral System in Mozambique with Drones:

FINAL EVALUATION SUMMARY

OCTOBER 2023

Introduction

The Mozambique health sector is committed to ensuring universal access to quality primary health care, yet challenges persist in providing timely diagnostic services and access to medical products, especially for under-reached communities. The national specimen-referral system, while essential, faces transportation obstacles, including inconsistent sample collection, lack of cold chain equipment, and logistical barriers, particularly during the rainy season. These issues result in delayed laboratory sample pick-ups, reduced traceability, and extended turnaround times for results.

To address these challenges, innovative solutions are needed. Drone transportation offers a potential solution by overcoming transportation barriers and expediting case management. Therefore VillageReach, in partnership with the National Institute of Health (INS) and the Ministry of Health conducted a phased study[1] to assess how drones could improve the sample transportation network in Mozambique. Phase 1 indicated that drone transportation did not affect the quality of TB specimen.[1]

The Phase 2 study, conducted in collaboration with the Inhambane Provincial Health Authorities, explores the feasibility, performance and cost of complementary drone transportation. Phase 2 was conducted within four districts of the Inhambane lab referral network over a 6-month period (May to October 2022). By introducing daily drone transportation, provided by Swoop Aero, this research aims to generate crucial evidence for enhancing Mozambique's laboratory referral network and improving diagnostic services for its population.

Methodology

The study employed a single-group design with pre-test and post-test measurements, using a mixed methods approach (quantitative and qualitative). Two main components were evaluated:

1. **Process Evaluation of Drone Transportation:** This aimed to assessed ground and drone transportation for lab samples in remote areas, focusing on speed, reliability, safety, quality, health worker efficiency, local capacity, and community acceptability.
2. **Cost and Cost-effectiveness Analysis:** This aimed to understand the comprehensive costs and cost-effectiveness of ground and drone transportation for the analyzed specimen referral network.

Inhambane province was chosen due to its high COVID-19 cases in 2021. Seven primary health facilities across the Govuro, Inhassoro, Mabote, and Vilankulo districts were selected based on challenging access and high sample referral volume.

Data was collected before drone introduction and after six months of combined drone and ground transportation operation. Data collection included validating quantitative data and conducting qualitative interviews. Data sources included health records, LMIS reports, and data recorded by the drone operator, covering product details, transport times, and flight metrics. Ethical approval was obtained from the National Bioethics Committee for Health.

1 Malamule, D.; Moreira, S.; Madeira, C.; Lutucuta, C.; Ailstock, G.; Maxim, L.; Bechtel, R.; Defawe, O.; Viegas, S. Quality Analysis of Tuberculosis Specimens Transported by Drones versus Ground Transportation. Drones 2022, 6, 155. https://doi.org/10.3390/drones6070155

Phase 2 of the Drones for Health project implementation involved several key steps:

1. Flight authorizations
2. Systems design workshop
3. Site surveys
4. Drone network design
5. Community sensitization
6. Health worker and drone operator training

Findings

Photo Credit: Gabriella Ailstock, VillageReach

Drone logistics performance

During the implementation period, 2,996 lab samples, 690 lab results and 11,801 units of medical products were transported by drone. The performance of the drone flights was mostly without disruption. Less than 15% of flights were delayed or rescheduled and only 8% of flights rescheduled during the six-month period.

Weather conditions were the leading cause of flight disruptions. The weather was a consistent issue due to the proximity of the coastline and the likelihood of weather conditions changing with short notice. This means that ground transportation methods are still needed where possible so that transport can be conducted during poor weather periods.

FLIGHT PERFORMANCE

1,080
Total flights

99.5%
Flights completed

592
Deliveries

608
Total flight hours

MEDICAL ITEMS TRANSPORTED BY DRONE

3,696
Total lab samples and results transported

2,996
Lab samples

690
Lab results

11,801
Total units of medical products

6,518
Essential medicines

1,700
Medical materials

39
Blood units

2,649
Immunization products

106
Rapid Test Kits

789
Other materials

Effect of drones on laboratory sample transportation

Beyond the direct effect of drone delivery, there was measurable change in multiple parts of the overall sample referral system. Because the availability of daily drone transport enabled samples to move faster through the system, facilities could refer samples more often and more quickly. Increased availability of transportation also made it possible to deliver samples from facilities without on-site diagnostics to facilities with on-site diagnostics that could not be transported before. 10% more laboratory samples were referred and transported after the introduction of drone transportation.

It was observed that TAT for all referred samples was reduced significantly after the introduction of drone transport. TAT for TB culture did have an increase of 6%, but the P-Value (0.55) indicates that the change was not statistically significant.

Cost and cost-effectiveness

The annual cost of laboratory sample transportation in the Inhambane study sample increased after the introduction of drone transportation, which was not surprising as the cost of innovative technology is historically high. The intervention's incremental cost-effectiveness ratio was $82,467, indicating that the intervention was **not cost-effective**. Estimated future costs of drone transportation were modeled, incorporating reduced rates for drone transportation negotiated after the study period. Estimated future cost per sample transported is on par with ground transportation but still not cost-effective, as it remains above the ICER threshold of 3x Mozambique's GDP per capita.

