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MID-TERM EVALUATION OF UAV PILOT ACTIVITY, USAID/MADAGASCAR HEALTH PROJECT

October 2021

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Submitted by:
Andrea Camoens, Chief of Party
GH EvaLS
4350 East-West Highway, Suite 210
Bethesda, MD 20814-4410
Tel: (301) 652-4334
Email: acamoens@engl.com

Cover Photo: The UAV used by PSI/IMPACT for the project evaluated, photographed by Pierrot Ramanamandimby.

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Global Health EvaLS
4350 East-West Highway, Suite 210
Bethesda, MD 20814-4410
Tel: (301) 652-4334
Website: https://ghevals.meandahq.com

ABSTRACT

Community health systems worldwide need reliable supply chains for basic health commodities, reaching remote areas where needs are often the greatest. Deliveries may be most difficult where villages are isolated, roads seasonally impassable, and even water courses difficult to navigate. In 2019, Improving Market Partnerships and Access to Commodities Together (IMPACT) program, implemented by Population Services International (PSI) in Madagascar, initiated a pilot project to test the effectiveness of Unmanned Aerial Vehicles (UAVs, or drones) to overcome barriers of geography and climate for delivering a limited range of products to the districts of Maroantsetra, Antalaja, and Mananara in Northeast Madagascar.

USAID/Madagascar contracted Global Health Evaluation and Learning Support Activity (GH EvaLS) to evaluate the effectiveness and efficiency of the drone pilot project and to identify factors that might affect its continuation and possible expansion. An evaluation team consisting of two international and two Malagasy experts utilized a mixed-methods approach to conduct the evaluation. They interviewed 44 community, district, national, and international key informants, reviewed project documents, flight data and other documents, and conducted direct observations at field drone sites.

The evaluation team found that drones were indeed effective at overcoming technical and meteorological obstacles to deliver requested commodities to Supply Points (*Points d'Approvisionnement* or PAs in French) up to 100 kms from the drone's take-off point. Supplies arrived within 24 to 72 hours of the order. Drone systems were safer and more reliable than traditional systems in adverse weather, and they relieved shopkeepers at the PAs of the obligation to spend two to four days each month traveling to the district warehouse for health products. The drone was relatively costly during the pilot phase because fixed monthly costs were distributed over a small number of flights, but it will become much more cost-efficient as the range of commodities carried and the number of flights increase.

Replication and expansion of UAV services is feasible and appropriate, but requires national leadership and a systems approach, particularly to include port-to-district supply chains and strong community health services. UAVs will be more efficient if potential users, including the government and various projects, coordinate their activities and consolidate payloads. Technical difficulties can be overcome, while administrative and managerial challenges may be more problematic.

ACKNOWLEDGEMENTS

This evaluation could not have occurred without the assistance of numerous individuals interviewed in Antananarivo, Maroantsetra, and rural communes outside Maroantsetra. Many interviews were conducted remotely because of COVID-related restrictions. We are grateful for the respondents' time and confidence in us.

We thank the USAID/Madagascar team, led by Ramy Razafindralambo, who met with us virtually on a frequent basis and provided invaluable inputs and insights during this evaluation. We appreciate the staff at PSI/Madagascar and Aerial Metrics who provided numerous relevant and useful documents and served as key informants for this evaluation. Special thanks go to UNICEF's Tautvydas Juskauskas, Coordinator of the Interagency Supply Chain Group, for inviting us to participate remotely in several international meetings concerning drones and for providing useful documents.

Unable to travel to Madagascar, the two international evaluation team members are extremely grateful to their Malagasy colleagues for informing us about the local context and conditions in Madagascar and collecting data on the ground. Special thanks go to Gregoire Marie Flora Raminosoa, a local data collector, who stepped in on short notice to support the in local evaluation team with data collection, filling a much-needed role that was unexpected at the beginning of the assignment due to COVID-19.

Remote evaluations will always be a challenge to those far away, and this evaluation would not have been possible without these steady and patient hands.

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ACRONYMS

Acronym	Definition
ACCESS	Accessible Continuum of Care and Essential Services Sustained
ACM	*Aviation Civile de Madagascar* (Civil Aviation Authority of Madagascar)
AM	Aerial Metric
ATC	Air Traffic Control
BVLOS	Beyond Visual Line of Sight
CA	Cooperative Agreement
CHV	Community Health Volunteers
CO	Contracting Officer
COP	Chief of Party
COR	Contracting Officer Representative
COVID-19	Coronavirus Disease 2019
CSB	*Centre de Santé de Base* (Basic Health Center)
DEXIS	DEXIS Consulting Group
DHIS2	District Health Information Software 2
EQs	Evaluation Questions
FANOME	Non-Stop Financing for Medical Supplies
FCR	Findings-Conclusions-Recommendation
FP	Family planning
FRZ	Flight Restriction Zones
FSF	Flight Safety Foundation
GH EvaLS	Global Health Evaluation and Learning Support Activity
Global Fund	The Global Fund to Fight AIDS, TB, and Malaria
GOM	Government of Madagascar
HPN	Health, Population and Nutrition
ICAO	International Civil Aviation Organization
IMPACT	Improving Market Partnerships and Access to Commodities Together
IP	Implementing Partner
IR	Intermediate Results
ISG	Interagency Supply Chain Group
JARUS	The Joint Authorities for Rule-making on Unmanned Systems
KII	Key Informant Interview
KIs	Key informants
M&E	Monitoring and Evaluation
MCH	Maternal and child health
MCH	Maternal and Child Health
MDA	Market Development Approach
ME&A	formerly Mendez England & Associates

Acronym	Definition
MoPH	Ministry of Public Health
NGO	Nongovernmental Organization
PA	*Point d'Approvisionnement* (Supply Point)
PARC	*Point d'Approvisionnement Relais Communautaire* (Community Relay Supply Point)
PEPFAR	The President's Emergency Plan for AIDS Relief
PSI	Population Services International
RH	Reproductive health
RSOOs	Regional Safety Oversight Organizations
SALAMA	*Centrale d'Achat de Médicament Essentiels et de Matériel de Madagascar* (Madagascar National Sourcing for Essential Medicines and Equipment, National Medical Stores)
SC	Supply Chain
SGI	Small Group Interview
SOW	Scope of Work
SPS	Supply Point Supervisors
TB	Tuberculosis
TL	Team Lead
TOP	Take-off point
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UCP	*Unité de Coordination du Projet* (Project Coordination Unit)
UNICEF	United Nations Children's Fund
USD	United States dollars
USAID	United States Agency for International Development
WCS	Wildlife Conservation Society

EXECUTIVE SUMMARY

INTRODUCTION AND EVALUATION PURPOSE

The USAID/Madagascar Mission commissioned the Global Health Evaluation and Learning Support Activity (GH EvaLS) to conduct an evaluation of the Unmanned Aerial Vehicles (UAV) pilot activity used for last mile distribution of health commodities by the USAID-funded program Improving Market Partnerships and Access to Commodities Together (IMPACT). The evaluation team consisted of five members: Team Lead (TL), Wayne Stinson; Senior Drone Expert, Denise Soesilo; Local Evaluation Specialist, Dr. Jean Claude Randrianarisoa, Local Drone Specialist, Pierrot Ramanamandimby; and Local Data Collector, Gregoire Raminosoa. The evaluation took place from May to September 2021.

In late 2019, the five-year IMPACT project (2018-2023), managed by Population Services International (PSI) in Madagascar, began delivering health commodities by UAVs (commonly called drones) to rural sub-districts (communes) in Maroantsetra district in northeast Madagascar, targeted for UAV delivery services because they are very isolated and not accessible during rainy seasons or, in some cases, at any time during the year. This was a pilot activity intended to ensure consistent supply channels to remote areas, to reduce stockouts, and free community health workers from the time and opportunity costs of traveling by land and water to obtain supplies. The activity was designed as a pilot to test the drone as a means for achieving last mile distribution and to assess if operational and environmental challenges could be overcome.

The main purpose of this evaluation was to assess the efficiency and effectiveness of the UAV pilot phase in Maroantsetra district. More specifically, the evaluation would assess the extent that the demand for health commodities in the pilot study are serviced by the drone delivery system. The evaluation focused on the effectiveness of the drone delivery operating model under local environment, weather conditions, and other contextual factors; and to provide an assessment of current and projected costs and benefits of the drone delivery system, incorporating the investment needs to expand the pilot activity. Finally, the evaluation was also expected to assess successes, challenges, and lessons learned from the UAV pilot activity.

EVALUATION QUESTIONS (EQS)

USAID posed four questions for the team to consider:

EQ1. To what extent is the demand for health commodities in the pilot study area serviced by the drone delivery system?

EQ2. How effective is the drone delivery operating model under the local environment, weather conditions, and other contextual factors?

EQ3. What are the high-level requirements and investment needs to expand the pilot activity in high potential health areas that make the drone delivery system most efficient and sustainable?

EQ4. What are the successes, challenges, and lessons learned from the pilot activity in a development and health supply chain context?

EVALUATION METHODS

The evaluation team used a multi-method design that produced the information needed to answer the EQs. The methodology included a desk review of project documents, implementation records, and international reports; key informant interviews with policymakers, donors, implementing partners, and field-level respondents; small group interviews with Supply Points (*Points d'Approvisionnement* or PAs,) Aerial Metric drone pilots, and Community Health Volunteers; and direct observations.

In spite of COVID-related lockdowns, the team was able to conduct interviews remotely, review numerous documents, and send two local team members to the field for two weeks each to visit PAs,

observe and record activities, and conduct interviews. This was an unusual evaluation conducted in unusual times.

KEY FINDINGS

EQ1: The drone delivery system has fully met demand (defined as response to paid PA requests for approved commodities) with minimal delays and minimal or no stockouts. However, the drone could not reach communes beyond 100 kms from the take-off point.

EQ2: Drones show promise in effectively delivering health products from the district to hard-to-reach communes (where PAs are located). There are no or minimal stockouts, and requests for supplies are responded to within 24-72 hours. Drones are reliable to deliver vaccines to the communes, with satisfactory protection using ice and bubble wrap to ensure the cold chain.

EQ3: Several conditions for further expansion of the UAV operation were met. Regulatory permissions were secured, flight operations were demonstrated to be safe, and reliable and local stakeholders support the drone activity. Initial hypotheses for cost drivers and supply chain benefits were established. However, the national ownership and partnerships that are necessary are not yet in place, and they require attention and resources. Opportunities, furthermore, exist for greater efficiency.

EQ4: Working alongside each other, USAID/IMPACT and the Global Fund Innovation activity achieved successful UAV deliveries under difficult circumstances. Expanded implementation will benefit from greater efficiency and donor and government willingness to reduce administrative barriers.

The evaluation team concluded that drones work. USAID/IMPACT has shown that UAVs can deliver life-saving commodities to remote communities and free up health worker time for educational and patient care responsibilities. They overcome barriers of weather and technology and deliver preventive and curative medications to the lowest fixed level in the Madagascar health system. They meet recorded demand in a timely fashion, with minimal product damage, but so far without totally replacing traditional land-based logistics methods. Potential regulatory and safety issues have been avoided.

At approximately $317 per month per commune[1], drone services may seem relatively costly, but the costs of traditional methods (including possible hidden costs associated with stockouts) have not been fully evaluated. In any case, as a pilot project, USAID/IMPACT has focused on effectiveness rather than cost-reduction, but efficiency is increasing and likely to grow as administrative constraints are resolved.

Engagement at national levels – essential for expansion and for major new donor funding – has been slow to emerge, due both to COVID-19 and to inadequate reporting of achievements. As we complete this report, we have just learned that the Government of Madagascar has endorsed the use of drones for delivering COVID-19 vaccines.

CONCLUSIONS

The twin pilot projects supported by USAID/IMPACT and the Global Fund Innovation Challenge Fund have clearly demonstrated what is called the "**use-case**" for drone delivery in rural Madagascar. They have shown that **UAVs can overcome barriers** of infrastructure and weather to provide both routine and emergency supplies to remote communes and to eliminate stockouts. They have significantly reduced opportunity costs for rural managers and volunteers and reportedly increased public confidence in drug supply and quality. Health workers gain credibility when they have the products that the public expects; and they can devote more time to family care and health education when they do not have to spend up to four days a month traveling to district warehouses. These services have not been low cost, partly

[1] Based on high efficiency operations, i.e., 100 drone flights per month.

because pilot projects like these focus first on effectiveness; but costs per commune will decrease as more communes are served and more products delivered.

Over the period between October 2019 and May 2021, IMPACT successfully completed 376 flights, without any accidents. A few parachute drops were blown off target by high winds, but these incidents were rare and did not lead to significant safety issues or significant product damage or loss. These results are good in relation to similar activities elsewhere in Africa.

There are some caveats: UAVs were primarily used for one-way delivery of loads weighing up to 3.8 kgs within a 50 km distance from the district office, and only 2 kgs for greater distances up to 100 kms. (The Global Fund financing aimed to support two-way services – landing and returning from the drop point – but implementers were only able to do limited test flights in a few areas.)

As a pilot activity, the UAV effort was designed to maximize effectiveness rather than efficiency, but that emphasis is changing as services reach new service points and take on new commodities. The drone operation could have made five times as many flights as it actually did in the first 20 months, in what looks like underutilization of transport capacity and available human resources. However, because no precedent for these operations existed in Madagascar and with the chosen technology, operations needed to start carefully and increase incrementally. As noted in this evaluation, existing demand was fully satisfied but had to be limited to products supported by USAID and the Global Fund.

While supporting a "use-case" for drone delivery, USAID/IMPACT has **not yet developed a sustainability plan**, and has been unable to build a national coalition for UAV development or to identify champions within the MoPH. This failure was partly due to COVID-19 lockdowns but also – according to some KIs – due to inadequate presentation and discussion of results. Support is strong at the district and commune level, according to PAs and CSB chiefs, but national-level KIs stated clearly that the GOM could not take on the costs of UAV services. Future donor funding may require national leadership and "ownership," but they should not assume that the government can take on costs.

Pilot projects of this nature are usually not intended for research but rather for **problem resolution and demonstration**, hopefully leading to scaling up and replication. This implementation opened a new chapter for Madagascar's aviation. National leadership will be instrumental in paving the way for scale-up. Other countries, notably Rwanda, have had longer experience, with very strong national ownership. The ability of drones to carry vaccines with effective cold chain had not been tested before in Madagascar but was proven by AM with Global Fund funds. The only operational challenge not met was for delivery of mosquito nets (again, through the Global Fund); they are simply too heavy and bulky for UAV transport.

RECOMMENDATIONS

1. Pending fund availability, continue to support this phase of UAV development until the end of USAID/IMPACT, while setting measurable goals and monitoring closely for transition from a pilot project to an MoPH-owned national program.
2. USAID, MoPH, USAID/IMPACT, and Accessible Continuum of Care and Essential Services Sustained (ACCESS) should work together to increase efficiency by maximizing the use of existing UAVs, such as pooling all demand for UAV deliveries. In addition, the efficiency of UAV deliveries can further increase by reaching out and coordinating with other projects and donors, such as the Global Fund, GAVI, and private sector entities working on the supply of health commodities.
3. Costs can and should be reduced, by maximizing use of available UAV delivery capacity.
4. Develop a national strategy and build MoPH's "ownership" by finding and routinely informing national "champions" and engaging leadership in decision-making.
5. Work with the government and development partners, USAID/Madagascar should encourage competitive contracting of private sector logistics firms to provide a common UAV service cutting across multiple projects in the long term.

6. If so desired by ACM, USAID/Madagascar and development partners should encourage ACM to collaborate with international bodies concerned with drones and aviation safety, other civil aviation authorities, and international expert groups that can act as a peer reference group for the next iteration of drone regulations and to exchange lessons learned and best practices.

1. EVALUATION PURPOSE AND EVALUATION QUESTIONS

1.1 EVALUATION PURPOSE

The USAID/Madagascar Mission commissioned the Global Health Evaluation and Learning Support Activity (GH EvaLS) to conduct an evaluation of the Unmanned Aerial Vehicles (UAV) pilot activity used for last mile distribution of health commodities by the USAID-funded program Improving Market Partnerships and Access to Commodities Together (IMPACT).

In late 2019, the five-year IMPACT project (2018-2023), managed by Population Services International (PSI), began delivering health commodities by UAVs (commonly called drones) to rural sub-districts (communes) in Maroantsetra district in northeast Madagascar, prioritized because they are very isolated and not accessible throughout the year or during the rainy seasons. This was a pilot activity intended to ensure consistent supply channels to remote areas, to reduce stockouts, and to free community health workers from the time and opportunity costs of traveling by land and water to obtain supplies. The activity was designed as a pilot to test the drone as a means of achieving last mile distribution and to assess if operational and environmental challenges could be overcome.

The main purpose of this evaluation was to assess the efficiency and effectiveness of the UAV pilot phase in Maroantsetra district. More specifically, according to the Statement of Work (SOW) (see Annex 1), the evaluation would assess the extent that the demand for health commodities in the pilot study are serviced by the drone delivery system. The evaluation would focus on the effectiveness of the drone delivery operating model under the local environment, weather conditions, and other contextual factors; and it would provide an assessment of current and projected costs and benefits of the drone delivery system, incorporating the investment needs to expand the pilot activity. Finally, the evaluation was also expected to assess successes, challenges, and lessons learned from the UAV pilot activity.

1.2 EVALUATION QUESTIONS

The evaluation was guided by four evaluation questions (EQs):

EQ1. To what extent is the demand for health commodities in the pilot study area serviced by the drone delivery system?
EQ2. How effective is the drone delivery operating model under the local environment, weather conditions, and other contextual factors?
EQ3. What are the high-level requirements and investment needs to expand the pilot activity in high potential health areas that make the drone delivery system most efficient and sustainable?
EQ4. What are the successes, challenges, and lessons learned from the pilot activity in a development and health supply chain context?

1.3 EVALUATION AUDIENCES

The immediate audience for the evaluation report is the USAID/Madagascar Mission, specifically the Health, Population and Nutrition (HPN) team, and current and potential implementing partners (IPs). The broader audience includes local and international parties interested in the UAV technology and its potential application in remote geographic areas where traditional transportation may be poor or impossible. The international community has established the Interagency Supply Chain Group (ISG) to share experiences and lessons learned, and this report may be useful to them. The Global Fund against AIDS, Tuberculosis and Malaria (the Global Fund) has expressed interest in the findings, conclusions, and recommendations presented in this report. It is our hope that in addition to USAID/Madagascar and various IPs, this report will also serve a global audience.

2. BACKGROUND

2.1 IMPACT PROJECT BACKGROUND

USAID-funded IMPACT is a five-year Cooperative Agreement (CA), implemented by PSI in Madagascar, as the prime recipient. The project started in 2018 and is implementing activities in 13 regions, including hard-to-reach zones such as the districts of Maroantsetra, Antalaha, and Mananara where the UAV pilot was implemented. USAID/IMPACT supports the Government of Madagascar (GOM) to improve the capacity of the Malagasy health system to ensure that quality pharmaceuticals and health commodities are available and accessible to all Malagasy people on a sustainable basis.

IMPACT aims to ensure continuous availability of medicines and medical supplies, including malaria products at convenient and accessible locations. The prices must be affordable, and the system should enhance sustainability through partial cost-recovery[2]. The project covers family planning (FP), reproductive health (RH), maternal and child health (MCH), and malaria.

The public health system in rural Madagascar is supplemented by private and voluntary efforts as described below:

1. **Basic Health Centers** (*Centres de santé de base* or CSBs) are the lowest level of public health facility in Madagascar and are normally staffed by a small number of health professionals. They provide basic health services and distribute government-financed health products with a cost-recovery scheme. CSBs fall under the aegis of the District Health Office.
2. **Points d'Approvisionnement (Supply Points or PAs**[3]) are private sector shops which sell health and other products but do not provide services; they are staffed by shopkeepers rather than health professionals.
3. **Community Health Volunteers (CHVs)** operate at the community level. Although they are not health professionals, CHVs play an important role in providing health care services and health education to beneficiaries in remote villages. CHVs receive training from international and national health projects, and are supervised by CSB staff. CHVs are supplied by CSBs and PAs for their needs in selected health commodities.

Using the Total Market Approach (TMA) described in its CA, IMPACT has delivered supplies to both the private (PAs) and public sector (CSBs), using land- and water-based methods (prior to UAVs). A limited range of commodities was stored at district-level Community Relay Supply Points (*Points d'Approvisionnement Relais Communautaire* or PARCs). From there, PAs purchased products and took them to communes. IMPACT provided a voucher which covered transportation costs but did not compensate for the two to four days that frequently had to be taken off from paid employment each month. As the final step, CHVs procured products from the PA to sell to villagers.

This system had several problems, which UAVs (or drones) were intended to overcome. Aside from the opportunity cost burden on PAs, the system was inflexible and sometimes dangerous. Travel from distant communes was often difficult, especially during inclement weather. Delivery delays and incorrect demand forecasting led to stockouts at the PA level,[4] which could only be resolved the next time someone traveled to Maroantsetra.

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[2] Currently, malaria treatment and testing is supported by the Global Fund and USAID, and are available for free to the beneficiaries.

[3] PAs usually are run by one shopkeeper/owner. In this report, depending on the context, PA refers either to the shop (supply center) or to the shopkeeper/owner as an individual (i.e., key informant).

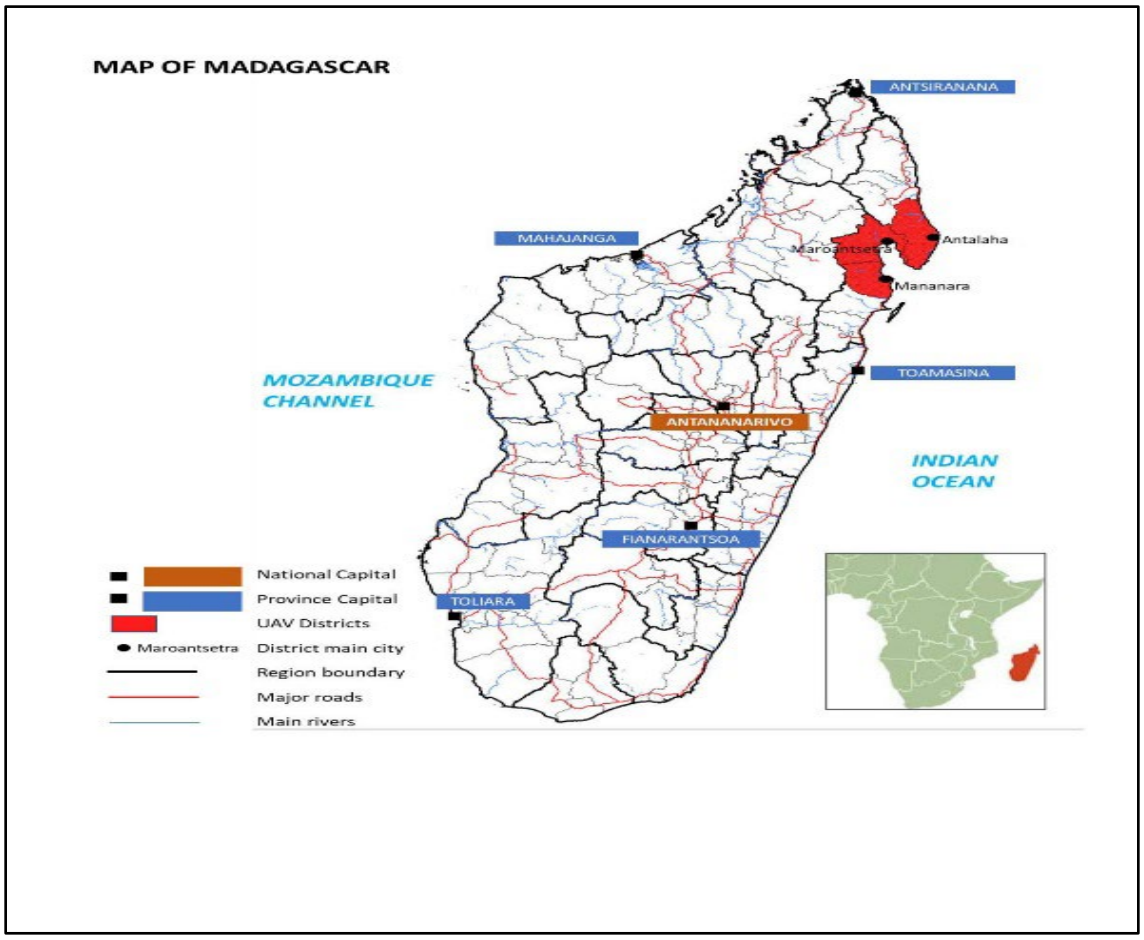
[4] SOW, Annex 1.