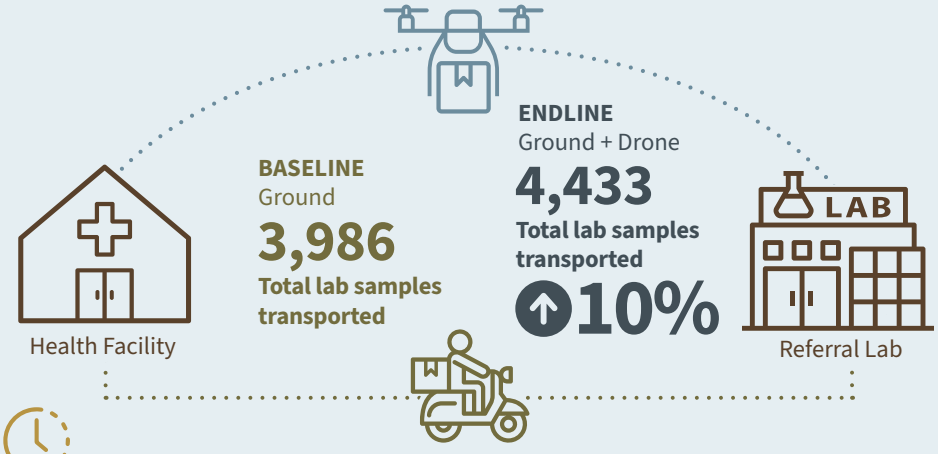
EFFECT OF DRONES ON LAB SAMPLE TRANSPORTATION

Sample referral days
% increase in number of days samples were transported to the referral lab

- **105%** Viral Load Tests — BASELINE 63 DAYS, ENDLINE 129 DAYS
- **880%** PCR HIV Tests — BASELINE 10 DAYS, ENDLINE 98 DAYS

Waiting time
% decrease in time specimens spend waiting for transportation to the referral lab

- **-33%** Viral Load Tests — BASELINE 3 DAYS, ENDLINE 2 DAYS
- **-80%** PCR HIV Tests — BASELINE 5 DAYS, ENDLINE 1 DAY



Turnaround time (TAT):

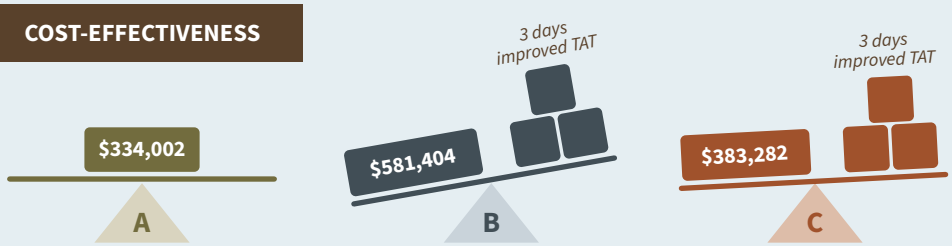
-34% Average
The interval between when a sample is sent to a referral lab and the time the result is received back at the health facility which requested the test

- **-42%** Viral Load Tests
- **-14%** PCR HIV Tests
- **6%** TB Culture
- **-43%** GeneXpert

LABORATORY SAMPLE TRANSPORTATION SYSTEM COSTS

	BASELINE Ground	ENDLINE Ground + Drone	ESTIMATED FUTURE Ground + Drone
Total Annual costs	$334,002	$581,404	$383,282
Average cost per sample transported	$42	$66	$43

COST-EFFECTIVENESS



A = BASELINE
0 days improved TAT

B = ENDLINE
Incremental Cost-Effectiveness Ratio (ICER) of A vs. B:
$82,467 per day of TAT

C = ESTIMATED FUTURE
Incremental Cost-Effectiveness Ratio (ICER) of A vs. C:
$16,427 per day of TAT

Community and health worker perceptions

A perception survey conducted at the endline involved interviews with 74 community members and 14 medical practitioners, representative of all communities and medical facilities in the study sample. The vast majority of community members surveyed were aware of drones and had seen them deliver supplies. 93% of interviewees expressed very high satisfaction and trusted drones to deliver medical products.

There was strong satisfaction with the drone system amongst medical practitioners. They indicated that the system improved their work and resulted in timely transport of samples and results.

Health worker perceptions imply that supplemental drone delivery of medical products may have helped improve availability of products, resulting in less cancellation of vaccination sessions and referrals of patients due to stock out.

COMMUNITY PERCEPTIONS

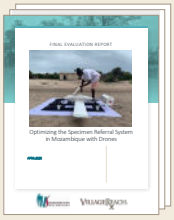
- **93%** — Expressed trust and very high satisfaction in drone delivery
- **95%** — Had heard about drones delivering medical products
- **97%** — Had personally witnessed drone deliveries
- **85%** — Believe drones reduced turnaround time
- **53%** — Mentioned drone crashes or theft as a risk
- **90%** — Had no concerns about product quality

HEALTH WORKER PERCEPTIONS

- **100%** — Had no complaints about the drones and deemed the drone system beneficial
- **100%** — Believed drones reduced stockouts, improved emergency supply delivery, and prevented vaccination session cancellations
- **100%** — Said the drone system improved their work
- **57%** — Said the drone system reduced their workload
- **72%** — Never had transportation delays for lab samples or results
- **92%** — Never turned away or referred patients due to low availability of essential medicines

Conclusion

The study in Inhambane, Mozambique, demonstrates the positive effect of drone transport on medical sample transportation. Findings suggest that the integration of drone as an additional and fit-for purpose mode of transportation has the potential to improve the efficiency of medical sample transport in remote and hard-to-reach areas. The perception survey demonstrates positive perceptions, strong community support, and the successful integration of drone operations into the health care system, improved service delivery and addressed logistical challenges. Based on these results, the study team recommends the use of drones to improve the transportation of lab samples, results and other medical products.



Read the full *Optimizing the Specimen Referral System in Mozambique with Drones: Final Evaluation Report*

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