The introduction of drones in 2019 delivered supplies directly to PAs and eliminated the need to travel for supplies. As described below, there were two drone activities in Maroantsetra during 2019-21, one supported by USAID (the pilot project evaluated here) and the other supported by the Global Fund Innovation Challenge account (described here when relevant for comparison). Both drone projects were implemented by PSI using Aerial Metric (AM) as the drone operator.

2.2 UAV PILOT PROJECT (USAID/IMPACT)

To reduce PA stockouts, starting in October 2019 and continuing to the present, IMPACT deployed one drone on a pilot basis to test product deliveries in the selected pilot area – Maroantsetra, Mananara, and Antalaha districts (Figure 1). The UAV base was in Maroantsetra town. For implementation, IMPACT sub-contracted the provision of drones and services to AM, the only drone service provider authorized by the Civil Aviation of Madagascar (ACM) to operate drones in health product deliveries. IMPACT rented UAV services from AM on a fixed-cost monthly lease, an arrangement which continues.[5]

Figure 1: Map of Madagascar



The three target districts are located in northeast Madagascar and were chosen for the pilot phase because they are enclaved and, due to accessibility issues, there are insufficient health products in some PAs for the local population. Within the districts, some of the communes can be reached by pirogue and motorbike, while others are very hard to reach. Road transportation, if it exists, is further hampered by

[5] AM is a private French/Malagasy international company created in 2010. AM is working in surveying and mapping; emergency relief; and health system strengthening, which includes drone delivery of health products in remote communes.

intense rains. Maroantsetra, Mananara, and Antalaha meet the conditions required for challenges in terms of accessibility and difficulty when using drone (mountainous field, existence of rivers, rainy region, etc.).

The USAID/IMPACT drone has served 36 communes, as listed in Table 1 below: 19 in Maroantsetra, ten in Mananara, and seven in Antalaha.[6]

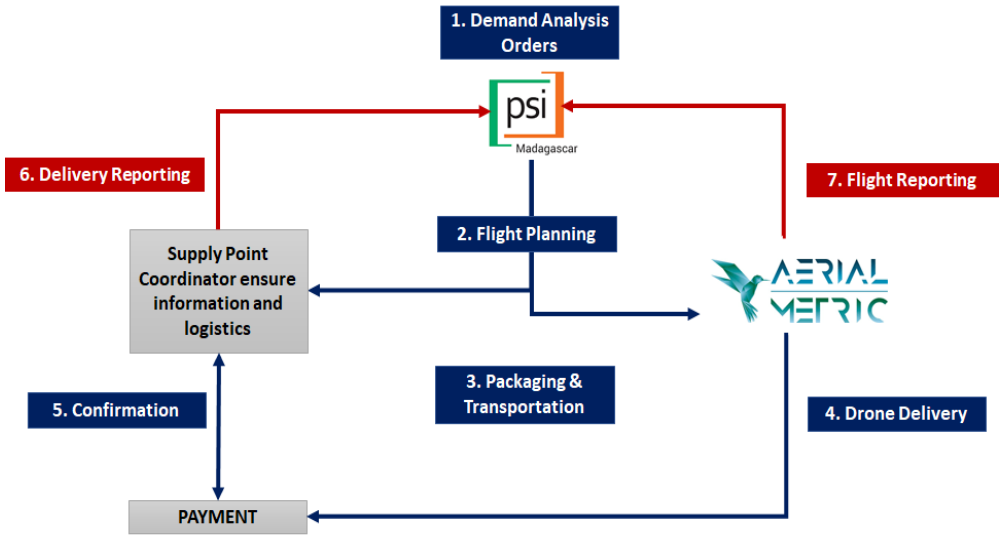
Table 1: Regions, Districts, and Communes Served by the USAID/IMPACT Drone Pilot

Regions	Districts	Communes		
Analanjirofo	Maroantsetra	Ambanizana Ambinanitelo Ambodimanga Anandrivola Andranofotsy Andranofotsy Anjahana	Rantabe Anjanazana Ankofa Ankofabe Antakoako Antsirabe Sahatany Mahalevona	Manambolo Mariarano Morafeno Rantabe Sahasindro Voloina
Analanjirofo	Mananara	Ambodiampampana Ambodivoanjo Analampotsy Andasibe	Antanambaobe Antananivo Imorona	Mahanoro Manambolosy Vanono
SAVA	Antalaha	Ambalabe Ambohitralanana Ampanavoana	Andampy Antananambo	Marofinaritra Vinanivao

Figure 2 below illustrates the steps involved in the drone delivery. Orders for USAID/IMPACT are initiated by PAs (Step 1), reflecting both health need and in some cases ability to pay, as some PAs may be constrained by their financial capacity to acquire the products. PAs consolidate the requests from CHVs. PAs then forward paid requests to the Supply Point Supervisors (SPS) in Maroantsetra who, along with the drone project coordinator, analyze the demand, organize the itinerary and flight plans, and send the schedule to AM (Step 2). The SPS prepares packaging (Step 3) and moves the products from storage units to the AM takeoff point (TOP), and informs the PA about the delivery schedule. Finally, AM drone pilots carry the products to the PA (Step 4). The financial flow remains the same as in the traditional delivery method, i.e., the PA pays the SPS for the ordered products, and must confirm reception of the package by phone or SMS to SPS (Step 5). IMPACT registers the delivery report with AM (Steps 6 and 7).

[6] Note that the Maroantsetra town did not require services and that Androndrona was dropped after one delivery because of communication challenges. In addition, only seven of 16 communes in Antalaha and 10 of 15 communes in Mananara could be reached from the drone base in Maroantsetra.

Figure 2: Process of Drone Delivery, USAID/IMPACT



Source: USAID/IMPACT

2.3 THE GLOBAL FUND INNOVATION PROJECT

For purposes of comparison, the evaluation team also reviewed drone activities financed by the Global Fund Innovation Challenge between July 2020 and March 2021. In contrast to the USAID's focus on private PAs, this activity delivered supplies to 27 public sector CSBs (20 in Maroantsetra, six in Mananara, and one in Toamasina). The Global Fund supported leasing of six drones for this activity, also from AM.

The approach used by the public supply chain differs from the USAID/IMPACT supply chain. Commodities procured by government are managed by Madagascar National Store for Essential Medicines and Equipment (*Centrale d'Achat de Médicament Essentiels et de Matériel de Madagascar* or *SALAMA*) and move directly to the district warehouse in Maroantsetra (Pha-G-Dis) from the SALAMA main warehouse in Antananarivo.[7] In Maroantsetra, the two supply chains use the same drone operator (AM) and process to deliver the products to the communes, but with different recipients (PAs and CSBs). Drones financed by the two donors are all stored at a single TOP.

The evaluation team did not evaluate the Global Fund drone activity. However, the USAID/IMPACT and Global Fund activities overlapped for a substantial period of time and benefited from their joint presence. The evaluation team reviewed the Global Fund drone activities to assess if there were any significant differences in how the Global Fund drones operated compared to the USAID/IMPACT drones in terms of logistics, cost, efficiency of geographic coverage, and other activity components.

2.4 COMMODITIES DELIVERED

Table 2[8] shows the supplies delivered by USAID/IMPACT's drone and by the Global Fund drones. The IMPACT drone transported contraceptives, MCH supplies, and water treatment tablets. Until project termination, Global Fund drones carried malaria supplies, emergency obstetrical medicines, family planning products, and vaccines.

[7] The evaluation team noted that Pha-G-Dis seemed larger and better organized than PARC (see Annex I photos).
[8] Table 2 also shows supplies delivered by the Global Fund (see Section 2.3 for more details).

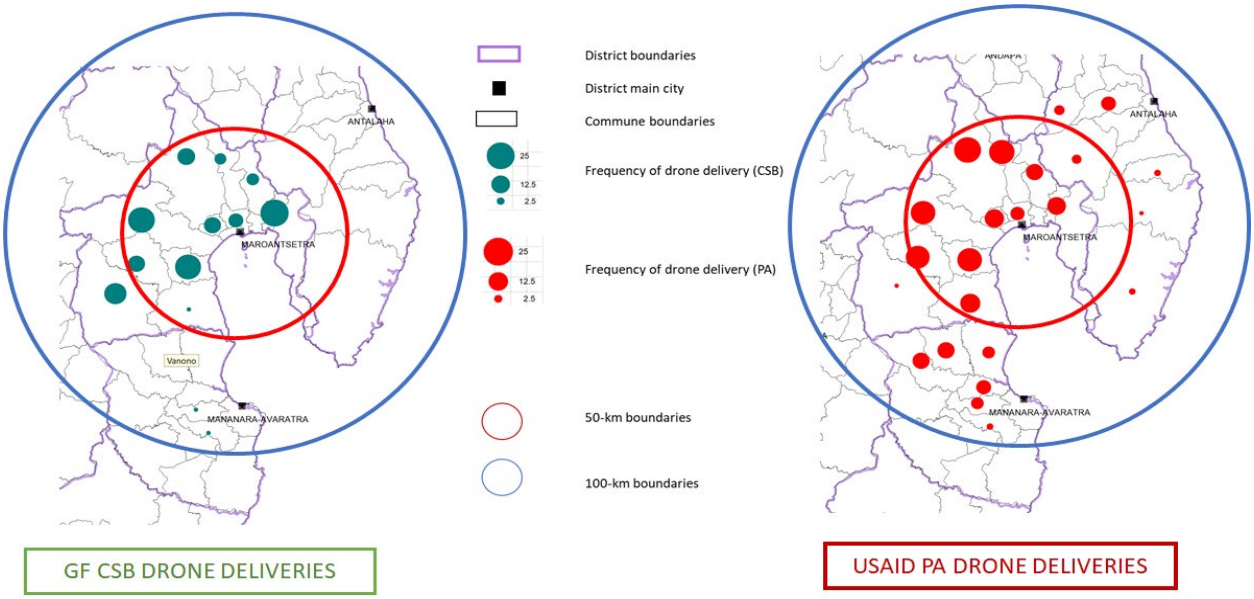
Table 2: List of Products Delivered by Drones, USAID/IMPACT and the Global Fund

Products Delivered by Drones	IMPACT	GLOBAL FUND
FAMILY PLANNING		
Oral contraceptive: Zinia F, Combination 3, Microgynon	X	X
Injectable contraceptive: Triclofem, Sayanna press	X	X
Rojo & male condoms	X	
MATERNAL, NEONATAL, AND CHILD HEALTH		
Pneumox	X	
Arofoitra/Chlorexidine	X	
ORS/Zinc	X	X
WATER PURIFICATION		
Sureau pills	X	
MALARIA		
Kit Rapid diagnostic test		X
ACT, SP, Artesun injectable		X
SAFE MATERNITY CARE		
Oxytocin injectable, Misoprostol		X
Chlorhexidine Gluconate		X
Gentamicine injectable		X
VACCINES		
Oral & injectable polio vaccine		X
Diphtheria, Pertussis, and Anti-Tetanus		X
Pneumococcal vaccine		X
Measles, BCG, Rotarix vaccines		X

Source: USAID/IMPACT

Figure 3 shows the destinations and frequencies to which the two drone systems provided supplies. Most went to communes within a 50-km radius from the TOP, although all areas served in Mananara and Antalaha were more distant. The number of IMPACT deliveries to PAs exceeds Global Fund deliveries to CSBs, because the latter ran for only nine months rather than 20.

Figure 3: Districts and Communes and Frequency of Drone Delivery



Source: USAID/IMPACT Flight Data

Note that virtually all communes in Mananara and Antalaha were more than 50 kms from the TOP in Maroantsetra, significantly affecting flight operations.

3. EVALUATION METHODS AND LIMITATIONS

3.1 EVALUATION METHODOLOGY

The evaluation team was composed of five members: Team Lead (TL) Wayne Stinson; Senior Drone Expert, Denise Soesilo; Local Evaluation Specialist, Dr. Jean Claude Randrianarisoa; Local Drone Specialist, Pierrot Ramanamandimby; and Local Data Collector, Gregoire Raminosoa. The evaluation took place from May to September 2021.

The evaluation team used a multi-method design that produced the information needed to answer the EQs. The methodology included a desk review of project documents, implementation records, and international reports; key informant interviews (KIIs) with policymakers, donors, IPs, and field-level respondents; small group interviews (SGIs) with PAs, AM drone pilots, and CHVs; and direct observations.

As mentioned earlier, although the evaluation team did not evaluate the Global Fund drone activity per se, they reviewed their activities in order to assess if there were any significant differences in how the Global Fund drones operated compared to the USAID/IMPACT drones in terms of logistics, cost, efficiency of geographic coverage, and other activity components.

3.2 DATA SOURCES

The main sources of data for this evaluation are described in detail below.

3.2.1 Document and Secondary Data Review

The evaluation team reviewed reports and documents from various sources, including PSI/Madagascar, AM, Aviation Civile de Madagascar (ACM), and the Ministry of Public Health (MoPH). PSI provided annual

reports, background project documents for IMPACT, information on the structure and organization of the drone pilot project, bi-weekly schedule for drone activities, and reports on supply chain (SC) activities.

AM, the drone operator, provided technical data on the drones and flights, incidents during the pilot projects, and drone characteristics. Both ACM and MoPH provided links to policy and regulation documents on their respective websites. Other documents from web searches include experiences on the design and use of drones in other countries. The desk review was conducted by all evaluation team members. A list of the reviewed documents, reports, and websites is presented in Annex 3.

3.2.2 Key Informant and Small Group Interviews

The evaluation team developed a list of key informants (KIs) to participate in the evaluation in close collaboration with USAID/Madagascar. The KIs were divided into three categories based on type of respondent: (a) national-policymakers and representatives from international organizations; (b) implementing partners (IPs); and (c) field-level respondents. For each category, the evaluation team developed interview guides in English (Annex 2) which were translated into Malagasy and French after getting approval from USAID. Most of the KIIs were conducted in Malagasy, except for a few with foreign respondents from international organizations and private companies that were conducted in English.

For national-policymakers and representatives from international organizations, the KII guide focused on the roles of entities and respondents in the design and operations of the pilot drone project, the performance of the project, the potential use of drones, and prospects for scaling-up. For IPs, the KII guide includes detailed questions on the operations and the participation of stakeholders in the drone pilot project, the success, and the challenges of the project. The KII guide for the field respondents includes more questions on the effectiveness of the pilot project, the constraints encountered, and the need for improvement.

SGIs targeted PAs, AM drone pilots, and CHVs in Maroantsetra. The SGI interviews used the same guides as the KIIs and were conducted in Malagasy.

In total, the evaluation team conducted KIIs and SGIs with 44 respondents: 12 from national-level organizations, IPs, and international organizations; and 32 from the field (Maroantsetra). Each SGI had several respondents and was aimed at gathering information through a discussion format with PAs and CHVs.

Evaluation team members visited two communes in Maroantsetra - Manambolo, and Voloina - and conducted KIIs at the respondents' locations. For three other communes, Ankofabe, Morafeno, and Rantabe, the respondents were invited to go to Maroantsetra where KIIs and SGIs took place. An IMPACT workshop with all PAs in Maroantsetra during the field work presented an opportunity for one additional SGI with six PAs from different communes (Anjahana, Antakotako, Mahalevona, Anandrivola, Sasindro, and Mariarano).

Table 3 presents the number of respondents who participated in KIIs and SGIs by stakeholder group and location. A full list of the KII and SGI respondents is shown in Annex 3.

Table 3: Number of Respondents who Participated in the KIIs and SGIs, by Stakeholder Group and Location

Stakeholder	National-Level Organizations, Implementing Partners, and International Organizations	Maroantsetra	Total
PSI	4	2	**6**
AM	1	3	**4**
MoPH (including CSB chiefs)	3	6	**9**
ACM	1		**1**
PAs		11	**11**
CHVs		10	**10**
International Organizations	3		**3**
Total	**12**	**32**	**44**

3.2.3 Direct Observations

For direct observations, two evaluation team members traveled to the communes of Manambolo and Voloina to watch the behavior of the population near the drop-off sites during drone deliveries, as well as the process used by PAs for filling out checklists. The field team observed two drones dropping off health commodities, two storage facilities at PAs, one PARC warehouse, the drone TOP, and the AM office. The team recorded videos of drones delivering health commodities and took pictures of the drones at the TOP, at the commune storage facilities, and in the PSI district warehouse.

3.3 SAMPLE SELECTION

The KIs from the national-level and international organizations and IPs were selected based on their position within the health system in Madagascar and/or their participation and experience in the implementation of the pilot drone project in Maroantsetra. These KIs are mostly from the MoPH, PSI, the drone service provider AM, ACM, USAID, and the Global Fund and UNICEF (the United Nations Children Fund).

Sample selection of communes in Maroantsetra for the field KIIs and observations started with the list of all communes where the pilot drone project was implemented, obtained from PSI. In total, there are 21 communes in the district of Maroantsetra, of which 19 are served by the drone pilot project (see Table 1 in Section 2.2 above). The two exceptions are the urban commune of Maroantsetra and the rural commune of Androndrona, which is over 100 km from Maroantsetra and without access to a telephone network. For the commune of Androndrona, the drone pilot project conducted only one flight for testing and decided to stop delivery to that commune. Data provided by PSI included: the commune's name, location, means and costs of transportation, quality of phone network and internet, the existence of drone delivery to CSBs and PAs, and the name and gender of the PAs.

The evaluation team used this information to determine criteria for purposively selecting the communes and PAs[9] for this evaluation. The selected sample is shown below.

- **Two PAs** less than 50 flight kilometers of the drone TOP (Voloina and Ankofabe)
- **Two PAs** within 50 to 100 kilometers distance from the drone TOP (Morafeno and Rantabe)
- **One PA** with good land or water access to Maroantsetra town, in addition to the drone service (Manambolo)
- **Gender Balance:** Two female and three male PAs

At **each PA,** the evaluation team requested a list of affiliated **CHVs**, from which the team randomly selected one woman and one man for the in-depth interview (for a total of 10 CHVs). To get more information on the Global Fund drone project, the team interviewed **the chiefs of the affiliated CSBs** within the five selected communes.

The evaluation team visited two communes in Maroantsetra - Manambolo, and Voloina - where they interviewed the PAs, the CSB chiefs, and the CHVs from surrounding villages, and also observed the drone delivery. Pictures and videos were recorded during the dropping-off of the health commodities. For the other three communes that could not be visited - Ankofabe, Morafeno, and Rantabe - PAs, CHVs, and CSB chiefs were invited to Maroantsetra to be interviewed. CHVs were divided into two small groups for SGIs. During the team's visit in Maroantsetra, IMPACT was conducting a PA training and they took the opportunity to conduct an SGI with the six PAs that attended the training. The PAs came from six communes: Anjahana, Antakotako, Mahalevona, Anandrivola, Sasindro, and Mariarano.

For the KIIs and field observations, the evaluation team had to replace the commune of Ankofabe with the commune of Voloina due to a change in the drone delivery schedule.

The selection of the KIIs at the national level was followed by a snowball sampling process, where the first round of selected KIIs helped identify other respondents that could be of interest for the evaluation.

3.4 DATA MANAGEMENT AND ANALYSIS

The evaluation team used a series of tools for analysis of the KIIs, SGIs, observations, and other existing sources. They first collated information across the data sources and analyzed the material by EQ. During data analysis and triangulation, the evaluation team developed a running list of emerging themes that provided the basis for the thematic content analysis and the findings by EQ. Evaluation team members first compiled key findings and conclusions individually and then compared, contrasted, discussed, and validated them against the findings of the rest of the team, to arrive at a consolidated agreed-upon set of findings.

The team triangulated the findings from each data source into a Findings-Conclusions-Recommendation (FCR) matrix to highlight the relevant conclusions and recommendations by EQ, which ensures a clear line of sight from conclusions and recommendations back to the supporting findings.

The evaluation team gave a presentation of the preliminary findings to the USAID/Madagascar Mission team, later followed by a presentation to the PSI/Madagascar team. Feedback from both presentations has been incorporated into the report.

3.5 LIMITATIONS

This evaluation took place during the COVID-19 pandemic, which prevented international travel to Madagascar and caused some delays in local travel to project sites in Maroantsetra. Three members of the team were in Madagascar and two overseas, in the United States and Switzerland, and they held regular online meetings. Malagasy team members who traveled to Maroantsetra for the evaluation followed strict guidelines in regard to personal protective equipment and social distancing. The evaluation team

[9] PAs usually are run by one shopkeeper/owner; here we refer to the shopkeeper/owner of the PA.

conducted the majority of KIIs with representatives from national-level and international organizations virtually, using broadly-used platforms such as Zoom, Teams, or Google Hangout. While virtual interviewing has been intensively used during the COVID-19 pandemic and is a viable alternative, it can be very formal and hard to probe. Face-to-face interviews and consultations would have made it easier for the respondents to share opinions and views more freely. For evaluation team members who couldn't travel to Madagascar, this was a lost opportunity to see and appreciate the strengths and challenges of the drone pilot activity on the ground.

The IMPACT drone pilot was one of two such efforts occurring in Maroantsetra during this time (the other was supported by the Global Fund Innovation account), and respondents sometimes mixed the two in their interviews. When this occurred, the evaluation team member clarified again the scope of the evaluation. Even when the conceptual distinction was clear, the operational one was not: the two activities were synergistic, with overlapping staff and facilities. For example, the end of the Global Fund funding may have affected the perception of respondents on the performance of IMPACT's pilot project. The evaluation team is confident in findings for the USAID-supported pilot drone activities, but cannot know the degree to which they might have been affected by the Global Fund drone activity.

The qualitative methodology is based on the perceptions of informants and their understanding at the time of the evaluation and is prone to "recall and halo bias." Recall bias was mitigated by focusing on the respondents' current experience with the drones. The halo bias, that is, informants giving a positive response meant to please, was mitigated by explaining to the informants that their comments were confidential and their identity would not be revealed.

The team could access only limited cost data for this evaluation, although crucial data pertaining to monthly leasing expenses were obtained from AM and PSI/Madagascar. Accounts from the IMPACT project did not distinguish start-up from routine costs, limiting the team's ability to estimate requirements for any future expansion of the drone operations.

In order to ensure a comprehensive evaluation, the evaluation team triangulated the qualitative data with data from direct observations, project and other relevant documents, and other existing sources provided to the evaluation team. Data triangulation strengthened the evaluation team's ability to reach concrete findings. The evaluation team believes that the robustness of the evaluation methods allows it to present valid findings, conclusions, and recommendations.

3.6 ETHICAL CONSIDERATIONS

In-person and group interviews conformed to the local COVID-19 guidelines, including social distancing rules.

The evaluation team ensured privacy and confidentiality in all data collection. All KIIs conducted during the evaluation began with an informed consent process and written documentation (see consent statement elements listed below), in alignment with the Common Federal Policy for Protection of Human Subjects in Research (the Common Rule) adopted by USAID.[10]

- Introduction of facilitator/note-taker
- Purpose of the evaluation
- Purpose of the interview
- Statement that all information provided is confidential and information provided will not be connected to the individual
- Right to refuse to answer questions or participate in interview and right to stop interview at any time

[10] See Annex 2 for the data collection tools.

- Request for consent prior to initiating data collection (i.e., interview).
- No one under the age of 18 years was interviewed or participated in the evaluation.

Data were analyzed without any identifying information. The citations in this report do not include any names of the person who was quoted; the confidentiality of the respondents is maintained by pooling and citing all input by stakeholder group and by anonymizing any quotations. To protect confidentiality, the interview notes, extraction forms, and recordings are saved in a safe folder within GH EvaLS and will be deidentified when the report is completed.

> *"Before the drone system, the demand from CHVs must wait for our availability to go and get the health products from Maroantsetra. Now with the drones, we can order products anytime and the products are delivered within three days at the commune. Drone deliveries have significantly reduced stockouts, without the need to overstock."* – PA KI in Maroantsetra

4. FINDINGS

4.1 EQ1. TO WHAT EXTENT IS THE DEMAND FOR HEALTH COMMODITIES IN THE PILOT STUDY AREA SERVICED BY THE DRONE DELIVERY SYSTEM?

KEY FINDING: The drone delivery system has fully met demand, defined as response to paid PA requests for approved commodities, with minimal delays and minimal or no stockouts. However, the drone could not reach communes beyond 100 kms from the TOP.

Finding 1.1: The drone pilot project met the demand from the PAs.

Between October 2019 and May 2021, the IMPACT/USAID project conducted 376[11] flights to 36 communes in three target districts – Maroantsetra, Mananara, and Antalaha. Looking at distance, 50 percent (18 of 36) of the communes (all in Maroantsetra) were less than 50 kms from the TOP (with an average distance of 22.3 kms). However, 73.2 percent of the flights went to these destinations, while 26.8 percent went to those more than 50 kms from TOP (with an average distance of 72.3 km, see Table 4).

According to PSI and AM flight data, 99 percent of the supplies requested for short-distance flights and 96 percent for long-distance flights were effectively delivered. All the interviewed PAs reported satisfaction with the performance of the delivery services provided by drones.

The findings from the analysis of flight data are further supported by the information from KIIs and SGIs with 11 PAs in Maroantsetra. The informants reported that drones were effective in delivering products from PARC to PA, through SPS,[12] virtually eliminating stockouts because of the quick response and delivery. Analysis of records from five PAs reviewed during fieldwork revealed very low stockouts for tracer drugs.[13] All informants in the six KIIs and SGIs with PAs confirmed that orders were fulfilled in less than 72 hours, including last-minute requests.

Similarly, the Global Fund drones that provided health commodities to Basic Health Centers (*Centres de Santé de Base* or CSBs), also responded successfully to requests. Almost 97 percent of both short- and long-distance requests were satisfied (see bottom panel of Table 4). During its period of operation, July

[11] Average of 375 and 377 flights, which are shown divergently in the flight data.
[12] SPS receives the requests from PAs, then gets the products from PARC and brings the products to AM at the take-off point for delivery to PAs.
[13] Stockouts are measured using tracer drugs, which are representative of essential medicines that PAs must have in stock all the time.

2020 to March 2021, 23614 Global Fund flights transported 355 kg of health products and vaccines to 26 CSBs. Overall, 97 percent of the Global Fund flights served the Maroantsetra district, with virtually no service to the two outlying districts. The Global Fund innovation activity also demonstrated capacity to deliver vaccines, using ice and insulated bubble wraps, delivering 38,049 vaccine doses to CSBs within the 9-month implementation period10 (see Table 2 in Section 2.4).

Table 4: Effectiveness of Drone Delivery for USAID/IMPACT and the Global Fund Drones

	% of Flights	Average distance (in km)	Ratio Delivered/ Ordered	Average weight (kg/flight)
PAs (IMPACT)				
Distance from TOP				
Less than 50 km	73.2%	22.3	99.0%	2.10
More than 50 km	26.8%	72.3	96.0%	1.63
District				
Antalaha	6.4%	70.1	100.0%	1.63
Mananara	15.8%	79.5	92.3%	1.44
Maroantsetra	77.8%	23.9	99.1%	2.12
Total	**100.0%**	**35.7**	**98.2%**	**1.98**
CSBs (The Global Fund)				
Distance				
Less than 50 km	80.1%	22.0	96.6%	1.46
More than 50 km	19.9%	61.0	96.7%	1.66
District				
Mananara	3.0%	89.3	100.0%	1.22
Maroantsetra	97.0%	27.1	96.6%	1.51
Total	**100.0%**	**28.3**	**96.7%**	**1.50**

Source: PSI and AM Flight Data

Finding 1.2: Responding to demands from farther locations, over 50 kms from the TOP, is more challenging, but still successful.

Findings show that it is more challenging to respond to demand in communes beyond 50 kms from the TOP than the nearby ones. AM is usually able to reach the far-away communes with some modifications on the drone equipment – as reported by the KIIs with drone pilots and AM managers. AM has considered additional criteria for the longer flights, such as the capacity of the battery to be able to get back to the TOP after a long flight, the weight, the volume and shape of the container rack (as heavier and bulkier drones consume more power), and the changing weather conditions.

IMPACT recorded load weight for both short- and long-distance flights, although in fact volume (un-recorded) was more of an operational constraint than weight. AM designed the loading racks differently and condensed volume for long distances, by using two separate aerodynamic capsules of 2 liter-capacity each – in contrast to the 12-liter capacity, flat box shaped rack, for short-distance flights (See picture 7 in

[14] Final Report, September 2019-April 2021, Innovation Challenge Fund – Investment case for the use of Unmanned Aerial Vehicle (UAV) for malaria prevention in Madagascar. PSI 2021

Annex 1). KIs with AM and PSI emphasized the fact that volume is critical because health products are often put in blisters, with several layers of wrap to protect against damage during the flight and drop-off.

Weight did not constrain the flights, since all payloads were well below the ceiling for this type of drone. Thus, volume of the package rather than weight, restricts the total amount that the drone carried. However, because package weight is a far more convenient measure to track, this drone pilot project in line with emerging best practices in the industry, uses package weight as an indicator. Data show that the average weight carried per flight was 2.1 kg for flights less than 50 kms and 1.63 kg for flights over 50 kms from the TOP. The difference in terms of weight is not substantial (22 percent less for long-distance flights) compared to the difference in volume (4 liters vs. 12 liters, respectively for long- and short-distance flights) (See picture 11 in Annex 1).

Flights over 100 kms (one-way) from the TOP remain challenging, and a distance of 200 kms round-trip would be the recommended maximum distance that can be reached with the current equipment. IMPACT tested long-distance delivery of health products only once, to the commune of Androndrona, and then stopped deliveries to that commune. During KIIs, the drone pilots reported that drones consume more power if facing strong headwind and crosswind, and the wind speed and direction are more likely to change in the course of longer flights. The lack of a communication network adds to the technical problems.

The KII with the AM Manager revealed that the drone used in Maroantsetra has one of the best available batteries in the market. Still, there are limitations to the type of drones used by the project, and the evaluation team suggests some solutions later in the report (see Section 4: Findings).

Finding 1.3: Good communication is critical to the use of drone services.

Communication Infrastructure: According to KIIs with AM drone pilots and PSI staff, the drone system requires reliable communication between IMPACT local staff, AM, and PAs, in order to effectively respond to PA demands. The critical communication steps that necessitate phone access (calls or messages) include: (i) PAs communicating their requirements to SPS, who in turn validates the requests, collects the products from PARC, and brings the approved products to AM TOP (ii) IMPACT and AM informing PAs about the delivery schedule and the contents of the packages, and (iii) PAs confirming receipt of the supplies delivered by drones.

Phone networks and internet are available in most communes in Maroantsetra, except in the commune of Androndrona, which is more than 100 kms from the drone TOP. This infrastructure gap was one of the reasons that the drone delivery system could not respond to the demand for health products from this commune. As previously mentioned, this commune was dropped from drone service after one delivery.

The lack of access to the phone network is the main obstacle to the direct delivery of products from the district warehouse to the village CHVs. The great majority of CHVs (80-85 percent) work within a half day's walk from the drop-off points in the communes. A few KIs from the MoPH and IMPACT project staff suggested that in some cases, it may be better to bypass PAs and CSBs, and move the supplies directly from the district warehouse to the villages. This way, CHVs do not spend substantial time to travel to the communes to get the supplies. In order to achieve direct delivery to CHVs, the phone network would need to be in place to allow for the communication steps outlined above.

Raising Awareness in Communities: IMPACT relies on good communication for the pre-project briefing and providing updates to the communities. KIs at the local level reported informative briefings at the project onset, leading to a better understanding and awareness of health products to be distributed by IMPACT and also ensuring their high quality. During the KIIs, a few PAs and CHVs reported that there was a slight increase in the use of health services by CHVs due to their assurance of the quality of products delivered by the project, in contrast to the unknown products sold by illegal sellers in their communities.

> *"Our customers started to be more confident on the quality of the health products from PAs as they see that these are drugs supplied by drones, thus from reliable sources. They can make clear distinctions from other drugs distributed by informal sellers, which could be fake"* – CHV KI in Maroantsetra

Finding 1.4: Due to donor restrictions, not all important health commodities, such as essential drugs and vaccines, were delivered by drones.

Although this evaluation focused on the use of the drones by IMPACT, the team also gathered information on the demand from CSBs that are supplied by the Global Fund. Some of the interviewed CSB chiefs complained about restrictions in the list of products eligible for drone delivery. This is an important finding as IMPACT will soon phase out the supply chain involving PAs and move toward integrating the public supply chain involving CSB chiefs. KIIs with CSB chiefs revealed that demands for supplies to be delivered by drones are limited by donor funding constraints. Funds from the Global Fund, for example, can only be used to deliver health commodities related to malaria, MCH, FP, and vaccines. Deliveries to CSBs ended when the Global Fund project came to a close. Five CSB chiefs reported that they no longer received health products through drones. They also reported dissatisfaction with the supply restrictions; the Global Fund drones did not deliver essential drugs such as paracetamol, diclofenac, or cotrimoxazole, as they are outside the list of commodities funded by the Global Fund.[15]

However, the drone delivered vaccines to CSBs[16] even though vaccines are not part of either USAID or the Global Fund lists of health commodities. The purpose of the vaccine delivery was to prove the concept of cold chain transportation with UAV, and was made possible because vaccines are free, i.e., no flow of cash in the supply chain.

These missed opportunities to respond to the needs of the communities have resulted in a low use of the drones. According to AM and PSI, one drone can theoretically do up to 100 flights per month or 3-5 flights per day, with the current lease-based business model. So far, the actual implementation has been below the frequency threshold; the maximum number of flights per month was in May 2021, at 63 flights (Figure 3). Flight data show that monthly flight volume increased continuously and incrementally as the project gained confidence and experience. Flight data further show that a plateau was not yet reached by May 2021, the last month of this evaluation. Demonstrating the operation at full theoretical capacity at the rate of performance increase would have taken several more months. It is noted however, that demand from PAs in the region for the commodities covered is not sufficient to utilize the drone at its full capacity as discussed in later sections of this report.

4.2 EQ2. HOW EFFECTIVE IS THE DRONE DELIVERY OPERATING MODEL UNDER THE LOCAL ENVIRONMENTAL, WEATHER, AND OTHER CONTEXTUAL CONSTRAINTS?

KEY FINDING: Drones show promise in effectively delivering health products from the district to hard-to-reach communes (where PAs are located). There are no or minimal stockouts and requests for supplies

[15] PAs did not receive these essential drugs from the IMPACT drone, as they are only distributed by SALAMA and not PARC (which is managed by IMPACT).
[16] Vaccine injections can only be administered by health professionals at CSBs.

are responded to within 24-72 hours. Drones are reliable to deliver vaccines to the communes, with satisfactory protection using ice and bubble wrap to ensure the cold chain. Opportunities, nevertheless, exist for greater efficiency.

Finding 2.1: The drone system performed consistently and safely in the local environmental and weather conditions in Maroantsetra.

Drone deliveries were proven effective for one-way delivery flights within 100 kms of the TOP. According to reviewed documents and flight data, the IMPACT drone pilot project conducted 376 return flights within the 20-month pilot period, with only 19 incidents[17] recorded and no accidents. Incidents are occurrences other than an accident, associated with the operation of an aircraft, which affect or could affect the safety of the operation. As opposed to accidents, incidents do not involve physical harm to persons or major damage to objects and infrastructure.

Examples of incidents in the context of IMPACT operations were mainly limited to damage of delivered products (14 incidents in total). In one example, the box that contained health commodities dropped too early, a few kilometers from the TOP, the motor was damaged and the drone had to return to the TOP (Incident Report written on October 9, 2020). In another incident, the drone flew close to a telecommunication pylon after having delivered health commodities in Mananara. The pilot lost control of the drone due to signal interference. The drone landed on a tree but did not cause fire (Incident Report written on March 16, 2020). Another incident was reported on January 26, 2020 when the drone flew downwind at more than 50 km/h wind speed (although the maximum wind speed supported by the drone is 35 km/h). Consequently, the drone had to land in a rice field.

Considering the novel nature of the UAV delivery operations in Madagascar, the evaluation team considers this a satisfactory performance, although improvements to further reduce incidents must be continuously sought and implemented.

Forty-two flights occurred during rainy conditions and four incidents were recorded among those flights due to damaged or partially damaged products. On average, incidents[18] were twice as likely to occur during rainy conditions as during dry conditions, because packaging was damaged by moisture. AM drone pilots confirmed that drone delivery is possible in a range of weather conditions, except when there is a strong wind of more than 35 km/h. The drones are waterproof and as such, they can perform during rainfall. On average, between October 2019 and May 2021, about 8 percent of the flights[19] faced wind speed exceeding 35 km/hour.[20]

PAs and AM staff in the field reported that 10-20 percent of product drops missed the target area. Often the parcels can be retrieved without damage to products and missing the drop target area per se is not a reportable incident. As a result, no detailed records are kept of these occurrences.

Budgeting funds for an operational safety audit by an aviation auditor will help identify further optimizations in the operations, reduce incidents, and ensure continued safety as the program expands geographically and in terms of operational volume.

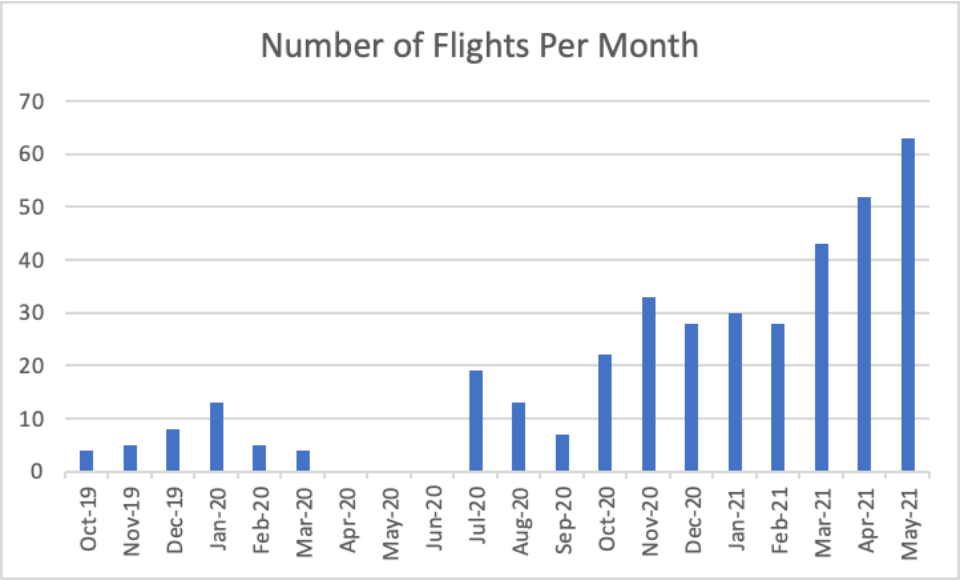
The frequency of IMPACT drone flights increased steadily during the pilot project implementation period, from an average of 6.5 flights per month during the first six months to an average of 30.7 flights per month during the last 11 months (there was a three-month hiatus with no flights during April-June 2020 due to battery supply issues at the onset of the COVID-19 pandemic). Traditional transportation systems via

[17] An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation (ICAO definition).
[18] Mostly parcels landing outside the drop-off areas and resulting in (partially or entirely) damaged products.
[19] Source: USAID/IMPACT flight data.
[20] Wind speed in which drone flights can be done safely.

ground continued to perform all necessary deliveries during this time period. The number of monthly flights was the highest in May 2021, the last month for which data were available, at 63 flights.

For analytical purposes, the evaluation team distinguished three time periods: October 2019 to March 2020 (average of 6.5 flights/month); July 2020 to February 2021 (average of 22.5 flights/month); and March to May 2021 (average of 52.7 flights/month). The project has thus progressively increased the number of delivery flights per month throughout the implementation period (Figure 4).

Figure 4: Number of Flights per Month, USAID/IMPACT Drone



It seems that even though there are, in some ways, clear delineations between the USAID-funded drone pilot project and the Global Fund drone activity, the USAID/IMPACT flight operations did likely benefit from the larger overall operational footprint that was developed, maintained, and cost-shared with the Global Fund. Starting in July 2020 when the Global Fund activities commenced, the frequency of IMPACT flights increased drastically. For example, there was greater capacity on site in Maroantsetra to repair and maintain the drone, replace the drone with another model in case of malfunctions, and set up the operation, engage the local stakeholders, and run the TOP site. There were also more flight data and resources available for system optimization that may have led to greater effectiveness overall.

Finding 2.2: In harsh weather, drones provided a safer transportation option when compared to ground transport.

In contrast to traditional means of transportation, the use of drones seems to be safer for health product transportation in the harsh weather conditions and poor road infrastructure quality of Maroantsetra. During KIIs, a PA reported that she had to transfer the package three times in transit from PARC to the communes: first by motorbike, then by boat, then by foot. During the six-hour trip, she had to make sure that the package was protected against rain.[21] (On other days, she had to protect the package from the sunlight). During the canoe portion of the trip, she had to pay extra attention to keep the box from falling out. This did in fact happen once in the past, resulting in the loss of the entire box and the products it contained. In these cases, PAs had to bear all the risk and cost associated with the incident.

With the drone delivery, strong wind is the main constraint that would lead to unsafe delivery. Beyond reportable incidents, the landing of the packages outside the dropping areas is the most common

[21] Maroantsetra has an average of more than 300 rainy days per year, the highest in Madagascar.

occurrence. KII respondents reported, however, that the damages to the products are small. If damages occur, IMPACT replaces the products.

Finding 2.3: Deliveries are made in a timely manner and respond to last minute requests.

All PAs interviewed for the evaluation reported receiving their products on time and that they were generally satisfied with the quality of service. According to PA KIIs and verified by PSI reports for damaged products (that would trigger complaints in the system), health commodities typically reached their destination without any complaints related to quantity.

The number of flights required to meet the needs of a PA depends on remoteness from the TOP and the volume of the requested products. If the distance is below 50 km, the maximum payload is 10 kg or 12 liters, so that fewer flights (around 2) are needed to meet PA monthly supply needs. If the distance is more than 50 km, the maximum payload is 5 kg or 4 liters and a higher number of flights (more than 3) may be needed. The total capacity is not usually limited by payload (weight) but by the volume of the health commodities, which is not reported in flight data. (The maximum weight recorded was for a Global Fund flight: 4.1 kg.)

The USAID/IMPACT drone did not deliver emergency medications, but KIIs reported that it did respond promptly to occasional last-minute requests from PAs to meet unexpected demand. According to KIIs with 10 PAs, their requests for deliveries related to unanticipated stockouts were delivered via drone typically within 1-3 days following the request (10/12 PAs).

Finding 2.4: AM liaised directly with ACM for most tasks related to flight permits, approvals and incident reporting.

Any use of unmanned aircraft with commodities on board in the absence of specific authorization is liable to penalties provided for in Article L.7.1.1-6 of Law no 2012-011 of August 13, 2012, amended and supplemented by the Law (N°2015-006 of February 12, 2015 of the Malagasy Code of Civil Aviation). Therefore, UAV flights need permissions from ACM. AM has permission to fly UAVs obtained from and signed by ACM during the project.

Flights inside a Flight Restriction Zones (FRZ) are forbidden without explicit permission. The TOP and landing point in Maroantsetra is situated inside the Maroantsetra FRZ. AM always made sure to get the green light from the Air Traffic Control (ATC) both in Maroantsetra and in Mananara for every flight. This was done via phone 15 minutes prior to take-off and landing. In case UAVs fly over protected areas, the drone operator has to request permission from the Ministry of Environment and Sustainability and the Park Manager (Wildlife Conservation Society or WCS manages the Makira National Park, whose space is traversed by the UAVs). WCS agreed (by verbal statement) that AM can fly UAVs over Makira as the purpose of the project is not to record videos or take pictures.

AM, along with PSI, has also collaborated with communes in the area from the beginning of the project. Together, they have provided information on the hazardous contents of the parcels and on safety regulations, and identified appropriate dropping sites with local authorities.

The remote pilot uses software (Mission Planner) that localizes the drone on a map in real time. In case of an incident, AM submits incident reports directly to ACM.

Finding 2.5: Differences between the implementation of IMPACT UAV pilot project and the Global Fund drone activity were mostly related to the frequency of flights.

The main difference between the IMPACT pilot project and the Global Fund drone activity was in the frequency of flights per drone. Six drones were leased through the Global Fund grant, as opposed to only one for IMPACT. The overall frequency of flights per drone was higher for IMPACT, but more experimentation and innovation took place under the Global Fund, especially in the two-way flights, delivery of vaccines, and simulation of laboratory tests. For example, the Global Fund drones conducted

cold chain deliveries and a reverse logistics simulation for tuberculosis (TB) samples. Notably, as part of the Global Fund activity, a large number of vaccine orders was fulfilled, typically within a day of the order, effectively proving the operational feasibility for cold chain deliveries.[22]

Finding 2.6: Operational costs per flight have been high to date because of limited flights, but they can fall substantially as the number of delivered payloads reaches theoretical maximums.

USAID/IMPACT and the Global Fund drone projects were both pilots and, as such, focused on technology validation, experimentation and innovation rather than efficiency and cost-effectiveness. However, efficiency will become increasingly important for any follow-on activities. Most important is cost-effectiveness, i.e., cost per delivered payload (health products).

Only limited documentation and financial records were available to assess the costs and benefits of the UAV delivery service. Following is an analysis of the operational costs of the IMPACT drone pilot project using data provided by PSI and AM.

Broadly speaking, the costs were divided into:

1. **PSI management**: This includes salary and expenses for PSI staff and equipment and managing the operation, monitoring and evaluation, and sensitization.
2. **Drone leasing and operational service (AM)**: This is a fixed monthly cost of $7,500 per drone that included a full-service operation, equipment, maintenance, and flight operations, as well as regulatory approvals and staffing. This amount is not affected by the number of flights, up to the maximum of 100 per month or 3-5 per day.

As discussed below, management costs comprised approximately one-third of all operational expenses.

UAV costs through May 2021

The Evaluation Team attempted a full cost analysis of the USAID/IMPACT drone activities, but was stymied by delayed billing for the AM drone contract and the uncertain distinction between start-up and operational costs. The AM sub-contract costs $7,500 per month regardless of the number of flights; however, it appears that AM charged only nine months between October 2019 and December 2020. When fully billed, the AM sub-contract including drone rental and operations accounts for 65.7 percent of total costs, with the balance going for PSI management (national coordinator and Monitoring and Evaluation/M&E specialist, and three local supervisors), travel, training, and promotion. Training and promotion (totaling less than 4 percent of the first year budget) were clearly start-up costs, as were the purchase of two motorcycles. However, the much larger and less easily measured start-up cost was in the under-utilization of available drone capacity, caused by the need to solve operational problems and switch demand from traditional delivery to drones.

PSI management costs varied from month to month. The evaluation team calculated an overall monthly average of $3,914. Adding the cost of the AM drone lease (not always charged but counted here nevertheless), the total monthly cost has been $11,414. For each of the 36 communes served by the IMPACT drone, this translates to an average cost of $317 per commune.

UAV costs for full capacity operation

[22] The Global Fund delivered 38,000 vaccine doses to CSBs within the nine-month implementation period.

Table 5 shows the monthly cost per flight during the three phases of the pilot drone project[23]. Data show that the cost per flight has decreased steadily and substantially over time, from $1,756 to $217, as the number of flights has increased (see also Figure 4).

Table 5: Cost Per Flight

Time Period	Cost Per Flight
October 2019 – March 2020 (no flights April-June, 2020)	$1,756
July 2020 – February 2021	$507
March 2021 – May 2021	$217

As mentioned earlier, according to AM and PSI, one drone can theoretically do up to 100 flights per month or 3-5 flights per day, with the current lease-based business model. The number of drone flights per month is still below capacity, although it risen steadily during 2021. If the drone reaches its full operational capacity of 100 flights per month[24], the average cost per flight would decrease be $114 (including PSI management costs): total monthly cost of $11,414 divided by 100 flights. Another way to decrease the cost per flight, discussed elsewhere in the report, would be to expand the range of products that IMPACT drones carry.

> *"Prior to the delivery by drones, I spent three days to get to Maroantsetra and back getting supplies of health products, among other things, The costs of the travel reach up to 300,000 ariary per trip during the rainy season, and the district health service does not pay for that cost. During my absence, there is no one to take care of the patients in my CSB."*
> – CSB Chief in Maroantsetra

Monthly logistics costs per PA before drones

Evaluation should ideally compare logistics costs before and after UAVs. However, the pre- and post-drone costs were substantially different in nature, and quantitative comparison was not possible. A more rigorous analysis would be helpful but it would still depend on significant assumptions.

Numerous KIIs with PAs and CSBs provided evidence of direct and indirect personal costs due to monthly travel to Maroantsetra town for commodity supplies.[25]

While project vouchers sometimes covered direct travel costs, none of them covered the opportunity costs of absence from routine activities (farming, shopkeeping, community education and health services). PA shopkeepers had to abandon their marketing; CSB health workers had to leave CSBs uncovered, sometimes without professional services; mothers had to leave children in the care of others. Public confidence in health services likely declined when clinics had to close. Professional health workers may have continued to receive salary support, but others suffered direct economic consequences.

USAID and Global Fund support for UAV activities effectively translates to subsidy for community health work, even though the exact size of this subsidy could not be quantified.

[23] For analytical purposes, the evaluation team distinguished three time periods: October 2019 to March 2020 (average of 6.5 flights/month; July 2020 to February 2021 (average of 22.5 flights/month); and March to May 2021 (average of 52.7 flights/month).

[24] KIs involved with the drone operation indicated that communes less than 50 kms distance from the TOP should require two flights per month to meet demand and the more distant ones three. Half of the 36 targeted communes are within 50 kms, the other half are more than 50 kms away. This results in at least 90 flights/month (18 communes* 2 flights + 18 communes*3 flights). The evaluation team did not verify these reports.

[25] Data from PSI indicates that travel costs could be up to 200,000 ariary (round trip) for Androndrona and 160,000 ariary for Morafeno. The costs exclude handling, which is important during rainy days.

Note that any improvements in health worker or household practices due to commodity availability or worker time cannot be either confirmed or measured. We cannot confirm if products were used appropriately or if health workers used "liberated" time for education and patient care.

Finding 2.7: Transportation of medicines to geographically-challenging locations using UAVs has not impacted drug stability.

> *"Since the beginning of the drone delivery, I don't have to worry about protecting the health products against damage from dropping, rain, sun, and extreme heat. Before, the risks were high as I had to transfer from motorbike to canoe, and then carry the products on foot for several kilometers"* – CHV in Voloina

Statistical datasets have shown that the quality of medicines is kept despite the fact that some drugs were damaged after landing (dropping then landing). PSI flight and incident reports show that most of these incidents occurred in Mananara Nord and Antalaha. These two districts are located at more than 50 km from Maroantsetra and flight times last more than one hour. The cardboard box that contains the products can get wet during the trip as the weather in the area is constantly changing. The box might be susceptible to moisture or humidity. Humidity varies from place to place and season to season. However, compared to traditional mechanisms, the effectiveness of transporting medicines with drones is good. In fact, with transportation via "not really ridable" roads, rivers, and boats, most of the PAs and CSB chiefs have complained that health commodities have been damaged or broken (for example, during rainy seasons, medicines got wet).

As Table 6 shows, even among reported incidents (19 of 376 flights – 5 percent), less than a quarter of transported commodities were damaged.

Table 6: Overview of Drug Supplies/Stability Among Reported Incidents (N=19), USAID/IMPACT Drone[26]

Types of products	Number of ordered products	Number of non-damaged products	Percent of damaged products
District of Antalaha Number of incidents recorded: 6			
Pneumox	20	15	25
SRO	62	59	4.8
Triclofem	400	383	4.3
Zinc	10	6	40
District of Mananara North Number of incidents recorded: 9			
Pneumox	20	8	60
Seringue	340	193	43.2
SurEau	2	1	50
Triclofem	200	147	26.5
Zinia	240	229	4.5

[26] This table shows drug supply stability data from the 19 flights where incidents were reported. For the remaining 357 flights where no incidents were recorded, no products were damaged.

District of Maroantsetra Number of incidents recorded: 4			
Arofoitra	10	0	100
Mycrogygnon	60	0	100
Triclofem	20	0	100
Total	**1,384**	**1,041**	**24.7**

4.3 EQ3. WHAT ARE THE HIGH-LEVEL REQUIREMENTS AND INVESTMENT NEEDS TO EXPAND THE PILOT ACTIVITY IN HIGH POTENTIAL HEALTH AREAS THAT MAKE THE DRONE DELIVERY SYSTEM MOST EFFECTIVE AND SUSTAINABLE?

KEY FINDING: Several conditions for further expansion of the UAV operations were met. Regulatory permissions were secured, flight operations were demonstrated to be safe and reliable and local stakeholders support the drone activity. Initial hypotheses for cost drivers and supply chain benefits were established. However, the national ownership and partnerships that are required are not yet in place, and they require attention and resources. Opportunities, furthermore, exist for greater efficiency.

Contextual Insights

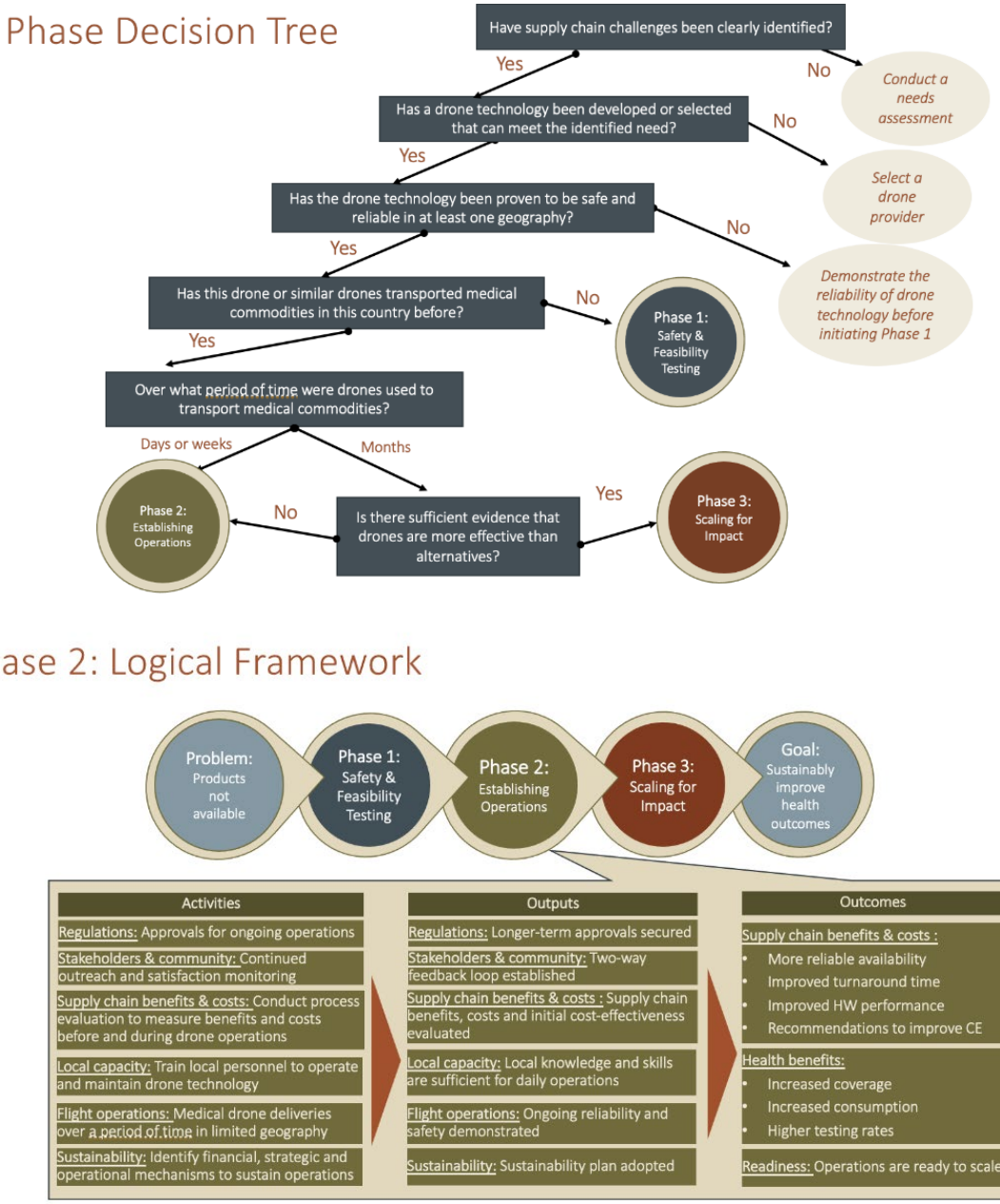
As shown by Figure 4 below, Village Reach and the ISG Unmanned Aircraft System (UAS) Coordinating Body have developed the drone evidence generation toolkit: Helping medical drone delivery implementers collect the right data for decision-making and to support evidence-based scaling of operations. It includes a roadmap[27] for drone implementation and milestones to reach before advancing to the next phase, which is useful to project Madagascar's possible UAV expansion. The Maroantsetra activities have clearly advanced from a "Safety and Feasibility Testing" Phase to an extended pilot project that includes many elements of establishing an operation (Phase 2). The Roadmap provides common guardrails and milestones that the project should aim to reach within its current phase and inform present investment needs.

This section draws on international best practices along with the contextual insights generated from this evaluation. Broadly speaking, to evolve, the project's subsequent phase will further strengthen the contextual ecosystem to sustain routine operations (Phase 2). This includes working on securing long-term flight approvals, monitoring stakeholder satisfaction, demonstrating ongoing reliability and safety, strengthening local capacity, lowering operating cost per flight and identifying a sustainable business model that can achieve desired outcomes in a cost-effective way.[28] The business model or sustainability plan should address service structure and offering, priority products to transport, geographic constraints, long-term financing of the service, and strategies for evaluating benefit and value.

[27]VillageReach/Interagency Supply Chain Group (ISG) Unmanned Aircraft System (UAS) Coordinating Body. Drone evidence generation toolkit: Helping medical drone delivery implementers collect the right data for decision-making. 2021. VillageReach. Accessible through: https://www.updwg.org/resource-library/.

[28] Toolkit for generating evidence around the use of UAS for medical commodity delivery V2 2019 https://www.updwg.org/wp-content/uploads/2019/12/UAS-Evidence-Generation-Toolkit-V2-Dec-2019.pdf

Figure 5: Roadmap for Drone Implementation and Milestones to Reach



Source: Village Reach 2021 Updated from Toolkit for Generating Evidence (2018)

Finding 3.1: No acute regulatory challenges arose during the drone pilot project implementation. Regulations and the capacity of oversight organizations such as ACM may pose bottlenecks as Madagascar transitions to increasing complexity and frequency of flights.

The project successfully obtained flight authorizations and approvals through an exemption mechanism from the ACM. Approvals for pilot implementation were sought directly by the operator, AM, via ACM, who approved the flights by granting exemptions from Madagascar's national civil aviation regulations. The securing of approvals is AM's responsibility as per the lease agreement between PSI and AM. An approval is typically valid for six months but can be valid for a longer timeframe. The current rules do not ordinarily

allow drone flights to take place beyond the visual line of sight (BVLOS), likely because of the risks involved and since these types of operations were not anticipated when rules[29] were established; however, approvals did not appear to present any major problems in this implementation (once the operator had established the operation). The aim of the next phase will be to obtain regulatory approval for the longer term that can safely enable sustained operations and a higher volume of flights. ACM has signaled that they are willing to continue working with AM on exemptions for these activities.

To ensure the safety of the Malagasy airspace while supporting sustained growth of these activities, operations should ideally be underpinned by a robust regulatory framework and adequate capacity of ACM as the competent authority and oversight organization to assess applications and to audit operators. Currently, a technical committee for drone operations within ACM has completed drafting an operational framework for drones, and plans to promulgate it soon, so regulatory changes can be foreseen in the near future[30]. However, as ACM has signaled continued willingness and support for the cargo drone operation, acute and immediate challenges are not foreseen.

Finding 3.2: Stakeholder engagement was strong with ACM but weak with other national actors, particularly MoPH.

> *"It seems the sustainability aspect [of government ownership] is missing; it seems [the national government] are not involved from the presentations and publications I have seen.*" – KI, International Donor Organization

The project partners, particularly AM, have developed a strong working relationship with ACM that could continue even after IMPACT, as indicated in project reports and KIIs. Direct contacts between PSI and ACM were limited as all necessary approvals and exchanges were managed directly by AM. This model appears to work well, as this full service helps more accurately forecast budgets even when regulatory delays and other operational challenges are accommodated in a fixed leasing fee agreed upon between the operator and PSI.

Coordination with MoPH and other national stakeholders involved in health supply chain management as well as with other donors seems to be missing. While the initial project presentation had taken place at the MoPH at the onset of the project, later engagement throughout the project was delayed in the case of the Global Fund implementation. The USAID/IMPACT operation appears to be taking place in isolation from MoPH. This may be due in part to the fact that no responsible point person for drones has been assigned by MoPH. For the pilot activities, MoPH was not actively involved in the design or ongoing implementation of the project and several key national stakeholders have reported that they were not aware of project activities.

Finding 3.3: Local capacity and contextual systems, including the middle mile, may significantly hinder utility of the drones.

Drones convey supplies to PAs and occasionally CSBs, but supply drops are only useful if they are received properly and delivered to end users (who in most cases are within half a day's journey from the drone drop-off location). Moreover, they can only be sent from district warehouses if higher level supplies systems have ensured adequate "middle-mile" supply to that level. PSI has supported both start points and end points for drone delivery, at least for PAs, but expansion areas might have to develop new systems. Moreover, PSI's systems duplicate government systems, and are to be phased out in any continuation.

[29] Decision N°75/ACM/DGE/DRG prohibiting operation of remotely piloted aircraft and Instruction N° 01 ACM/DGE/DRG/17 Concerning the Operation of Remotely Piloted Aircraft.
[30] The team was not informed of the potential details of the regulatory changes.

Certain contextual systems are essential for any drone operation, and some of these will have to be significantly strengthened in any expansion:

1. Human resource management: training of CSB staff on financial and stock management, as well as on quality control and monitoring
2. Information systems (perhaps District Health Information Software 2/DHIS2) to develop medium-range commodity forecasts and account for commodity utilization
3. Cell phone networks (such as GSM) or, alternatively, other methods for scheduling and confirming deliveries
4. Cold storage and cold chain, from central levels to points of service (if vaccines are added)

All this is *in addition* to commodity procurement (often international), to ports and to regional and district warehouses.

Much of this is already in place. Any expansion would require detailed systems analyses, investments in reinforcement, and frequent monitoring to ensure adequate functioning.

During the drone pilot project implementation, communes were served both at PAs through the IMPACT drone and CSBs through the Global Fund drones. Layering potential products by combining other donor sponsored products or MoPH priority items alongside USAID/IMPACT deliveries will lead to greater efficiency.

Finding 3.4: A sustainability plan or business model for operationalizing drones for supply chain improvements is still missing.

It is not clear that cargo drone operations in rural contexts can operate at a profit anywhere in the world if not subsidized, especially in emerging economies. The market environment is challenging, which is evidenced by recent cancellations of cargo drone programs by giant corporations such as Amazon (Prime Air) and DHL (Parcelcopter). At the same time, the case for using drones in rural areas to improve access to health services is increasingly emerging.[31] Development organizations have a role to play in addressing the market failure by budgeting investments to support drone implementations that strengthen access to health services in rural and hard-to reach areas.

A medium- to long-term plan and business model for the drone delivery system is still missing for Madagascar. Cost efficiency and effectiveness will be helpful to establish potential advantages over other traditional transport modes. However, robust empirical data to understand costs and cost efficiency of cargo drones in these contexts can only be collected during a full operation which should occur in the next phase of the project.

The evaluation team identified opportunities that might be pursued to strengthen the business model in the current pilot project implementation.

Increasing flight frequency to full capacity will help assess true costs and cost effectiveness potential as well as operational viability going forward. The full capacity of the available UAVs was not utilized, hinting at the potential for efficiency gains at a relatively low marginal cost per additional flight.

Increasing range and parcel volume capacity of the system will enable layering of services (i.e., carrying several types of products potentially for different customers), and multi-drop operations as well as increase flight frequency as more remote communes can be accessed. Wind posed the greatest weather-related challenge to the system; this can be addressed by improving the airframe aerodynamics or increasing power of the system.[32]

[31] https://openknowledge.worldbank.org/handle/10986/35593

[32] https://www.nature.com/articles/s41598-021-91325-w

Finding 3.5: Opportunities exist for UAV service expansion and greater efficiency.

The UAV system is technically capable of carrying more types of products. Currently, the drone flights for the IMPACT pilot project do not transport vaccines, essential drugs or other products not included in the USAID/IMPACT package. In addition, some of the drugs that every CSB must have in stock at any time were not within scope of the Global Fund drone pilot project deliveries.

PSI tested out for feasibility of additional use cases, including rapid emergency deliveries outside of the scheduled deliveries and reverse logistics (two-way transport). Two-way systems can improve reporting (according to KIIs), deliver payments for purchased drugs, and carry laboratory tests. The MoPH district chief stated that, for these purposes, they would like drones to land at the communes (instead of simply dropping supplies by parachute).

Two-way systems, however, are more complex to implement. They introduce new safety risks that require mitigations and management in form of additional infrastructure and personnel at the remote location. While one-way systems only have one take off point, two-way systems operate with a second take-off point. As the drone lands discharges and takes on new cargo, personnel needs to be trained to handle the drone, secure the site for landing and take-off and safely dispatch the drone.

Collaboration with other development partners will help utilize the available capacity by increasing flight frequency and delivering more types of commodities utilizing the existing operation.

As indicated in Table 7, additional use cases and products that were of interest for transport by drone have emerged as possible additions to current IMPACT UAV pilot flights during the evaluation.

Table 7: Summary of Requests for Additional Products to be Delivered by UAVs in Madagascar

Use case	Product examples	Source of suggestion
Emergency medications	Oxytocin, rabies vaccines, infant malaria treatment	KIIs with national stakeholder, literature review
"Just in time" Resupply	FP products, malaria treatment, nutrition products, vaccines, generic drugs such as diclophenac, paracetamol	Primary and secondary data, KIIs, the Global Fund reports
Two-way transport	TB samples, cash, reports and documents, repositioning of stock that is close to expiration (including malaria products).	Literature review, KIIs

Additional products can be added by merging supply chains and delivery routes or planning deliveries to health centers with cold chain storage capacity. There is an opportunity to do this through collaboration with health projects, such as Accessible Continuum of Care and Essential Services Sustained (ACCESS), and by including products that were previously delivered to CSBs by the Global Fund drones and emergency deliveries (as requested by MoPH KIs).

Cold chain transport will require additional packaging layers to maintain the integrity of the product as well as careful temperature monitoring. Extensive cold chain transports were successfully made as part of Global Fund implementation and the operator and PSI have demonstrated their capacity to perform cold chain transports.

Using multi-drops as for shorter flights and small packages offers potential capacity to make drops at more than one location before returning to the takeoff point. According to the Global Fund report, this was already done using the long-distance capsules. According to KII with AM, with some adaptation on the design of the capsules, one flight can accommodate up to four drop-offs at different locations, as long as the volume of the products remains within the capacity of the drone.

Explore deliveries to communes that are outside of administrative boundaries but within the UAV system range. Note that 28 percent of IMPACT flights already go to Mananara and Antalaha, but several communes within these two districts are not yet served by drones even though they are also in remote locations. AM seems to favor setting up secondary TOPs rather than increasing the capacity of batteries (according to the KII with AM Manager). Secondary TOPs would require recharging capabilities, and additional staffing among other investments[33].

The current operation and technology set up are not ready for dangerous goods transports such as infectious substances. Upgrades to operational aspects would be needed. The transport of dangerous goods requires triple packaging, specialized handling, and hazard labels.[34] The operator would need to follow the International Civil Aviation Organization (ICAO) Annex 18 –The Safe Transport of Dangerous Goods by Air, which is applicable to all international civil aircraft operations and recommended for domestic civil aircraft operations. The ICAO Doc 9284 "Technical Instructions for the Safe Transport of Dangerous Goods by Air" applies as well.

According to international best practices for civil aviation regulations, the transport of infectious substances likely requires certification of the aircraft and flying operation. This can be a costly process for a small operator. Alternatives to certification can possibly be explored in close collaboration with ACM and their specific requirements or civil aviation bodies in other countries for alternative means to mitigate risks, such as the use of crash-proof containers.

4.4 EQ4: WHAT ARE THE SUCCESSES, CHALLENGES, AND LESSONS LEARNED FROM THE PILOT ACTIVITY?

KEY FINDING: Working alongside each other, USAID/IMPACT and the Global Fund Innovation Challenge activity achieved successful UAV deliveries under difficult circumstances. Expanded implementation would benefit from greater efficiency and donor and government willingness to reduce administrative barriers.

4.4.1 Successes

PSI and AM have successfully piloted an innovative model for pharmaceutical deliveries in rural Madagascar; one may be replicable in appropriate contexts, within Madagascar and elsewhere. KIIs report that UAVs have shortened time delays in responding to commodity needs, from four days to one day (or less). Emergency supplies now arrive within 24 to 72 hours. PA informants report significantly reduced stockouts. Remote areas of Madagascar, difficult to reach in the best of circumstances, can now be at least partially served using modern transport and communication techniques.

While drones deliver *products* not *services*, there is reason to believe that they have also improved services by relieving health workers of the time requirements for pick-up and delivery. Many KIIs confirm a previous monthly burden of up to four days to walk, paddle, and drive to Maroantsetra for supplies. Stockouts have been virtually eliminated, increasing both product use and community confidence in quality. Life-saving emergency supplies have been made available in 24 to 72 hours, contrasting with common

[33] The team was unable to determine the detailed cost implications of secondary TOPs.
[34] Guidelines for the Safe Transport of Infectious Substances and Diagnostic Specimens: https://www.who.int/csr/emc97_3.pdf

unavailability previously. The UAV pilots – respectively funded by USAID and the Global Fund – have demonstrated that this can be done.

This was not merely a demonstration of capabilities already proven elsewhere. IMPACT staff were fully aware that they faced challenges when they started. In fact, according to KIIs, they were not confident that they would succeed in the face of prevailing weather conditions, ambiguous regulatory hurdles, and safety concerns about drop-offs. Startup was slow because of need for community-level training, simulated flights, and fine-tuning drop-off locations. They could not be sure how communities would respond to UAVs or parachutes. The technological performance also needed to be carefully monitored as the drone system had not previously been used for cargo deliveries. IMPACT's success was not simply in demonstrating drone capacity, but in problem-solving and refinement. The potential demonstration effect, the process where developments in one place will act as a catalyst in another, is still weak, partly because both the government and donors are concentrating on COVID-19 relief. However, that may change as the MoPH implements its recent decision to use drones for last-mile delivery of COVID vaccines. The Maroantsetra experience will be there to study when they are ready to start.

4.4.2 Challenges

As noted, drones can overcome most weather conditions and satisfy regulatory and safety concerns, but any effort to replicate or expand current activities will face significant challenges. At best, drones only close one link in a functioning public health system, and any weakness in other elements threatens the entire system. High quality medical supplies have to be imported or produced in the country and must reach and be safely stored at district warehouses. Community health workers have to be trained, supervised, and motivated to use supplies correctly; and those in need have to know about, want, and – in some cases – have the financial resources, to seek and use them correctly. The challenge for any future activity will be to ensure that comprehensive support and implementation systems are in place, or at least developed in tandem with drones; and this will not be easy in a resource-challenged environment.

Specific challenges to drone development include:

- Improving efficiency
- Developing flexible payment mechanisms for drone services
- Overcoming administrative barriers (limitations of individual funding sources or project contracts; restrictions due to district boundaries)
- Building supportive health systems
- Strengthening two-way communication between communes and the district
- Reaching the most remote communes (beyond 100 km from the current TOP)
- Maximizing coordination and perhaps cost-sharing between health projects (e.g., ACCESS and IMPACT)
- Building national strategies and partnerships for remote area logistics, including an appropriate role for UAVs

Improving Efficiency: The two UAV projects, the USAID/IMPACT pilot and Global Fund Innovation drone activities, emphasized effectiveness rather than efficiency – proving that something important could be accomplished – rather than trying immediately to control costs. Since costs are largely fixed, through the monthly lease from AM, efficiency requires maximizing use of the available drone and other fixed assets. The challenge moving forward is efficiency – not necessarily to become self-sufficient financially but to manage and reduce costs per beneficiary. Drones can probably never compete with traditional methods on cost alone; but, the method by which they are paid for (fixed monthly leases) could be more cost-effective if the number of daily flights could be significantly increased. Potential methods for doing so (elaborated elsewhere in this report) include:

- Expanding the range of products carried, by relaxing donor restrictions or allowing transport of commodities financed by non-USAID sources (including government)
- Reducing administrative obstacles to cross-border deliveries
- Developing systems and capacity for two-way flights

Developing Flexible Payment Mechanisms*:* At present, USAID/IMPACT pays a fixed monthly fee for one drone, to be used exclusively for the transport of USAID-financed commodities, ruling out the sale of services to other potential customers. A more flexible use-based arrangement, such as a pay-per flight option, might allow AM to sell capacity which USAID/IMPACT does not need, while keeping the drone available for emergencies. As mentioned under Finding 2.6, with the current lease-based business model, one drone can theoretically do up to 100 flights per month. If the drone reaches its full operational capacity, the average cost per flight would be $114 (including PSI management costs), substantially lower than the average cost of $217 per flight in the most recent quarter (March-May 2021, see Table 5). It would be a challenge to develop more flexible costing arrangements, but they would reduce PSI's responsibility to maximize capacity utilization if that could happen.[35]

Overcoming Administrative Obstacles*:* The commodities that drones carry are financed through specific (and often inflexible) funding channels, and USAID contracts in particular require segregation of funds. USAID funds cannot be mixed with Global Fund or government funds, and malaria funds cannot be used for unrelated primary health care activities. Supplies previously carried by Global Fund-financed drones are now reverting to traditional delivery mechanisms but could be consolidated with those carried by the USAID drone to increase the number of flights and contribute to efficiency.[36] Similarly, a drone based in Maroantsetra could serve nearby drop-off points in neighboring districts while transferring responsibility for distant communes in Maroantsetra to other TOPs.

Building Supportive Health Systems: Drones operate within broader systems that national governments and donors have struggled for years to strengthen. Deficiencies cannot be remedied overnight, but some requirements (such as reliable supplies at district warehouses) are truly essential for drug delivery, while others (e.g., high quality human resource capacity) may be sub-optimal but still function. The challenge is to coordinate government and donors around systematic strengthening strategies and to design drone delivery programs that support overall strengthening of the primary health care system.

> *"Donors are looking to see if governments are willing to take up and create capacity for themselves, not as a stand-alone pilot project but integrated as an integral part of the transport and distribution network."* – KI, International Organization

Strengthening Communication Systems*:* Inadequate communication systems make it difficult to schedule and operate drones, and to confirm deliveries, (but of course they also affect traditional delivery mechanisms). They will continue to challenge logistics managers.

Reaching Distant Communes*:* By reducing payloads, the drone which USAID/IMPACT used can fly up to 100 kms, but only three times per day rather than the five times per day available for shorter flights. More distant drop-off points continue to pose challenges and might sometimes be more efficiently served from other TOPs.

[35] More flexible arrangements might allow either AM or PSI to sell unused flight capacity. In theory, AM could sell some proportion of flights to IMPACT and offer the balance to other potential users. PSI could theoretically sell unused capacity itself, but this seems likely to raise accounting issues and run counter to IMPACT's development mission.

[36] In fact, IMPACT began services to CSBs in July, and now carries malaria medications, test kits, and other supplies previously carried by Global Fund drones.

Maximizing Coordinating and Perhaps Cost-Sharing Between Health Projects: USAID's ACCESS project has a mandate to strengthen public sector health services through CHVs and CSBs in 13 regions of Madagascar, but it has only recently deployed to Maroantsetra. USAID/IMPACT will gradually phase out support for private sector shops (PAs), in favor of CSBs; and it will need to coordinate with ACCESS for future support to the public sector. This transition from PAs to CSBs offers new opportunities to serve remote areas, but additional training, record-keeping and district and communal storage capacity may also be required.

Building National Strategies and Partnerships: Although the evaluation team was unable to interview the most senior MoPH officials (specifically the Secretary General and Director General), they did hear from others that they had limited information and thought that UAVs were too costly for routine use and should be reserved for emergency services. PSI did attempt to engage senior staff and proposed creation of a Technical Council, as documented in the draft Global Fund report; but this effort did not proceed because of leadership turnover and COVID-19. The evaluation team was unable to document PSI efforts to generate local "ownership," although KIIs assert that they did occur. KIIs within Maroantsetra as well as nationally complained about lack of updates.

Even if money were not an issue, this activity appears to be donor-driven and dependent. Overcoming this perception, perhaps best accomplished through a functioning Technical Council, will be a major challenge, especially for expansion and development of a national strategy. Additional donor support, especially through the global fund appears unlikely until this occurs.

4.4.3 Lessons Learned

- Battery-powered drones used by IMPACT can carry and drop compact loads in remote locations (up to 100 kms), even under adverse weather conditions
- Drones can potentially deliver and pick up cold chain-protected commodities and lab tests, provided essential ground-based capacity is in place.
- UAV services become more efficient as demand grows and inefficiencies are resolved. Close monitoring of costs and processes is essential for continuous quality improvement. Administrative constraints may be more difficult to overcome than technical ones.
- National leadership may expedite the development of UAV delivery systems, but well-documented pilot implementations can be very useful for identifying problems and improving processes. [37]
- Parallel developments to strengthen the supply chain, including national to district commodity supply, record-keeping and reporting systems, human resources, and community demand and use, are all essential. UAVs only work as one element in broader primary health care systems.

5. CONCLUSIONS

The twin pilot projects supported by USAID/IMPACT and the Global Fund Innovation Challenge Fund have clearly demonstrated what is called the "**use-case**" for drone delivery in rural Madagascar. They have shown that **UAVs can overcome barriers** of infrastructure and weather to provide both routine and emergency supplies to remote communes and to eliminate stockouts. They have significantly reduced opportunity costs for rural managers and volunteers and reportedly increased public confidence in drug supply and quality. Health workers gain credibility when they have the products that the public expects;

[37] The government's recent decision to deliver COVID vaccines by drone may benefit from prior work in Maroantsetra.

and they can devote more time to family care and health education when they do not have to spend up to four days a month traveling to district warehouses. These services have not been low cost, partly because pilot projects like these focus first on effectiveness; but costs per commune will decrease as more communes are served and more products delivered.

Over the period between October 2019 and May 2021, IMPACT successfully completed 376 flights, without any accidents. A few parachute drops were blown off target by high winds, but these incidents were rare and did not lead to significant safety issues or significant product damage or loss. These results are good in relation to similar activities elsewhere in Africa.

There are some caveats: UAVs were primarily used for one-way delivery of loads weighing up to 3.8 kgs within a 50 km distance from the district office, and only 2 kgs for greater distances up to 100 kms. (The Global Fund financing aimed to support two-way services – landing and returning from the drop point – but implementers were only able to do limited test flights in a few areas.)

As a pilot activity, the UAV effort was designed to maximize effectiveness rather than efficiency, but that emphasis is changing as services reach new service points and take on new commodities. The drone operation could have made five times as many flights as it actually did in the first 20 months, in what looks like underutilization of transport capacity and available human resources. However, because no precedent for these operations existed in Madagascar and with the chosen technology, operations needed to start carefully and increase incrementally. As noted in this evaluation, existing demand was fully satisfied but had to be limited to products supported by USAID and the Global Fund.

While supporting a "use-case" for drone delivery, USAID/IMPACT has **not yet developed a sustainability plan**, and has been unable to build a national coalition for UAV development or to identify champions within the MoPH. This failure was partly due to COVID-19 lockdowns but also – according to some KIs – due to inadequate presentation and discussion of results. Support is strong at the district and commune level, according to PAs and CSB chiefs, but national-level KIs stated clearly that the GOM could not take on the costs of UAV services. Future donor funding may require national leadership and "ownership," but they should not assume that the government can take on costs.

Pilot projects of this nature are usually not intended for research but rather for **problem resolution and demonstration**, hopefully leading to scaling up and replication. This implementation opened a new chapter for Madagascar's aviation. National leadership will be instrumental in paving the way for scale-up. Other countries, notably Rwanda, have had longer experience, with very strong national ownership. The ability of drones to carry vaccines with effective cold chain had not been tested before in Madagascar but was proven by AM with Global Fund funds. The only operational challenge not met was for delivery of mosquito nets (again, through the Global Fund); they are simply too heavy and bulky for UAV transport.

6 RECOMMENDATIONS

The evaluation team presents the following recommendations based on the evaluation findings and conclusions.

6.1 CONTINUE TO SUPPORT THIS PHASE OF UAV DEVELOPMENT UNTIL THE END OF USAID/IMPACT WHILE SETTING MEASURABLE GOALS AND MONITORING CLOSELY FOR TRANSITION FROM A PILOT PROJECT TO AN MOPH-OWNED NATIONAL PROGRAM.

UAVs may never be cheaper than traditional methods for commodity delivery, per item or client served; however, they have significant other benefits which seem worth the cost. Further evidence needs to be gathered. The next phase should measure additional indicators for stakeholder and community satisfaction, determining and quantifying of benefits, actual costs segregated by start-up and operating

expenses, cost effectiveness, health benefits and local capacity building. Extensive guidance and tools for gathering and tracking performance data and are provided in the Evidence Generation Toolkit referenced in this report.

IMPACT must transition to work directly with CSBs for drone deliveries. The health worker time spent collecting supplies from district warehouses (up to 2-4 days a month) should be spent instead on patient care. The loss of credibility that comes from periodic stockouts, and concerns about the quality of hand-carried commodities, should be replaced by public confidence. Above all, the deaths which occur due to absence of emergency medications should be replaced by quick and dependable deliveries. These efforts should continue while strengthening evidence.

***Goal**: PSI and drone partners maintain services while increasing collaboration with the GOM.*

6.2 USAID, MOPH, USAID/IMPACT, AND ACCESS SHOULD COLLABORATE TO INCREASE EFFICIENCY BY MAXIMIZING THE USE OF EXISTING UAVS AND BY REACHING OUT TO OTHER PROJECTS AND DONORS WORKING ON THE SUPPLY OF HEALTH COMMODITIES.

USAID, MoPH, USAID/IMPACT, and ACCESS should work together to increase efficiency by maximizing the use of existing UAVs, such as pooling all demand for UAV deliveries. In addition, the efficiency of UAV deliveries can further increase by reaching out and coordinating with other projects and donors, such as the Global Fund, GAVI, and private sector entities working on the supply of health commodities.

6.3 COSTS CAN AND SHOULD BE REDUCED BY MAXIMIZING USE OF AVAILABLE UAV DELIVERY CAPACITY.

As a pilot activity, IMPACT aimed for (and achieved) effectiveness but did not maximize cost efficiency. The current fixed price drone leasing arrangement motivates PSI to reduce cost per flight by at least doubling the current number of loads, certainly beyond what Maroantsetra PAs currently require and can pay for. In addition to reducing administrative barriers to full capacity, USAID/IMPACT should review the current lease arrangement, possibly in favor of fee per service or flight. As long as operating costs are fixed, USAID/IMPACT should reject occasional suggestions that they should focus on emergency deliveries only, since this would greatly increase costs per flight.

There are several ways in which the number of flights could be increased:

- Lowering cost barriers at the community level by offering essential commodities as part of the Malagasy government FANOME[38] program.
- Authorizing USAID/IMPACT to carry a full range of supplies, including those previously supported by the Global Fund as well as newly available vaccines (e.g., COVID-19).
- Moving from a delivery-only model (one-way drop-offs) to a partial two-way system to bring products such as laboratory samples, reports, and expired products back to base. (This recommendation requires strong capacity building and excellent logistics at the sites to ensure proper packaging and take-off. AM must have a system capable of fixing technical issues related to take-off, otherwise drones could be immobilized for several days at remote locations.)
- Adapt the technical capacity and itineraries of drones to be able to drop packages to multiple sites in one flight.

PSI, USAID/Madagascar, and perhaps other donors need to nurture a full partnership to minimize these constraints.

[38] Non-Stop Financing for Medical Supplies (FANOME) is a government program aiming at recovering some logistical and administrative costs of medicines at Government health facilities.

Goal: PSI and drone partner spread fixed costs by maximizing the number of flights.

6.4 DEVELOP A NATIONAL STRATEGY AND BUILD MOPH "OWNERSHIP" BY FINDING AND ROUTINELY INFORMING NATIONAL "CHAMPIONS" AND ENGAGING LEADERSHIP IN DECISION-MAKING.

As noted, the enthusiastic support for drones documented at district and commune levels has not been adequately conveyed to the central MoPH, and it will be difficult to move forward without it. The results of this evaluation can be used to support engagement with MoPH and other national stakeholders, as well as potential partners. USAID and implementing partners should not plan significant geographic expansion without government "ownership.". USAID should work with other donors and with international groups such as UNICEF to review progress to date and engage support. PSI should facilitate this process by setting up a communication system to convey the best practices, performance, cost-efficiency, and constraints during the extension phase to stakeholders, from villages to the central-level government. The identification of champions, such as senior level staff at MoPH, will facilitate the process of gaining support for UAV delivery by the ministry.

The objective is that for the longer term, USAID/Madagascar should collaboratively work with the government and other stakeholders to pursue efficiencies for pharmaceutical delivery in remote areas. Options could include a system that will likely include both drones and land-based methods, depending on geography, seasons, and products. Ideally, such program should be independent but open to offer its services to any project.

Goal: *National UAV technical council is constituted, sets policies and objectives, and facilitates donor grant applications.*

6.5 WORKING WITH THE GOVERNMENT AND DEVELOPMENT PARTNERS, USAID/MADAGASCAR SHOULD ENCOURAGE COMPETITIVE CONTRACTING OF PRIVATE SECTOR LOGISTICS FIRMS TO PROVIDE A COMMON UAV SERVICE CUTTING ACROSS MULTIPLE PROJECTS IN THE LONG TERM.

In aiming for proof of concept, the drone pilot project has focused on developing technical systems and overcoming operational obstacles, rather than on minimizing cost per dose delivered. Moving towards sustainability, donors and national policymakers should cultivate and nurture the development of independent (private sector) logistics firms and/or support to existing logistics firms that could be contracted and take loads from multiple customers and make independent decisions about the most effective and efficient way to deliver a variety of loads. As an option among a multitude means of delivery, drones would become a commonly accessible service that multiple projects, government agencies, and stakeholders can avail of.

Goal: *The burden for fully using capacity shifts from existing operators to another – possibly private sector – group.*

6.6 IF SO DESIRED BY ACM, USAID/MADAGASCAR AND DEVELOPMENT PARTNERS SHOULD ENCOURAGE ACM TO COLLABORATE WITH INTERNATIONAL BODIES CONCERNED WITH DRONES AND AVIATION SAFETY, OTHER CIVIL AVIATION AUTHORITIES, AND INTERNATIONAL EXPERT GROUPS THAT CAN ACT AS A PEER REFERENCE GROUP FOR THE NEXT ITERATION OF DRONE REGULATIONS AND TO EXCHANGE LESSONS LEARNED AND BEST PRACTICES.

Airspace needs to be managed safely and securely while enabling access to qualified operators. Regulatory mechanisms, risk assessment methodologies and ancillary infrastructure need to be established that enable

access for potentially multiple service providers and accommodate high frequency services. The current waiver/exemption process works for experimental uses and one-offs, but is not as suitable for scaling or enabling other potential operators and airspace users to enter the market and provide their services.

There currently is no international regulatory standard that applies to small drone operations, leaving Civil Aviation Authorities on their own to develop regulations. Other countries are facing similar issues as Madagascar and there are collaborative platforms in which best practices are being exchanged and where new concepts, methodologies, and procedures for regulating and managing the airspace in a way that accommodates drones are developed. These for instance include Regional Safety Oversight Organizations (RSOOs), Joint Authorities for Rulemaking on Unmanned Systems (JARUS), ICAO, Flight Safety Foundation (FSF) where learning on aviation safety topics can be exchanged.

ANNEXES

ANNEX1: ANNOTATED PHOTOGRAPHS

Figure 6: Pha-G-Dis Storage in Maroantsetra

Figure 7: : Pha-G-Dis Storage in Maroantsetra

The health commodities are organized by the type and name. To avoid the humidity of the soil, wood shelves are used in the ground.

Figure 8: PARC in Maroantsetra

Figure 9: Inside of PARC warehouse in Maroantsetra

Figure 10: Drop-off area in Voloina

Figure 11: PA storage in Manambolo

Figure 12: Community Health Volunteers collecting the drugs dropped by Drone

Figure 13: Community Health Volunteers collecting the drugs dropped by Drone

Figure 14: Drone pilot operator from Aerial Metric doing a check list control before flight

Figure 15: Drone pilot operator from Aerial Metric doing a check list control before flight

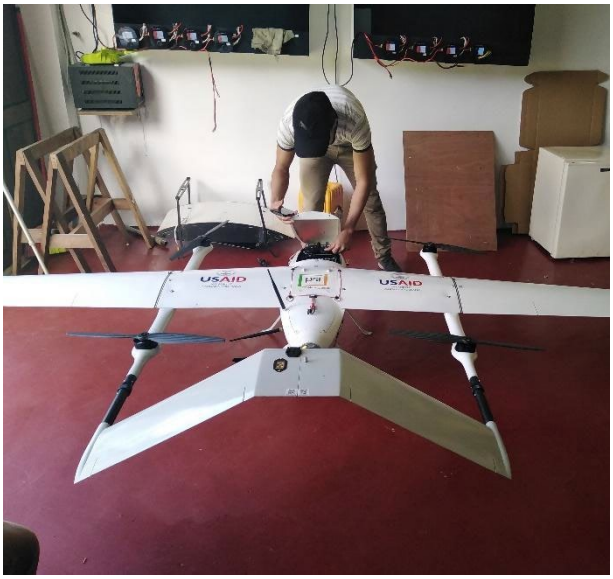


Figure 16: CAPSULE carried by Drone for long distance flight

Figure 17: Types of drugs transported by drone

ANNEX 2: SCOPE OF WORK

Evaluation #: 009 [*assigned by GH EvaLS*]

Global Health Evaluation and Learning Support Activity (GH EvaLS)

Contract No. GS-10F-154BA

STATEMENT OF WORK (SOW)

Date of Submission: December 14, 2020

Last update: April 27, 2021

INSTRUCTIONS: Complete this template in MS Word to develop a SOW for your evaluation, that may be an evaluation, a DQA, an assessment, or other analytic activity to be passed to the GH EvaLS team. Please be as thorough as possible in completing this SOW. The GH EvaLS team will assist you in refining your SOW which will be finalized when the Evaluation Team (Team) is in place. Some of the sections below have been pre-populated with information that is common to most evaluation/analytic activities. Please review these details and edit as needed to fit the needs of your specific analytic evaluation.

Note: Refer to the USAID How-To Note: Evaluation SOW and the Evaluation SOW: Good Practice Examples when developing your SOW.

I. SOW SPECIFIC INFORMATION

A. TITLE: Mid-Term Evaluation of UAV Pilot Activity, USAID/Madagascar Health Project

B. FUNDER/REQUESTER/CLIENT

c USAID/Washington

Office/Division: _____ / _____

g USAID Country or Regional Mission

Mission/Division: USAID/Madagascar

C. FUNDING ACCOUNT SOURCE(S): (Click on box(es) to indicate source of payment for this evaluation)

c HIV	c PIOET	g FP/RH
c TB	c Other public health threats	g WSSH
g Malaria	c MCH	c Nutrition
		c Other (specify):

D. BUDGET CEILING: Redacted

(Note: GH EvaLS will provide a cost estimate based on this SOW.)

E. PERFORMANCE PERIOD

Expected start date (on or about): Mid-April 2021

Anticipated end date (on or about): Early September 2021

F. LOCATION(S) OF EVALUATION

Please indicate where work will be performed: Madagascar (Capital and Maroantsetra)

II. TYPE OF EVALUATION

Instructions: Please check the box to indicate the type of evaluation.

A. EVALUATION:

1. Performance Evaluation g

Please check timing of data collection:

g Mid-term c Endline c Other (specify): _____

Performance evaluations encompass a broad range of evaluation methods. They often incorporate before–after comparisons but generally lack a rigorously defined counterfactual. Performance evaluations may address descriptive, normative, and/or cause-and-effect questions. They may focus on what a particular project or program has achieved (at any point during or after implementation); how it was implemented; how it was perceived and valued; and other questions that are pertinent to design, management, and operational decision making.

2. Impact Evaluation c

Please check timing of data collection:

c Baseline c Mid-term c Endline c Other (specify): _____

Impact evaluations measure the change in a development outcome that is attributable to a defined intervention. They are based on models of cause and effect and require a credible and rigorously defined counterfactual to control for factors other than the intervention that might account for the observed change. Impact evaluations in which comparisons are made between beneficiaries that are randomly assigned to either a treatment or a control group provide the strongest evidence of a relationship between the intervention under study and the outcome measured.

B. ANALYTIC EVALUATION:

c **Assessment**

Assessments are designed to examine country and/or sector context to inform project design, or as an informal review of projects.

c **Costing and/or Economic Analysis**

Costing and Economic Analysis can identify, measure, value and cost an intervention or program. It can be an assessment or evaluation, with or without a comparative intervention/program.

c **Other Analytic Activity**

Please specify what kind of activity: _____

C. PEPFAR EVALUATION:

Note: These questions are based on the PEPFAR Evaluation Standards of Practice v3.1 October 2019.

Note: If this is a PEPFAR-funded, check the box for the type of evaluation:

1. Process Evaluation c

Please check timing of data collection:

c Mid-term c Endline c Other (specify): _____

Process Evaluations focus on program or intervention implementation, including, but not limited to access to services, whether services reach the intended population, how services are delivered, client satisfaction and perceptions about needs and services, management practices. In addition, a process evaluation might provide an understanding of cultural, socio-political, legal, and economic context that affect implementation of the program or intervention. Example evaluation question: Are activities delivered as intended, and are the right participants being reached?

2. Outcome Evaluation c

Outcome Evaluations determine if and by how much, intervention activities or services achieved their intended outcomes. They focus on outputs and outcomes (including unintended effects) to judge program effectiveness but may also assess program process to understand how outcomes are produced. It is possible to use statistical techniques in some instances when control or comparison groups are not available (e.g., for the evaluation of a national program). Example evaluation question: To what extent are desired changes occurring due to the program, and who is benefiting?

3. Impact Evaluation c

Please check timing of data collection:

c Baseline c Mid-term c Endline c Other (specify): ____

Impact evaluations (IEs) measure the change in an outcome that is attributable to a defined intervention by comparing actual impact to what would have happened in the absence of the intervention (the counterfactual scenario). IEs are based on models of cause and effect and require a rigorously defined counterfactual to control for factors other than the intervention that might account for the observed change. There are a range of accepted approaches to applying a counterfactual analysis, though IEs in which comparisons are made between beneficiaries that are randomly assigned to either an intervention or a control group provide the strongest evidence of a relationship between the intervention under study and the outcome measured to demonstrate impact. Example evaluation question: What are the net effects of the program in achieving long term outcomes (e.g., changes in prevalence, incidence, mortality, sustainability)?

4. Economic Evaluation c

Economic Evaluations identify, measure, value and compare the costs and outcomes of alternative interventions. Economic evaluations are a systematic and transparent framework for assessing efficiency focusing on the economic costs and outcomes of alternative programs or interventions. This framework is based on a comparative analysis of both the costs (resources consumed) and outcomes (health, clinical, economic) of programs or interventions. Main types of economic evaluation are cost-minimization analysis (CMA), cost-effectiveness analysis (CEA), cost-benefit analysis (CBA) and cost-utility analysis (CUA). Example evaluation question: What is the cost-effectiveness of this intervention in improving patient outcomes as compared to other treatment models?

III. EVALUATION BACKGROUND

A. PROJECT/PROGRAM BEING EVALUATED/ANALYZED

Project/Activity Title:	Improving Market Partnerships and Access to Commodities Together (IMPACT)
Award/Contract Number:	72068718CA00001
Award/Contract Dates:	2018-09-03 until 2023-09-02
Project/Activity Funding:	$31,985,000
Implementing Partner(s):	Population Services International
Project/Activity AOR/COR:	Haja Razafindrafito

B. BACKGROUND OF PROJECT/PROGRAM/INTERVENTION

Provide a brief background on the country and/or sector context; specific problem or opportunity the intervention addresses; and the development hypothesis.

Introduction and Background

The USAID/Madagascar Mission plans to buy into the field support mechanism Global Health Evaluation and Learning Support (EvaLS) to conduct an evaluation of the Unmanned Aerial Vehicles (UAV) pilot activity used for last mile distribution of health commodities by the USAID funded program Improving Market Partnerships and Access to Commodities Together (IMPACT). Through a total market approach, the five-year IMPACT program (2018-2023) is building Madagascar's capacity to deliver quality health products to the Malagasy people. The UAV pilot activity aims to sustainably deliver health products to remote areas and contributing to improve the health of the Malagasy population. USAID/Madagascar is requesting external support to evaluate the efficiency and effectiveness of this pilot phase, prior to expanding to other areas.

The principal users for this award are USAID/Madagascar's Health, Population and Nutrition Office, Program Office and the health implementing partners.

Madagascar is the fourth largest island in the world (close to 600,000 sq. km), with an estimated population of 27 million (source: Preliminary report of national census in 2018 at https://www.instat.mg/rapport-provisoire-rgph-3/). Landscapes in Madagascar comprise of high mountainous areas in the central parts (altitude up to 2,800 meters), impenetrable tropical forests in the East and North, a semi-desert savanna in the South and many rivers pacing and dividing the whole country. The climate can also be challenging, rainy all year-round on the East coast, arid in the South and with a high risk of devastating cyclones between December and April every year.

These geographical conditions added to the lack of extensive road infrastructure[39] and deteriorating security (presence of dangerous armed gangs of bandits called "dahalo" in many parts of the country) have created lots of secluded areas with poor-to-no accessibility, making health services' delivery to people living in those regions extremely challenging. Currently, PSI distributes health products from marketing social to the district level through PARCs (Points

[39] 924/20837 (4.43%) of public facilities are accessible by car during the year. Sectorisation nationale 2017

d'Approvisionnement Relais Communautaire) serving as wholesalers for PA (Points d'Approvisionnement) that is a community-based supply point for CHVs.

To ensure increased access to health products in the most remote areas, IMPACT is exploring the use of Unmanned Aerial Vehicles (UAV), called drones, to deliver health products in very isolated areas not accessible throughout the year or during the rainy seasons. Prior to the scale up of the drone activity in other regions supported by USAID, a pilot activity was scheduled between November 2019 and February 2020 in Maroantsetra, Eastern Coast, where the drone is being tested for the first time as a means for achieving last mile distribution. One UAV was deployed from the district of Maroantsetra. Maroantsetra was selected based on its characteristics of being with most of the sub-districts (communes) accessible only by dugout canoe and its year-round rainfall pattern making the communes non-accessible during most parts of the year.

IMPACT Program Description

IMPACT is funded by USAID and led by PSI/Madagascar as the prime recipient and its consortium partners (Path, Banyan Global, Telma Fondation). IMPACT supports the Government of Madagascar to improve the capacity of the Malagasy health system to ensure that quality pharmaceuticals and health commodities are available and accessible to all Malagasy people in a sustainable way. For social marketing, IMPACT brings products to the district level through *Points d'Approvisionnement Relais Communautaire* (PARCs). The *Points d'Approvisionnement* (PA) procure the health products from PARC through a voucher system that covers transportation costs from Commune to District. Community health volunteers (CHVs) then procure products from the PA. Delivery drivers were recruited to provide products to PARCs on a monthly basis according to demand.

The challenge of the above model was frequent stock-outs due to incorrect demand forecasting and lack of timely deliveries to PARCs and PAs due to logistical challenges. To reduce stock outs / risk of stock out of PAs, one drone was deployed on pilot basis to test product deliveries in the pilot area which is Maroantsetra. Drone deliveries were scheduled by IMPACT and AerialMetric depending on many conditions:

- Distance between district and the PA
- GSM network coverage in the PA location and
- PA in stock-out of health product.

The following health products were delivered using the drone:

- Arofoitra (Chlorhexidine 7%)
- Combination 3 or Microgynon
- Male Condoms: Protector Plus or K'Poty
- DMPA-IM: Depo-Provera
- DMPA-SC: Sayanna Press
- Pneumox
- SurEau Pilina
- ORS/Zink

The District of Maroantsetra was chosen for the pilot phase because it is enclaved, and health product of some PA is not enough for the local population due to inaccessibility issues. Aerial Metrics is based in Maroantsetra. It is also more efficient for the drone project to be

implemented in the provider's location. Maroantsetra meets the conditions required for challenges in terms of accessibility and difficulty when using drone (mountainous field, existence of rivers, rainy region, etc.).

C. THEORY OF CHANGE (TOC) OF TARGET PROJECT/PROGRAM/ INTERVENTION

The IMPACT activity will implement a Total Market Initiative (TMI) that will improve Madagascar's total market health system. IMPACT covers the following health program areas: Family Planning (FP)/Reproductive Health (RH); Maternal and Child Health (MCH); and malaria. The PSI team includes Management Sciences for Health (MSH), the Axian Foundation, Banyan Global, and PATH as the consortium partners for the implementation of this activity.

Activity Goal: Sustainably improve the health of the Malagasy population through a strengthened health system and efficient health market, contributing to universal health coverage.

Activity Purpose: Improve the capacity of the Malagasy health system to ensure that quality pharmaceuticals and health commodities are available and accessible to all Malagasy people on a sustainable basis.

The IMPACT Activity is organized along five Intermediate Results (IRs):

- IR 1: Enhanced coordination among the public, nonprofit, and commercial sectors for the reliable supply and distribution of quality health products;
- IR 2: Strengthened capacity of the Government of Madagascar (GOM) to sustainably provide quality health products to the Malagasy people;
- IR 3: Expanded engagement of the commercial health sector to serve new health markets according to health needs and consumer demand;
- IR 4: Improved sustainability of social marketing to deliver affordable, accessible health products to the Malagasy people;
- IR 5: Increased demand for and use of health products among the Malagasy people.

The approach to the activity strategy design is based on PSI's broader Market Development Approach (MDA) process comprised of four key design and implementation stages directly linked to the IRs presented above: diagnose, plan, design, and deliver. Learning and/or knowledge management will be implemented across all IRs and the four key design implementation stages. Knowledge Management will be built throughout the program design and implementation process, as evidence gathered through market assessments, design testing, and the actual implementation of our market shaping activities will guide stakeholders to make informed decisions on the total market.

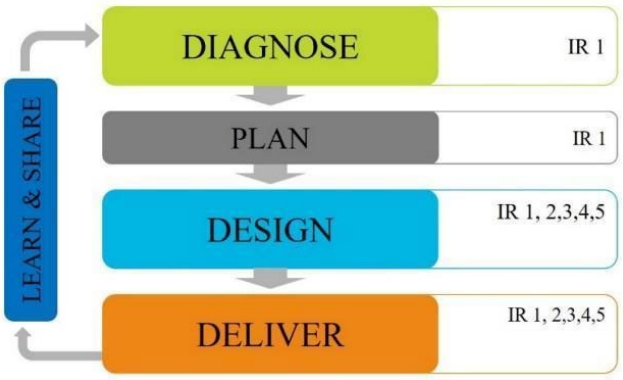
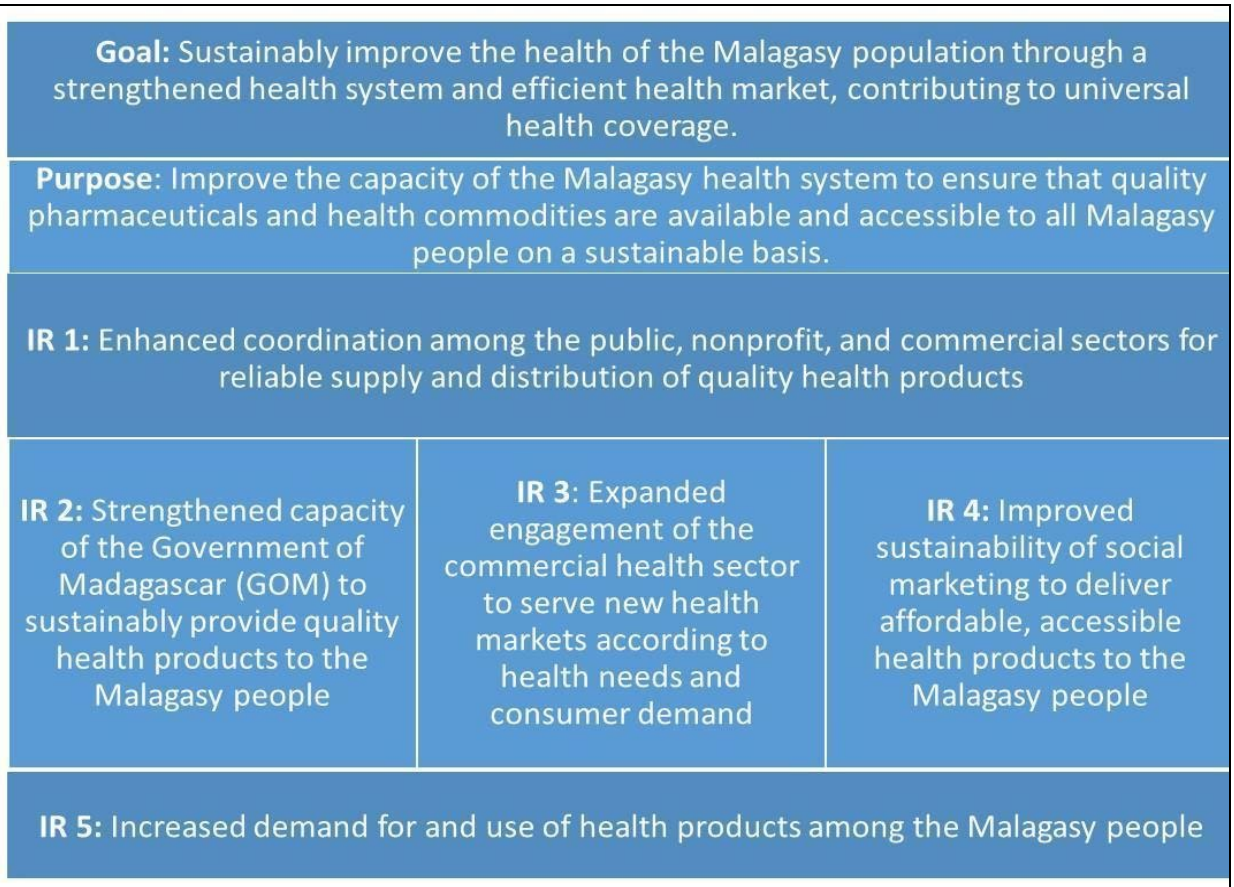


Figure 1: IMPACT's Design Stages

D. STRATEGIC OR RESULTS FRAMEWORK FOR THE PROJECT/PROGRAM/ INTERVENTION

Please also paste framework below.

The IMPACT logical framework is presented below, showing the goal, purpose, and integration of the five IRs. The drone activity is included in the IR4. IR4 is focused on the distribution of marketing social health products to PA.



This framework outlines IMPACT's conceptual framework by illustrating logical linkages between inputs/activities and expected results, outcomes, and anticipated impact. The framework will be underpinned by the following activity's principles: country ownership and sustainability, learning and innovation, gender, adolescent and youth considerations, and environmental considerations. It will be used for planning, implementation, monitoring and evaluation of the activity and the indicators to measure IMPACT's performance.

E. GEOGRAPHIC COVERAGE

What is the geographic coverage and/or the target groups for the project or program that is the subject of analysis?

PSI ensures distribution of health products using drone in remote areas located in Maroantsetra district. The drone serves communes in hard-to-reach areas as listed below.

Région	**ANALANJIROFO**
District :	**MAROANTSETRA**

Commune	Supply Point Responsable Name
Ambanizana Rantabe	Ranalison Paulin
Ambinanitelo	Randrianjafy Roger
Ambodimanga Rantabe	Razafindrasoa Fabiolah
Anandrivola	Zara Mardin
Andranofotsy	Arsene
Androndrona	Rabezaka
Anjahana	Zoliny
Anjanazana	Ramangasoavina Claire
Ankofa	Benamiana Yvy
Ankofabe	Randrianasolo Flavien
Antakotako	Jean Noel
Antsirabe-Sahatany	Zakandramora Olivier
Mahalevona	Rahelisoavolona Bernarda
Manambolo	Marie Angelette
Mariarano	Radimby Etienne
Morafeno Maroantsetra	Rakotonandrasana Jaona
Rantabe	Toto William Jean Christome
Sahasindro	Jaqueline Marthea
Voloina	Norasy Brigitte

IV. PURPOSE, AUDIENCE & APPLICATION

A. PURPOSE

Why is this evaluation being conducted (purpose of evaluation)? Provide the specific reason for this evaluation linking it to future decisions to be made by USAID leadership, partner governments, and/or other key stakeholders.

- Evaluation of the ***efficiency*** and ***effectiveness*** of UAV pilot phase in Maroantsetra district. More specifically, the evaluation will assess the extent that the demand for health commodities (in the pilot study) are (and can be) serviced by the drone delivery system. The evaluation will also focus on the effectiveness of the drone delivery operating model under the local environment, weather conditions and other contextual factors and it will provide an assessment of current and projected costs and benefits of the drone delivery system, incorporating the investment needs to expand the pilot activity.
- Evaluation of successes, challenges and lessons learned from the pilot activity.

B. AUDIENCE

Who is the intended audience for this analysis? Who will use the results? If listing multiple audiences, indicate which are most important.

The audience of the evaluation report will be the USAID/Madagascar Mission, specifically the HPN team, and the implementing partners.

C. APPLICATIONS AND USE

How will the findings be used? What future decisions will be made based on these findings?

This evaluation will serve as one of the key documents to learn to what extent the pilot objectives and results have been achieved, to identify weaknesses and challenges for adjustment during scaling up phase and design. Evaluation results will be used to provide actionable short and medium-term recommendations for the on-going pilot activity. Recommendations must capture additional opportunities to use the UAV, as well as corrective actions to resolve outstanding issues and improve activity performance within the IMPACT program duration.

The evaluation will provide information to inform USAID's decision on whether to expand the program in Maroantsetra and surrounding areas, as well as in other health services such as data transfer, etc.

V. EVALUATION QUESTIONS & MATRIX

Instructions: Questions should be: a) aligned with the evaluation purpose and the expected use of findings; b) clearly defined to produce needed evidence and results; and c) answerable given the time and budget constraints. Include any disaggregation (e.g., sex, geographic locale, age, etc.), they must be incorporated into the evaluation questions. USAID Evaluation Policy recommends 1 to 5 evaluation questions.

State the method and/or data source and describe the data elements needed to answer the questions.

	Evaluation Question(s)	Method(s)/Data Source(s)
EQ 1	To what extent the demand for health commodities in the pilot study area is serviced by the drone delivery system?	- Review of documentation and existing data - In-depth key informant interviews (KIIs) - Focus group discussions (FGDs)
EQ 2	How effective is the drone delivery operating model under the local environment, weather conditions and other contextual factors?	- Review of documentation and existing data - In-depth key informant interviews (KIIs) - Focus group discussions (FGDs)
EQ 3	What are the high-level requirements and investment needs to expand the pilot activity in high potential health areas that make the drone delivery system most efficient and sustainable?	- Review of documentation and existing data - In-depth key informant interviews (KIIs) - Focus group discussions (FGDs)
EQ 4	What are the successes, challenges and lessons learned from the pilot activity in a development and health supply chain context?	- Review of documentation and existing data - In-depth key informant interviews (KIIs) - Focus group discussions (FGDs)

Other Questions *[OPTIONAL*]

(*Note*: Use this space only if necessary. Too many questions can lead to an ineffective evaluation.)

VI. DATA COLLECTION METHODOLOGY

Instructions: Describe the recommended methods for this evaluation. Selected methods should be aligned with the evaluation questions and fit within the time and resources allotted for the

evaluation. Also, include the sample or sampling frame in the description of each method selected.

The Evaluation Team (Team) must consider a range of possible methods and approaches for collecting and analyzing the information. The primary methodologies for this evaluation will include (but are not limited to): review of documentation and existing data, direct flight observations, in-depth key informant interviews, focus group discussions and short surveys. Data collection methodologies will be discussed with and concurred by USAID/Madagascar and the COR at the beginning of the evaluation work. The Team will use participatory methods and activities that will enhance collaboration and dialogue among counterparts, particularly partners and communities. In any case, the contractor must submit a written description of the proposed sound methodology to carry out the evaluation to effectively answer the evaluation questions.

Note Related to Methods

A critical part of the methodology will be to assess the situation during the COVID-19 pandemic. It is anticipated that for the evaluation, especially where borders are closed and access is restricted, highly qualified national/regional evaluators and experts will be contracted. Additionally, virtual approaches to data collection will be used, including virtual stakeholder meetings, key informant interviews, and focus groups, where possible. See also USAID Guide to Remote Monitoring in COVID-19.

All interviews in the field will be conducted in Malagasy.

g **Document and Data Review**

Please list of documents and data recommended for review.

USAID/Madagascar will provide the Evaluation Team with key documents describing the IMPACT program and the UAV pilot activity, as well as other relevant information sources. Prior to conducting fieldwork, all team members will review and use these documents in the development of the evaluation methodology and to inform further data collection, field visits, and key information interviews.

The Evaluation Team will review the routine data collected by PSI, the supply point supervisors (SPS) and the drone project coordinator. Routine data include stock data, delivery schedules, recording of all flight operations and delivery data, incident data.

g **Secondary analysis of existing data**

This is a re-analysis of existing data, beyond a review of data reports. Please list the data source and recommended analyses.

Data Source (existing dataset)	Description of Data	Recommended Analysis
Data collected from central flight database	Flight distance, types of health products and weight transported, flight itinerary and schedules. Recordings of issues (weather condition, technical and geographical issues, etc.) for unsuccessful or delayed flights	Assess performance metrics (i.e., flight success rate, UAV capacity versus PA need, quality and consistency of data collection)
Data on drone operational costs from IMPACT	Costs of salary, travel, equipment, promotion activities and Monitoring & Evaluation, Consultants and Service providers	Assess efficiency of the pilot phase
Data on health commodities and mapping of PA supply points and CHVs	Stock status, purchase orders, commodity sales and average stock-out rate by types of products at PARC warehouse and PA supply point level. Geographic location of PARCs, PAs and CHVs	Determine stock needs from PAs and supply gaps to be serviced by the drone delivery

g **Key Informant Interviews**

Please list categories of KIs, and purpose of inquiry.

- PSI Madagascar: COP, drone project coordinator, supply points supervisors
- Aerial Metric
- Aviation Civile de Madagascar, the air-space regulator in Madagascar
- Local government officials: District Chief, Mayor, Chiefs of Fokontany
- Health officers: Medical Inspector at district level/Technical Assistant of Medical Inspector, Chefs CSB at commune level
- Various health stakeholders: PARCs, PAs, CHVs, PIVOT health project

The main purpose of KIIs is to assess the health product availability and accessibility with and without the drone, assess the level of awareness, attitudes and perceptions towards the drone pilot activity by the local authorities, assess the technical feasibility and regulatory requirements of the pilot expansion by the flight operator and ACM.

g **Focus Group Discussions**

Please list categories of groups, and purpose of inquiry.

- Community beneficiaries

- Local authorities (assess the level of awareness, attitudes and perceptions towards the drone pilot activity)

g **Group Interviews**

Please list categories of groups, and purpose of inquiry.

KIs may be interviewed in small groups of similar respondents, as long as all participants feel free to express their own opinions.

c **Client/Participant Satisfaction or Exit Interviews**

Please list who is to be interviewed, and purpose of inquiry.

c **Survey**

Please describe content of the survey and target respondents, and purpose of inquiry.

c **Facility or Service Assessment/Survey**

Please list type of facility or service of interest, and purpose of inquiry.

c **Observations**

Please list types of sites or activities to be observed, and purpose of inquiry.

- Commodity supply points
- Drone flights already scheduled

c **Cost Analysis**

Please list costing factors of interest, and type of costing assessment, if known.

c **Data Abstraction**

Please list and describe files or documents that contain information of interest, and purpose of inquiry.

c **Case Study**

Please describe the case, and issue of interest to be explored.

c **Verbal Autopsy**

Please list the type of mortality being investigated (i.e., maternal deaths), any cause of death and the target population.

c **Rapid Appraisal Methods**

Please (ethnographic / participatory) list and describe methods, target participants, and purpose of inquiry.

c **Other**

Please list and describe other methods recommended for this evaluation and purpose of inquiry.

If this is an **Impact Evaluation**, then:

Is technical assistance needed to develop full protocol and/or IRB submission?

c Yes c No

Please list or describe below the "case" for the intervention and the "counterfactual" comparison group for the Impact Evaluation.

Case	Counterfactual

Note on Human Subject Protection

The Evaluation Team must develop protocols to insure privacy and confidentiality prior to any data collection. Primary data collection must include a consent process that contains the purpose of the evaluation, the risk and benefits to the respondents and community, the right to refuse to answer any question, and the right to refuse participation in the evaluation at any time without consequences. Only adults can consent as part of this evaluation. **Minors cannot be respondents to any interview or survey and cannot participate in a focus group discussion without going through an IRB**. The only time minors can be observed as part of this evaluation is as part of a large community-wide public event, when they are part of family and community in the public setting. During the process of this evaluation, if data are abstracted from existing documents that include unique identifiers, data can only be abstracted without this identifying information.

An **Informed Consent** statement included in all data collection interactions must contain:

- Introduction of facilitator/note-taker
- Purpose of the evaluation
- Purpose of interview/discussion/survey
- Statement that all information provided is confidential and information provided will not be connected to the individual
- Right to refuse to answer questions or participate in interview/discussion/survey
- Request consent prior to initiating data collection (i.e., interview/discussion/survey)

VII. EVALUATION ANALYSIS PLAN

Instructions: Describe how the quantitative and qualitative data will be analyzed. Include method or type of analyses, statistical tests, and what data it to be triangulated (if appropriate). For example, a thematic analysis of qualitative interview data, or a descriptive analysis of quantitative

survey data. The box below has been filled out to provide you with an example that you should edit, as necessary.

All analyses will be geared to answer the evaluation questions. Additionally, the Evaluation Team will review both qualitative and quantitative data related to the project/program's achievements against its objectives and/or targets.

Quantitative data will be analyzed primarily using descriptive statistics. Thematic review of qualitative data will be performed, connecting the data to the evaluation questions, seeking relationships, context, interpretation, nuances and homogeneity and outliers to better explain what is happening and the perception of those involved. Qualitative data will be used to substantiate quantitative findings, provide more insights than quantitative data can provide, and answer questions where other data do not exist.

Use of multiple methods that are quantitative and qualitative, as well as existing will allow the Evaluation Team to triangulate findings to produce more robust results. The evaluation will describe analytic methods and statistical tests employed.

Data Analysis Plan should include:

Analysis of the delivery and supply chain data at PA level

- Determine stock needs in PAs and identify supply chain gaps to be serviced by drone delivery
- Evaluate effectiveness of drone delivery to satisfy PAs needs and avoid stock-outs (e.g., speed of delivery, suitability of drone delivery for required health commodities, effect of weather/wind on performance, etc.)
- Evaluate effectiveness of drone delivery operating model, with focus on communication channels, end-to-end delivery time and adequacy of delivery to demand requisition from PAs

Analysis of the drone flight data from IMPACT central flight database

- Assess effectiveness of drone as delivery solution, measuring selected performance indicators (e.g., success rate (number of effective flights), time to delivery (including flight time and ancillary or preparatory activities))
- Estimate maximum usability/capacity of drone (number of deliveries per month/year)
- Evaluate quality and consistency of data collection, in particular of drone application

Formulation of an initial hypotheses on expansion of the pilot activity

- Determine effectiveness of utilizing drones as delivery system, including other health related services such as health data transfer and management where relevant
- Determine high-level requirements to expand drone delivery program in Maroantsetra and surrounding areas (e.g., cost estimate of scale up, operating model of project, infrastructure needs, capacity needs) (preliminary assessment)
- Identify potential risks and challenges to implementation at scale (preliminary assessment)

VIII. ACTIVITIES

Instructions: List the expected key activities, such as Team Planning Meeting (TPM), briefings, verification workshop with IPs and stakeholders, etc. Activities and deliverables may overlap. Please give as much detail as possible.

1. **Desk Review** – Several documents are available for review for this evaluation. USAID/Madagascar will provide the contractor with key documents describing the IMPACT program and the UAV pilot activity, as well as other relevant information sources. Prior to conducting fieldwork, all Evaluation Team (Team) members will review and use these documents in the development of the evaluation methodology and to inform further data collection, field visits, and key information interviews. The contractor will review the routine data collected by PSI, the supply point supervisors (SPS) and the drone project coordinator. Routine data include stock data, delivery schedules, recording of all flight operations and delivery data, incident data. This desk review will provide background information for the Evaluation Team and will also be used as data input and evidence for the evaluation.
2. **Evaluation Launch/In-brief with USAID** – A call/meeting among the USAID, GH EvaLS project staff and the Evaluation Team to initiate the evaluation and review expectations. USAID will review the purpose, expectations, and agenda of the evaluation. GH EvaLS will introduce the Team and review the initial schedule and other management issues.
3. **Team Planning Meeting** – A three to four-day team planning meeting (TPM) will be held at the initiation of the evaluation and before the data collection begins. During the TPM, the Team will:
    - Review and clarify any questions on the evaluation SOW
    - Clarify team composition from EvalS and USAID, and members' roles and responsibilities
    - Establish a team atmosphere, share individual working styles, and agree on procedures for resolving differences of opinion
    - Review and finalize the evaluation questions
    - Review and finalize the evaluation timeline
    - Develop a draft of the data collection methods, instruments, and guidelines
    - Review and clarify any logistical and administrative procedures for the evaluation
    - Develop a preliminary data collection plan
    - Draft the evaluation workplan
    - Develop a preliminary draft outline of the team's report
    - Assign drafting/writing responsibilities for the final report or final presentation.
4. **Workplan and Methodology** submitted to USAID and followed by a review meeting. Workplan will include:

- The anticipated schedule and logistical arrangements
- A list of the members of the evaluation team, delineated by roles and responsibilities.

(CVs of the proposed evaluation team as well as a detailed description of the evaluation management structure and team member roles and responsibilities);

- A detailed evaluation design matrix that links the Evaluation Questions in the SOW to data sources, methods, and the data analysis plan
- The data quality control process as well as the assessments and management of challenges and risks related to the data collection process
- The data collection protocol, including the training plan and agenda for the field team
- All data collection tools (KII and FGD Guides)
- The list of potential interviewees and sites to be visited and proposed selection criteria and/or sampling plan (must include calculations and a justification of sample size, plans as to how the sampling frame will be developed, and the sampling methodology)
- A description of ethical considerations
- Known limitations to the evaluation design
- Annexes, including:
    - Scope of Work of the evaluation
    - Location and map of selected sites to be visited during the evaluation

The Workplan and Methodology must not exceed 30 pages excluding annexes. If applicable, the contractor shall be required to include a conflict of interest mitigation plan based on the Disclosure of Conflict of Interests submitted with the proposal.

5. **In-brief with the target Project/Program** to review the evaluation plans and timeline, and for the project to give an overview of the project to the Evaluation Team.
6. **USAID and Stakeholder Briefings** – The Team Lead (TL) will brief the USAID POC **weekly** to discuss progress. As preliminary findings arise, the TL will share these during the routine briefing, and in an email.

A **final debrief** between the Evaluation Team, the IP and USAID will be held at the end of the evaluation and before the preparation of the final report, to present **preliminary findings to USAID**. During this meeting a summary of the data will be presented, along with high level findings and draft recommendations. For the debrief, the Team will prepare a **PowerPoint Presentation** of the key findings, issues, and recommendations. The Team will incorporate comments received from USAID during the debrief in the evaluation report. (*Note: preliminary findings are not final and as more data sources are developed and analyzed these finding may change.*)

7. **Fieldwork: Site Visits and Data Collection** – The Evaluation Team will conduct site visits for data collection. Selection of sites to be visited will be finalized during TPM in consultation with USAID. The Team will outline and schedule key meetings and site visits prior to departing to the field. During the time of COVID, when necessary, alternative means of data collection will be used, such as virtual stakeholder meetings, key informant interviews, and focus groups, where possible. See also USAID Guide to Remote Monitoring in COVID-19.
8. **Evaluation Report** – The Evaluation Team under the leadership of the Team Lead will develop a report with findings and recommendations. Report writing and submission will include the following steps:
    - Team Lead will submit draft final report to GH EvaLS for review and formatting
    - GH EvaLS will submit the draft report to USAID

- USAID will review the draft report in a timely manner, and send their comments and edits back to GH EvaLS
- USAID will manage implementing partner(s)'s (IP) review of the report and compile and send their comments and edits to GH EvaLS. (*Note: USAID will decide what draft they want the IP to review.)*
- GH EvaLS will share USAID's comments and edits with the Team Lead, who will then do final edits, as needed, and resubmit to GH EvaLS
- GH EvaLS will review and reformat the final report, as needed, and resubmit to USAID for approval.
- Once the final report is approved, GH EvaLS will re-format it for 508 compliance and post it to the DEC.

The evaluation/analytic report **excludes** any **procurement-sensitive** and other sensitive but unclassified (**SBU**) information. This information will be submitted in a memo to USAID separate from the report.

9. **Submission of Datasets to the Development Data Library** – Per USAID's Open Data policy (ADS 579, USAID Development Data), GH EvaLS will submit all quantitative data to USAID and the Development Data Library (DDL), at www.usaid.gov/data, in a machine-readable format (CSV or XML). The datasets created as part of this evaluation/analytic will be accompanied by a data dictionary that includes a codebook and any other information needed for others to use these data. It is essential that the datasets are stripped of all identifying information, as the data will be public once posted on USAID's DDL.

   Where feasible, qualitative data that do not contain identifying information should also be submitted to GH EvaLS.

10. **Submission of Final Evaluation Report to the Development Experience Clearinghouse** – Per USAID policy (ADS 201.3.5.18), GH EvaLS will submit the final evaluation/analytic report to the Development Experience Clearinghouse (DEC) within three months of final approval by USAID.

IX. TASKS, DELIVERABLES AND TIMELINES

Instructions: Select all deliverables and products required on this analytic evaluation. For those not listed, add rows as needed or enter them under "Other" in the table below. Provide timelines and deliverable deadlines for each.

Tasks/Deliverables	Timelines & Deadlines (estimated)
Evaluation Launch/In-brief with USAID	Week 1 of evaluation launch
Desk Review	Week 1-2 of evaluation launch
Team Planning Meeting/In-depth discussion with USAID on workplan and methodology	Week 2
Workplan and methodology review briefing	Week 3

Workplan submission (includes evaluation questions, methods, timeline, data analysis plan, and data collection instruments)	Week 3
In-brief with target Project/Program	Week 3
Preparation/logistics for site visits and data collection	Week 4
Data collection: in-person and virtual KIIs and site visits (including travel to sites)	Weeks 5-8
Data analysis	Weeks 7-9
Routine USAID briefings	Weekly/Biweekly
Debrief with USAID and IPs with PowerPoint presentation on progress of the evaluation and preliminary findings (including preparatory work)	Week 10
Draft report	*Submit to GH EvaLS*: Week 12 *GH EvaLS submits to USAID*: Week 14
USAID report review	Weeks 15-16
Finalize and submit report to USAID	*GH EvaLS submits to USAID*: Week 18
USAID approves report	Week 19
Final copy editing and formatting/508 Compliance	Week 20
Report uploaded onto the DEC	Week 21

Estimated USAID review time

Average number of business days USAID will need to review the report? 10 business days

X. TEAM COMPOSITION, SKILLS, LEVEL OF EFFORT (LOE) AND LOGISTICAL NEEDS

A. TEAM COMPOSITION AND SKILLS:

Instructions: Please list technical areas of expertise required for this evaluation:

- List desired qualifications for the team as a whole
- List the key staff needed for this analytic evaluation and their roles.
- Sample position descriptions are posted on USAID/GH EvaLS webpage
- Edit as needed GH EvaLS provided position descriptions

Please also consider:

- Key staff should have methodological and/or technical expertise, regional or country experience, language skills, team lead experience and management skills, etc.
- Team leads for evaluations/assessments must be an external expert with appropriate skills and experience.
- Additional team members can include research assistants, enumerators, translators, logisticians, etc.
- Teams should include a collective mix of appropriate methodological and subject matter expertise.
- Evaluations require an Evaluation/Analytics Specialist, who should have evaluation/analytic methodological expertise needed for this evaluation. Similarly, other analytic activities should have a specialist with methodological expertise.
- Note that all team members will be required to provide a signed Non-Disclosure and Conflict of Interest statements attesting that they will keep all information confidential and have no conflict of interest (COI) or describing the conflict of interest if applicable for further consideration.

Team Lead (TL) – Key Staff 1

Roles & Responsibilities: The TL should have significant experience conducting and leading project evaluations and/or assessments. S/he will be responsible for: providing team leadership; managing the team's activities; ensuring that all deliverables are met in a timely manner; serving as a liaison between the USAID and the team, and leading briefings and presentations. S/He will provide quality assurance on evaluation issues, including methods, development of data collection instruments, protocols for data collection, data management and data analysis. S/He will oversee the training of all engaged in data collection, ensuring highest level of reliability and validity of data being collected. S/He is the lead analyst, responsible for all data analysis, and will coordinate the analysis of all data, assuring all quantitative and qualitative data analyses are done to meet the needs for this evaluation.

Qualifications:

- Minimum of 10 years of experience in public health, which included experience in implementation of health supply chain management activities in developing countries
- Demonstrated experience in leading evaluation of health sector project/program activities, utilizing both quantitative and qualitative methods
- Excellent skills in planning, facilitation, and consensus building
- Excellent interpersonal skills, including experience successfully interacting with host government officials, civil society partners, and other stakeholders
- Excellent skills in project management
- Excellent organizational skills and ability to keep to a timeline
- Good writing skills, with extensive report writing experience
- Experience working in the Africa region, and experience in Madagascar is desirable
- Familiarity with USAID policies and practices:
    - Evaluation policies
    - Results frameworks

- Performance monitoring plans

- Familiarity with USAID strategic health areas and approaches
- Proficient in English

Senior Drone Specialist – Key Staff 2

Roles & Responsibilities: Serve as a member of the Evaluation Team, providing expertise in drone technology. S/He will participate in planning and briefing meetings, data collection, data analysis, development of presentations, and writing of the final report.

Qualifications:

- Experience in either the automotive or aeronautical industry
- Proven experience in managing, supporting, or assessing projects on promoting UAVs for development and/or health sectors
- Strong knowledge of international aeronautical/aerospace standards, technical, and safety requirements

Local Evaluation Specialist – Key Staff 3

Roles & Responsibilities:

The Local Evaluation Specialist will assist the Team with data collection, analysis, data interpretation and logistics. He/she will report to the Team Lead.

Qualifications:

- Basic familiarity with health topics, preferably malaria and supply chain/last mile delivery
- Experience conducting surveys, interviews, and focus group discussions, both facilitating and note taking
- Experience in translation of data collection tools, transcripts, and logistics, as needed
- Proficient in English and Malagasy
- Experience working on USAID programs or evaluations preferred
- Experience with data analysis methods

Local Drone Specialist – Key Staff 4

Roles & Responsibilities: Serve as a member of the Evaluation Team, providing local expertise in drone technology. S/He will assist in all the tasks, including evaluation design and planning, and will take the lead in local data collection activities, alongside the Local Evaluation Specialist.

Qualifications:

- Experience in either the automotive or aeronautical industry
- Knowledge and local Angola experience in managing, supporting, or assessing projects on promoting UAVs for development and/or health sectors
- Knowledge of international aeronautical/aerospace standards, technical, and safety requirements

1. USAID Participation

Will USAID participate as an active team member or designate other key stakeholders to as an active team member? This will require full time commitment during the evaluation or assessment evaluation.

c Full member of the Team (including planning, data collection, analysis and report development) – If yes, specify who: _____

c Some Involvement anticipated – If yes, specify who: _____

g No

B. STAFFING LEVEL OF EFFORT (LOE) MATRIX AND ANTICIPATED TRAVEL

1. LOE Chart

Instructions: The LOE Matrix below will help you estimate the LOE needed to implement this evaluation. If you are unsure, GH EvaLS can assist you to complete this table. Please note:

a) For each column, replace the label "Position Title" with the actual position title of staff needed for this evaluation.

b) Immediately below each staff title enter the anticipated number of people for each titled position.

c) Enter row labels for each evaluation, task and deliverable needed to implement this evaluation.

d) Then enter the LOE (estimated number of days) for each activity/task/deliverable corresponding to each titled position.

e) At the bottom of the table total the LOE days for each consultant title in the 'Sub-Total' cell, then multiply the subtotals in each column by the number of individuals that will hold this title.

The following is an **illustrative** LOE Chart. Please edit to meet the requirements of this evaluation. The level of effort is in **days** for each Team member.

Sample:

Tasks/Deliverables		Evaluation Team			
		Team Lead (Key Staff 1)	**Senior Drone Specialist (Key Staff 2)**	**Local Evaluation Specialist (Key Staff 3)**	**Local Drone Specialist (Key Staff 4)**
Number of persons [?]		**1**	**1**	**1**	**1**
1	Launch/In-brief with USAID	0.5	0.5	0.5	0.5
2	Desk review	2	1	1	1
3	In-brief with Mission	0.5	0.5	0.5	0.5
4	Team Planning Meeting (TPM)	2	2	2	2

5	Workplan and methodology briefing with USAID	0.5	0.5	0.5	
6	Workplan submission	1.5	1	1	0.5
7	In-brief with target Project/Program	0.5	0.5	0.5	0.5
8	Preparation/logistics for site visits and data collection	1	1	1	1
9	Data collection: in-person and virtual KIIs and site visits (including travel to sites)	9	4	12	8
10	Data analysis	5	3	5	1
11	Preparation of debrief for USAID	1	1	1	
12	Debrief with USAID and IPs with PowerPoint presentation on progress of the evaluation and preliminary findings (including preparatory work)	1	1	1	1
13	Draft report	8	3.5	2	1
14	USAID report review				
15	Finalize and submit report to USAID	3	1	1	1
	Total LOE per person	**35.5**	**20.5**	**29**	**18**
	Total LOE	**35.5**	**20.5**	**29**	**18**

A 6-day workweek permitted g Yes c No

6-day workweek approved for travel to/from work locations g Yes c No

2. Anticipated Travel

Please list international and local travel anticipated by what team members.

Analyst and Local M&E Specialist: Antananarivo- Maroantsetra and surrounding fokontany

C. LOGISTICS

1. Work week

Billing up to seven (7) days in any consecutive seven (7)-day period is approved when traveling to or from the consultant's home of record g Yes c No

2. Visa Requirements

List any specific Visa requirements or considerations for entry to countries that will be visited by consultant(s):

None

List recommended/required type of visa for entry into counties where consultant(s) will work:

Name of Country	**Type of Visa**		
	c Tourist	c Business	c No preference
	c Tourist	c Business	c No preference
	c Tourist	c Business	c No preference
	c Tourist	c Business	c No preference

3. Clearances & Other Requirements

Check all that the consultant will need to perform this evaluation, including USAID Facility Access, GH EvaLS workspace and travel (other than to and from post).

c USAID Facility Access (FA)

Specify who will require Facility Access: _____

c Electronic County Clearance (ECC) (International travelers only)

c High Threat Security Overseas Seminar (HTSOS) (*required in most countries with ECC*)

c Foreign Affairs Counter Threat (FACT) (for consultants working on country more than 45 consecutive days)

c GH EvaLS workspace

Specify who will require workspace at GH EvaLS: _____

c Travel, other than posting (specify): _____

c Other (specify): _____

Specify any country-specific **security concerns and/or requirements**:

No visitor is allowed in the USAID facility; meetings with USAID will be virtually conducted

Note on Workspace and Clearances

Most Teams arrange their own workspace, often in conference rooms at their hotels. However, if a security clearance or facility access is preferred, GH EvaLS can submit an application for it on the consultant's behalf.

GH EvaLS can obtain **Facility Access (FA)** and transfer existing **Secret Security Clearance** for our consultants, but please note these requests, processed through AMS at USAID/GH (Washington, DC), can take 4-6 months to be granted. If you are in a Mission and the RSO is able to grant a temporary FA locally, this can expedite the process. FAs for non-US citizens or Green Card holders must be obtained through the RSO. If FA or Security Clearance is granted

through Washington, DC, the consultant must pick up his/her badge in person at the Office of Security in Washington, DC, regardless of where the consultant resides or will work.

If **Electronic Country Clearance (eCC)** is required prior to the consultant's travel, the consultant is also required to complete the **High Threat Security Overseas Seminar (HTSOS).** HTSOS is an interactive e-Learning (online) course designed to provide participants with threat and situational awareness training against criminal and terrorist attacks while working in high threat regions. There is a small fee required to register for this course. [*Note: The course is not required for employees who have taken FACT training within the past five years or have taken HTSOS within the same calendar year.*]

If eCC is required, and the consultant is expected to work in country more than 45 consecutive days, the consultant may be required complete the one-week **Foreign Affairs Counter Threat (FACT) course** offered by FSI in West Virginia. This course provides participants with the knowledge and skills to better prepare themselves for living and working in critical and high threat overseas environments. Registration for this course is complicated by high demand (consultants must register approximately 3-4 months in advance). Additionally, there will be the cost for additional lodging and M&IE to take this course.

X. GH EvaLS ROLES AND RESPONSIBILITIES

GH EvaLS will coordinate and manage the team and provide quality assurance oversight, including:

- Review SOW and recommend revisions as needed
- Provide technical assistance on methodology, as needed
- Develop budget for evaluation
- Recruit and hire the team, with USAID POC approval
- Arrange international travel and lodging for international consultants
- Request for country clearance and/or facility access (if needed)
- Review and assist with development of methods, workplan, evaluation/analytical instruments, reports, and other deliverables as part of the quality assurance oversight, as appropriate
- Report production - If the report is public, then coordination of draft and finalization steps, editing/formatting, 508ing required in addition to and submission to the DEC and posting on GH EvaLS website. If the report is internal, then copy editing/formatting for internal distribution.

XI. USAID ROLES AND RESPONSIBILITIES

Below is the standard list of USAID's roles and responsibilities. Add other roles and responsibilities as appropriate.

USAID will provide overall technical leadership and direction for the analytic team throughout the evaluation and will provide assistance with the following tasks:

Before Field Work

- SOW
  - Develop SOW.

- Peer Review SOW
- Respond to queries about the SOW and/or the evaluation at large.

- Consultant Conflict of Interest (COI). To avoid conflicts of interest or the appearance of a COI, review previous employers listed on the CV's for proposed consultants and provide additional information regarding potential COI with the project Evaluation Teams evaluated/assessed and information regarding their affiliates.
- Documents. Identify and prioritize background materials for the consultants and provide them to GH EvaLS, preferably in electronic form, at least one week prior to the inception of the evaluation.
- Local Consultants. Assist with identification of potential local consultants, including contact information.
- Site Visit Preparations. Provide a list of site visit locations, key contacts, and suggested length of visit for use in planning in-country travel and accurate estimation of country travel line items costs.
- Lodgings and Travel. Provide guidance on recommended secure hotels and methods of in-country travel (i.e., car rental companies and other means of transportation).

During Field Work

- Mission Point of Contact. Throughout the in-country work, ensure constant availability of the Point of Contact person and provide technical leadership and direction for the team's work.
- Meeting Space. Provide guidance on the team's selection of a meeting space for interviews and/or focus group discussions (i.e., USAID space if available, or other known office/hotel meeting space).
- Meeting Arrangements. Assist the team in arranging and coordinating meetings with stakeholders.
- Facilitate Contact with Implementing Partners. Introduce the analytic team to implementing partners and other stakeholders, and where applicable and appropriate prepare and send out an introduction letter for team's arrival and/or anticipated meetings.

After Field Work

- Timely Reviews. Provide timely review of draft/final reports and approval of deliverables.

XII. FINAL REPORT

Provide any desired guidance or specifications for Final Report. (See *How-To Note: Preparing Evaluation Reports*)

The Evaluation Report must follow USAID's Criteria to Ensure the Quality of the Evaluation Report (found in Appendix I of the USAID Evaluation Policy).

- The report must not exceed 25-30 pages (excluding executive summary, table of contents, acronym list and annexes).

- The structure of the report should follow the Evaluation Report template, including branding found here or here.
- Draft reports must be provided electronically, in English, to GH EvaLS who will then submit it to USAID.
- For additional guidance, please see the Evaluation Reports to the How-To Note on preparing Evaluation Draft Reports found here.

USAID Criteria to Ensure the Quality of the Evaluation Report (USAID ADS 201):

- Evaluation reports should be readily understood and should identify key points clearly, distinctly, and succinctly.
- The Executive Summary of an evaluation report should present a concise and accurate statement of the most critical elements of the report.
- Evaluation reports should adequately address all evaluation questions included in the SOW, or the evaluation questions subsequently revised and documented in consultation and agreement with USAID.
- Evaluation methodology should be explained in detail and sources of information properly identified.
- Limitations of the evaluation should be adequately disclosed in the report, with particular attention to the limitations associated with the methodology (selection bias, recall bias, unobservable differences between comparator groups, etc.).
- Findings and conclusions should be specific, concise, and supported by strong quantitative or qualitative evidence.
- If evaluation findings assess person-level outcomes or impact, they should also be separately assessed for both males and females.
- If recommendations are included, they should be supported by a specific set of findings and should be action-oriented, practical, and specific.

The UAV Pilot Mid-Term Evaluation Report must clearly describe the following:

- Assessment of pilot phase, including drone flight metrics and costs, relevant technical specifications, and operating model set up by IMPACT
- Quantitative analysis of health commodities demand in the area
- Qualitative synthesis of stakeholder experience
- Summary of lessons learning, including challenges and success factors
- Recommendation on program expansion, including potential range of health commodities that can be delivered and other health services potentially provided

Reporting Guidelines: The draft report should be a comprehensive analytical evidence-based evaluation report. It should detail and describe results, effects, constraints, and lessons learned, and provide recommendations and identify key questions for future consideration. The report shall follow USAID branding procedures. ***The report will be edited/formatted and made 508 compliant as required by USAID for public reports and will be posted to the USAID/DEC.***

The Evaluation Report should use the following format:

- Abstract: briefly describing what was evaluated, questions, methods, and key findings or conclusions (not more than 250 words)
- Executive Summary: summarizes key points, including the purpose, background, questions, methods, limitations, findings, conclusions, and most salient recommendations (2-5 pages)
- Table of Contents (1 page)
- Acronyms
- Evaluation Purpose and Questions: state purpose of, audience for, and anticipated use(s) of the evaluation (1-2 pages)
- Project [or Program] Background: describe the project/program and the background, including country and sector context, and how the project/program addresses a problem or opportunity (1-3 pages)
- Methods and Limitations: data collection, sampling, data analysis and limitations (1-3 pages)
- Findings (organized by Evaluation questions): substantiate findings with evidence/data
- Conclusions
- Recommendations
- Annexes
    - Annex I: Evaluation Statement of Work
    - Annex II: Methods and Limitations ((if not described in full in the main body of the final report)
    - Annex III: Data Collection Instruments
    - Annex IV: Sources of Information
- List of Persons Interviewed
- Bibliography of Documents Reviewed
- Databases
- [etc.]
    - Annex V: Statement of Differences (if applicable)
    - Annex VI: Disclosure of Any Conflicts of Interest
    - Annex VII: Summary information about Team members, including qualifications, experience, and role on the team.

The evaluation methodology and report will be compliant with the USAID Evaluation Policy **and** Checklist for Assessing USAID Evaluation Reports.

The final report should **exclude** any **potentially procurement-sensitive information**. As needed, any procurement sensitive information or other sensitive but unclassified (SBU) information will be submitted in a memo to USIAD separate from the report.

All data instruments, data sets (if appropriate), presentations, meeting notes and report for this evaluation/analysis will be submitted electronically to the GH EvaLS Program Manager. All datasets developed as part of this evaluation will be submitted to GH EvaLS in an unlocked machine-readable format (CSV or XML). The datasets must not include any identifying or confidential information. The datasets must also be accompanied by a data dictionary that includes a codebook and any other information needed for others to use these data.

Qualitative data included in this submission should not contain identifying or confidential information. Category of respondent is acceptable, but names, addresses and other confidential information that can easily lead to identifying the respondent should not be included in any quantitative or qualitative data submitted.

XIII. USAID CONTACTS

	Primary Contact	**Alternate Contact 1**	**Alternate Contact 2**
Name:	Ramy Razafindralambo	Haja Razafindrafito	Falihery Rabetaliana
Title:	Economist	Health Systems Strengthening Senior Advisor	Monitoring, Evaluation, and Learning Specialist
USAID Office/Mission	Program Office/Madagascar	HPN/Madagascar	Program Office/Madagascar
Email:	rrazafindralambo@usaid.gov	hrazafindrafito@usaid.gov	frabetaliana@usaid.gov
Telephone:	(261) 20 23 480 00 - Ext. 2766	(261) 33 44 327 50	
Cell Phone:	(261) 34 07 428 45	(261) 34 07 428 32	(261) 34 16 064 30

List other contacts who will be supporting the Requesting/Funder Team with technical support, such as reviewing SOW and final report (such as USAID/W GH EvaLS management team staff):

	Technical Support Contact 1	**Technical Support Contact 2**
Name:		
Title:		
USAID Office/Mission		
Email:		
Telephone:		

Cell Phone:		

XIV. OTHER REFERENCE MATERIALS

Documents and materials needed and/or useful for consultant evaluation, that are not listed above.

XV. ADJUSTMENTS MADE IN CARRYING OUT THIS SOW AFTER APPROVAL OF THE SOW

To be completed after evaluation implementation by GH EvaLS.

1. The start date was delayed slightly due to recruitment issues.
2. An additional team member, the Local Data Collector, was added to undertake the travel from Antananarivo to Maroansetra in the place of the Local Evaluation Specialist.
3. The LOE for the Local Evaluation Specialist was adjusted to allow for this addition, as was the LOE for the Local Drone Specialist.
4. The timeline was adjusted to accommodate additional refinement of the work plan and a delay due to onboarding the Local Data Collector and difficulties in booking the local flight.
5. An additional debrief presentation was given for the Implementing Partner.

ANNEX 3: DATA COLLECTION INSTRUMENTS

Key Informant Interview Guide

Country Level Stakeholders: MoPH (National and District), Global Fund, UNICEF

Interviewer:	**Interview Date:**
	Start time:

Interviewee's Name: **First:**	**Last:**
Current Position:	**Org:**
Contact email:	**Phone (Optional):**

Has the KI affirmed Informed Consent? YN

(Interviewer's initials)

Respondent's Unique ID: _____

	Questions/Topics	Responses
I. Background		
	1. Could you describe the roles of your entity in the supply of health products in Madagascar?	
	2. What have been the main challenges for the public supply chain for health products in general, and in remote areas in particular?	
II. Core Questions		
	3. Are you familiar with drone delivery systems in general?	EQ1
	4. IF ANY: Could you tell us about other activities in which your entity has used drones? Could you tell us about your experiences in using drones for delivery? *Screening: success, lessons learned, challenges*	EQ3
	5. Are you familiar with the drone delivery pilot project implemented by USAID in a few districts of eastern Madagascar? *IF YES: What roles did your institution play in the setting-up of the drone pilot project? What roles are you playing now?*	EQ1
	6. IF YOUR INSTITUTION WAS INVOLVED: Has the results met your expectation? *What are the main successes, the lessons learned?*	EQ4 EQ1

	7. What other investments or requirements must be in place for a drone delivery system to be more effective and sustainable in Madagascar?	EQ3
	8. IF THERE ARE SCALING UP OF THE DRONE PILOT PROJECT, what recommendations will you provide? *Probe on decision criteria for communes to be served by a drone, new regions/districts, donor's collaboration, roles of the entity*	EQ3
	9. What kind of contributions may your entity bring? Who should be the implementing agency?	
	10. What other areas in the health system do you think drones should be used?	EQ3
	11. So far, were any proposals made to your institution on the use of drones for the health system? *What activities, by whom, in which regions?*	EQ4
	12. What records and reports can we access?	EQ1 EQ2
III. Questions tailored for different stakeholder groups		
	13. Do national health strategies consider new technologies such as drone for public health?	Only for MoH Staff EQ3

	Other comments:
	Time at End of Interview:
	Interviewer’s observations or interpretations:

Key Informant Interview Guide

Technical Stakeholders Involved with UAV operations: PSI, Aerial Metric, Aviation Civile de Madagascar (ACM)

Interviewer:	**Interview Date:**
	Start time:

Interviewee's Name: **First:**	**Last:**
Current Position:	**Org:**
Contact email:	**Phone (Optional):**

Has the KI affirmed Informed Consent? Y N

(Interviewer's initials)

Respondent's Unique ID: _____

	Questions/Topics	Responses
I. Background		
	1. Could you describe the roles of your entity in the supply of health products in Madagascar?	

	2. Could you describe the roles of your entity in the management of USAID/GF/PSI UAV operations? *Screening: What roles did your institution play in the setting-up of the drone pilot project? What roles are you playing now?*	
	3. Would you say you are more involved with the management or policy of UAV operations or the technical aspects with operations, such as being a pilot? How long have you been working in this role?	
II. Core Questions		
	4. What is working well with the UAV operation? What have been the main challenges you have encountered? *Probe: Have there been any challenges with weather? What has been the context around incidents? What are the main limitations in terms of places where drones can fly?*	EQ2
	5. IF YOUR INSTITUTION WAS INVOLVED: Has the results met your expectation? *What are the main successes, the lessons learned?*	EQ4 EQ1
	6. What are your interactions with other stakeholders and the communities? *Probe on community engagement activities. Are other national stakeholders engaged and how?*	EQ3

	7. IF THE DRONE PILOT PROJECT IS SCALED UP, what recommendations would you provide? *Probe on additional regions, locations that can be reached, additional need for commercial products, more routes?*	EQ3
	8. What is the process to open new flight routes? Are you aware of any regulatory limitations that limit the UAV operations? *Probe: nature parks, other restricted areas.*	
	9. IF ANY: Could you tell us about other activities in which your entity has used or encountered drone operations?	EQ2 EQ4?
	10. What is the process to open new drone operation centers? *Probe any potential challenges with land use, and safety / infrastructure considerations*	EQ3
	11. So far, were any additional proposals made to your institution on the use of drones for the health system? *What activities, by whom, in which regions?*	EQ4
	12. What records and reports can we access?	EQ1 EQ2
III. Questions tailored for different stakeholder groups		
	13. What is the process for loading cargo on the drone?	Aerial Metric and PSI Drone Manager

	14. Has drone delivery met the demand for products from APs and CAs? *Discuss in detail?*	PSI staff
	15. What worked well and not well in partnering with a drone company such as Aerial Metric within the programmatic framework, procedures, and funding requirements of USAID?	PSI staff
	16. What would be the involvement of ACM in case the drone operations are expanded? What skills if any would be needed by your organization to accommodate additional drone operations? *Probe: is there sufficient capacity to open new routes, approve flights*	ACM
	Other comments:	
	Time at End of Interview:	
	Interviewer's observations or interpretations:	

Key Informant Interview Guide

Local Level Stakeholders: Commune Levels (PA, CSB, CHV, Mayors)

Interviewer:	**Interview Date:**
	Start time:

Interviewee's Name: **First:**	**Last:**
Current Position:	**Org:**
Contact email:	**Phone (Optional):**

Has the KI affirmed Informed Consent? Y____ N____

(Interviewer's initials)

Respondent's Unique ID: _____

	Questions/Topics	Responses
I. Background		
	1. Could you describe your role in the supply of health products at your commune/village? *How important is being a PA/CHV compared to your other businesses*	
	2. What have been the main challenges for the supply chain for health products in general at your commune/village?	

II. Core Questions		
	3. Are you familiar with the drone delivery pilot project implemented by USAID/GF/PSI at your commune? *Probe: Was there awareness session to the public or the authorities by PSI? What roles did you play in the setting-up of the drone pilot project? What roles are you playing now?*	EQ1
	4. How has the existence of drone delivery system affected the volume of the demand from your clients (villagers, CHV); the availability of products (less stock outs)? *Probe on seasonality, type of products* *Probe questions on health outcomes/changes perceived by Chefs CSB in the localities where CHVs are served by the drone.*	EQ1 EQ4
	5. How does the system changed the delays in getting health products? For emergency needs? For routine needs? *Screening: compare the situation before and after the drone pilot project; impact of weather.*	EQ1 EQ2 EQ4
	6. What are the main challenges in working with the drone delivery system? *What are the risks, the main constraints? How has PSI addressed the issues?*	EQ2 EQ4
	7. On a scale of 1-5 (1 is not satisfied at all), how do you score the drone system in supplying health products at your community? *Why?*	EQ1 EQ2

	8. Were there any circumstances where you've decided not to request products (or request less) even though there are high demand? *Screening: change due to weather, volume of products – How do you manage expired products?*	EQ2 EQ4
	9. How do you communicate with PSI in requesting health products through the drone pilot system? Is there any improvement you want to see?	EQ4
	10. Have there been any incidences with the supply of products since the use of drones? *Screening: unexpected delays, damaged products - How do you record these incidences?*	EQ2
	11. Are you aware of the rules and regulations related to drone operations? What training did you receive on working with drones? on supply chain management?	EQ1 EQ3
	12. What other investments or requirements must be in place for the use of drones to be more effective and sustainable at your commune?	EQ3 EQ4
	13. What other areas in the health system do you think drones should be used? What other products would you like to have delivered by drone?	EQ1 EQ3
	14. What do you think other villagers perceived the drone delivery system? *Probe if there was basic awareness if there are concerns that have been addressed / unaddressed*	EQ1
	15. What records and reports can we access?	EQ1 EQ2
III. Questions tailored for different stakeholder groups		

	16. What kind of coordination do you have with the CSB staff on drone operations?	PA
	17. What kind of coordination do you have with the PA manager on drone operations?	CSB
	18. Is there anyone else you think we should speak with to answer any of these questions?	ALL
	Other comments:	
	Time at End of Interview:	
	Interviewer's observations or interpretations:	

Field Observation Checklist and Guide

Observer:	**Date:**
Location:	

Technical Drone Operations Observations

Note: Safety for all involved is most important and the observer must maintain safety distances from charged aircraft. Observations may need to take place from a distance and in a manner that does not obstruct, distract, or otherwise negatively impact the operators from performing their duties. Questions can be asked later in case discrepancies are overserved.

Topic	Observations and Remarks
Documentation at operational site	
Drone maintenance manual	Present / not present Remarks:
Check list for normal flight procedures	Present / not present Remarks:

Checklist for procedures during abnormal flight conditions	Present / not present Remarks:
Drone Maintenance Manual	Present / not present Remarks:
Flight Logbook	Present / not present Remarks:
Procedures in flight, pre-flight, and post-flight	
Are any discrepancies observed with regards to procedures as laid out in technical reference documents? - "Procédure de communication entre le Télépilote Aerial Metric at l'agent AFIS de Maroantetra", - "Manuel d'utilisation implemented" - "Fiche Technique GS330".	No / Yes Remarks:

Safety and fixed infrastructure (Take photographs where possible to describe lay out and any safety features such as signs, and safety markings, barriers)	
Landing and Take-off Site: Are any safety concerns observed with regards to - maintenance of buffer zones - public access - battery charging set-up - Operator visibility of the sky, - General suitability of the site etc.?	No / Yes Remarks:

Additional notes, interpretations, and observations:

ANNEX 4: SOURCES OF INFORMATION

KEY INFORMANTS FOR THE MID-TERM EVALUATION OF THE UAV PILOT ACTIVITY, USAID/MADAGASCAR HEALTH PROJECT

NAME	ORGANIZATION
1. Sandrah Rahantanirina	PSI
2. Tsirihanitra Rakotoarinivo	PSI
3. Lia Reasa	ACM
4. Nicole Mahavany	MoPH
5. Marc Ottolini	The Global Fund
6. Scot Dubin	The Global Fund
7. Alain Ratsimbazafy	MoPH
8. Mahasoa Ratsima	Project Coordination Unit
9. Serge Raharison	USAID/ACCESS
10. Stephanie Ranaivo	USAID/ACCESS
11. Diary Ravoavy	AM
12. Dolin Sanga	Mayor Commune
13. Francois Lalahy Andriantsiory	MoPH
14. Leon Archelle Ratovoniaina	MoPH
15. Elyse Paul Joevin Tsilagnizara	MoPH
16. Razanadrasoa Jeannette Soafaniry	MoPH
17. Marie Angelette	PSI
18. Orlando Cleo Pelaka	MoPH
19. Tautvydas Juskauskas	UNICEF

20. Brigitte Noras	PSI
21. Marcel Bobilahy	PSI
22. William Toto	PSI
23. Favien Randrianasolo	PSI
24. Emmanuel Ferlin	MoPH
25. Ivelise Lalao Bevelo	CHV
26. Denise Rafarasoa	CHV
27. Stéphane Bihr	AM
28. Julio Lazara	Adjunct Mayor Commune

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Amukele, Timothy K; Street, Jeff; Carroll, Karen; Miller, Heather; Zhang, Sean X; Drone transport of microbes in blood and sputum laboratory specimens, American Society for Microbiology, Journal of Clinical Microbiology, 08.08.2016

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ANNEX 5: DISCLOSURE OF ANY CONFLICTS OF INTEREST

CONFLICT OF INTEREST (COI) VERIFICATION

(please fill/sign/date the form below)

Name:	Wayne Stinson
Title:	Consultant
Organization:	ME&A, Inc.
Evaluation Position:	Team Lead
Evaluation Award Number: *(or RFTOP or other appropriate instrument number)*	GH EvaLS GS-10F-154BA/ 7200AA20M00003
Project(s) Evaluated: *(Include project name(s), implementer name(s) and award number(s), if applicable)*	UAV Pilot Activity (within IMPACT Malaria
I have real or potential conflict of interest to disclose:	☐ YES ☑ NO ☐ NOT APPLICABLE
If yes answered above, I disclose the following facts: *Real or potential conflicts of interest may include, but are not limited to:* *1. Close family member who is an employee of the DoS operating unit managing the project(s) being evaluated or the implementing organization(s) whose project(s) are being evaluated.* *2. Financial interest that is direct, or is significant though indirect, in the implementing organization(s) whose projects are being evaluated or in the outcome of the evaluation.* *3. Current or previous direct or significant though indirect experience with the project(s) being evaluated, including involvement in the project design or previous iterations of the project.* *4. Current or previous work experience or seeking employment with the DoS operating unit managing the evaluation or the implementing organization(s) whose project(s) are being evaluated.* *5. Current or previous work experience with an organization that may be seen as an industry competitor with the implementing organization(s) whose project(s) are being evaluated.* *6. Preconceived ideas toward individuals, groups, organizations, or objectives of the particular projects and organizations being evaluated that could bias the evaluation.*	
Name and Signature: Wayne Stinson Wayne Stinson	
Date: Feb 16, 2021	

CONFLICT OF INTEREST (COI) VERIFICATION

(please fill/sign/date the form below)

Name:	**Denise Soesilo**
Title:	Consultant
Organization:	ME&A, Inc.
Evaluation Position:	Senior Drone Specialist
Evaluation Award Number: *(or RFTOP or other appropriate instrument number)*	GH EvaLS GS-10F-154BA/ 7200AA20M00003
Project(s) Evaluated: *(Include project name(s), implementer name(s) and award number(s), if applicable)*	UAV Pilot Activity (part of IMPACT Malaria)
I have real or potential conflict of interest to disclose:	☐ YES X NO ☐ NOT APPLICABLE
If yes answered above, I disclose the following facts: *Real or potential conflicts of interest may include, but are not limited to:* *1. Close family member who is an employee of the DoS operating unit managing the project(s) being evaluated or the implementing organization(s) whose project(s) are being evaluated.* *2. Financial interest that is direct, or is significant though indirect, in the implementing organization(s) whose projects are being evaluated or in the outcome of the evaluation.* *3. Current or previous direct or significant though indirect experience with the project(s) being evaluated, including involvement in the project design or previous iterations of the project.* *4. Current or previous work experience or seeking employment with the DoS operating unit managing the evaluation or the implementing organization(s) whose project(s) are being evaluated.* *5. Current or previous work experience with an organization that may be seen as an industry competitor with the implementing organization(s) whose project(s) are being evaluated.* *6. Preconceived ideas toward individuals, groups, organizations, or objectives of the particular projects and organizations being evaluated that could bias the evaluation.*	
Name and Signature: Denise Soesilo	
Date: 27 March 2021	

CONFLICT OF INTEREST (COI) VERIFICATION

(please fill/sign/date the form below)

Name:	**Jean Claude Randrianarisoa**
Title:	Consultant
Organization:	ME&A, Inc.
Evaluation Position:	National Evaluation Specialist
Evaluation Award Number: *(or RFTOP or other appropriate instrument number)*	GH EvaLS GS-10F-154BA/ 7200AA20M00003
Project(s) Evaluated: *(Include project name(s), implementer name(s) and award number(s), if applicable)*	UAV Pilot Activity (part of IMPACT Malaria)
I have real or potential conflict of interest to disclose:	☐ YES ■ NO ☐ NOT APPLICABLE
If yes answered above, I disclose the following facts: *Real or potential conflicts of interest may include, but are not limited to:* *1. Close family member who is an employee of the DoS operating unit managing the project(s) being evaluated or the implementing organization(s) whose project(s) are being evaluated.* *2. Financial interest that is direct, or is significant though indirect, in the implementing organization(s) whose projects are being evaluated or in the outcome of the evaluation.* *3. Current or previous direct or significant though indirect experience with the project(s) being evaluated, including involvement in the project design or previous iterations of the project.* *4. Current or previous work experience or seeking employment with the DoS operating unit managing the evaluation or the implementing organization(s) whose project(s) are being evaluated.* *5. Current or previous work experience with an organization that may be seen as an industry competitor with the implementing organization(s) whose project(s) are being evaluated.* *6. Preconceived ideas toward individuals, groups, organizations, or objectives of the particular projects and organizations being evaluated that could bias the evaluation.*	
Name and Signature:	**Jean Claude Randrianarisoa**
Date: 03/25/2021	

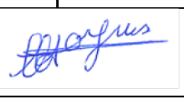
CONFLICT OF INTEREST (COI) VERIFICATION

(please fill/sign/date the form below)

Name:	RAMANAMANDIMBY Pierrot
Title:	Consultant
Organization:	ME&A, Inc.
Evaluation Position:	Local Drone Expert
Evaluation Award Number: *(or RFTOP or other appropriate instrument number)*	GH EvaLS GS-10F-154BA/ 7200AA20M00003
Project(s) Evaluated: *(Include project name(s), implementer name(s) and award number(s), if applicable)*	UAV Pilot Activity (part of IMPACT Malaria)
I have real or potential conflict of interest to disclose:	☐ YES ☒ NO ☐ NOT APPLICABLE
If yes answered above, I disclose the following facts: *Real or potential conflicts of interest may include, but are not limited to:* *1. Close family member who is an employee of the DoS operating unit managing the project(s) being evaluated or the implementing organization(s) whose project(s) are being evaluated.* *2. Financial interest that is direct, or is significant though indirect, in the implementing organization(s) whose projects are being evaluated or in the outcome of the evaluation.* *3. Current or previous direct or significant though indirect experience with the project(s) being evaluated, including involvement in the project design or previous iterations of the project.* *4. Current or previous work experience or seeking employment with the DoS operating unit managing the evaluation or the implementing organization(s) whose project(s) are being evaluated.* *5. Current or previous work experience with an organization that may be seen as an industry competitor with the implementing organization(s) whose project(s) are being evaluated.* *6. Preconceived ideas toward individuals, groups, organizations, or objectives of the particular projects and organizations being evaluated that could bias the evaluation.*	
Name and Signature: RAMANAMANDIMBY Pierrot	
Date: 23/03/2021	

CONFLICT OF INTEREST (COI) VERIFICATION

(please fill/sign/date the form below)

Name:	**RAMINOSOA Gregoire Marie Flora**
Title:	Consultant
Organization:	ME&A, Inc.
Evaluation Position:	Local Data Collector
Evaluation Award Number: *(or RFTOP or other appropriate instrument number)*	GH EvaLS GS-10F-154BA/ 7200AA20M00003
Project(s) Evaluated: *(Include project name(s), implementer name(s) and award number(s), if applicable)*	UAV Pilot Activity, USAID/Madagascar Health Project
I have real or potential conflict of interest to disclose:	☐ YES ■ NO ☐ NOT APPLICABLE
If yes answered above, I disclose the following facts: *Real or potential conflicts of interest may include, but are not limited to:* *1. Close family member who is an employee of the DoS operating unit managing the project(s) being evaluated or the implementing organization(s) whose project(s) are being evaluated.* *2. Financial interest that is direct, or is significant though indirect, in the implementing organization(s) whose projects are being evaluated or in the outcome of the evaluation.* *3. Current or previous direct or significant though indirect experience with the project(s) being evaluated, including involvement in the project design or previous iterations of the project.* *4. Current or previous work experience or seeking employment with the DoS operating unit managing the evaluation or the implementing organization(s) whose project(s) are being evaluated.* *5. Current or previous work experience with an organization that may be seen as an industry competitor with the implementing organization(s) whose project(s) are being evaluated.* *6. Preconceived ideas toward individuals, groups, organizations, or objectives of the particular projects and organizations being evaluated that could bias the evaluation.*	
Name and Signature: RAMINOSOA Gregoire Marie Flora 	
Date: 2021 JUNE 25	

ANNEX 6: EVALUATION TEAM MEMBERS

Wayne Stinson, PhD, MS, MIA – Team Lead

Wayne Stinson has worked in and for Africa for more than 30 years and is an experienced evaluator. He is acquainted firsthand with development challenges, having worked both as a USAID personal services contractor and an NGO Project Director. He strongly supports community self-help and community voices – knowing from experience that the best ideas often come from the bottom up. Wayne is a demographer by training, and as an evaluator, combines qualitative and quantitative instincts. Wayne served as the Team Lead for this evaluation, managing the team and overseeing the evaluation design, data collection, and data analysis.

Denise Soesilo, MEM – Senior Drone Expert

Denise has 10+ years of experience working with development and humanitarian organizations on the implementation and efficient integration of emerging technologies in development contexts and humanitarian response. Her work focuses especially on responsible robotics, social inclusion, equity, and sustainability. Denise has extensive experience working with international donors supporting governments to operationalize the use of drones for education, resilience, and supply chain integration. Previously, Denise led the European Union Humanitarian Aid flagship innovation project on using drones in humanitarian crises. Denise is based in Geneva, Switzerland and holds degrees in environmental studies and environmental management from Yale University. Denise served as the Senior Drone Expert for this evaluation, providing expertise in international drone operations and evidence.

Jean Claude Randrianarisoa, PhD, MSc – Malagasy Evaluation Specialist

Jean Claude Randrianarisoa served as the Senior Economist and Monitoring and Evaluation specialist at USAID/Madagascar from 2008 to 2016. He was responsible for the evaluation of most USAID bilateral development and social projects on health, food security, and water and sanitation. He wrote the Mission's policy to reflect the Agency's directive on M&E, managed evaluation contracts, ensured the quality of the data reported to the Mission, and made sure that evaluation results are incorporated into project design. During his tenure at USAID, he was the main point of contact for working relations with the government and the private sector. In the past five years, Jean Claude was a consultant in dozens of developing countries, mostly in Southeast Asia and in Africa. His areas of expertise include evaluation of development projects, policy and strategy designs, feasibility studies, and digital solutions.

Jean Claude is an alumnus of the MIT Poverty Action Lab (J-PAL) and USAID University. He holds an MSc. In Agricultural Economics from Michigan State University and a PhD (A exam) in Policy Analysis and Management from Cornell University. Jean Claude was the Malagasy Evaluation Specialist, providing expertise in designing data collection tools, data collection, and data analysis.

Pierrot Ramanamandimby Dipl. Ing. – Malagasy Drone Specialist

Pierrot Ramanamandimby is a PhD student studying at University of Antananarivo in collaboration with the Axel Lab (Marshall University). His research applies the use of UAVs (drones) to map Dry Forest Structure in Madagascar. He is experienced in forestry, conservation, environment, sustainable development, climate change, and remote sensing (+5 years). He has worked with several NGOs and international organizations (World Wildlife Fund, Food and Agriculture Organization, GIZ, UNDP, among others) as well as the Government of Madagascar. Since 2017, he has been working with drones to improve forest conservation and can therefore provide new tools using technologies for the IPs working in conservation. Furthermore, he is a research assistant at the Forestry and Environment (University of

Antananarivo) and an active member of the Association for Tropical Biology and Conservation. Pierrot was the Malagasy Drone Specialist for this evaluation, providing insight into Malagasy drone regulations, operations, and current evidence.

Gregoire Marie Flora Raminosoa, MPH – Local Data Collector

From 2008 to 2014, Dr. Grégoire Raminosoa conducted and supervised several surveys and key informant interviews on health during the evaluation of the use of mosquito nets, the use of family planning contraceptive products in the East coast of Madagascar, the evaluation and monitoring of the use of SMS system in the south of Madagascar, and the analysis of the improvement of the communication system for community health projects. For this assignment, he assisted the team in conducting KIIs and field observations during the field work on the evaluation of drone pilot program in Maroantsetra.

Gregoire holds a Master's in Public Health from the National Institute of Public Health of Antananarivo in 2009, and a MD from the University of Antananarivo in 1994. He also participated in several professional training on epidemiology, statistics, health management, and care for child illness at the community level (PCIMEC) between 2008 and 2011.