Introducing Unmanned Aerial Vehicles (UAVs) for Vaccine Transport in the Democratic Republic of Congo

Phase 1: Permissions, Preliminary Design, and Testing

Suggested citation:
Introduction

Effective and efficient immunization supply chains are an essential component of a quality healthcare system, but a lack of reliable infrastructure remains a pervasive barrier to achieving immunization coverage in low-resource environments. Governments in sub-Saharan Africa have begun to investigate the potential of drones or unmanned aerial vehicles (UAVs) as an integrated component of a responsive and resilient transportation network to better address longstanding in-country supply chain challenges.

VillageReach has been working with the Government of the Democratic Republic of Congo (DRC) and Gavi, the Vaccine Alliance, to test and integrate drones into the existing supply chain, through a phased approach. We have completed Phase 1 (Permissions, Preliminary Design, and Testing) on 31 October 2019, following successful drone demonstration flights conducted in July-August 2019 in collaboration with the Australian powered health logistics firm Swoop Aero, officials from the national, provincial and local level, and community leaders and community members in Equateur province.

The flights received widespread media attention, at the national and international level, and generated significant enthusiasm and momentum in DRC. The demonstration flights successfully showed stakeholders that a drone transport system can lead to more timely and consistent product deliveries. Subsequently, stakeholders expressed interest in rapid scale up to additional health centers and provinces, working towards the ultimate goal of vaccinating all children.

This is the final Phase 1 project report, which aggregates the main accomplishments, including deliverables (outputs), results (outcomes), lessons learned, and next steps for scaling up the intervention. VillageReach has previously submitted two quarterly updates to Gavi, and an interim report at the end of June 2019. While this final report encompasses all Phase 1 project activities (conducted over the course of approximately one year, from September 2018 to October 2019), much of the focus in this report goes to new activities conducted from July to October 2019, including the official drone demonstration flights.

Swoop Aero drone takes off from Mbandaka, capital of Equateur province, to make the 80 km round-trip by air towards the rural health center of Widifake, 2019. Photo by Swoop Aero
Summary: Phase 1 – Permissions, Preliminary Design and Testing

In order to understand the potential impact of UAVs on the performance of the immunization system, we have developed a multi-phased approach for introducing, testing, and expanding the use of UAVs in DRC.

Phased approach to introducing drones into the immunization supply chain in the DRC

Phase 1 Accomplishments

1. Raising Stakeholder Awareness and Gaining Commitment

From October 2018 to September 2019, Phase 1 put in place governance mechanisms for collaboration and coordination at the national and provincial government levels in DRC. The National Drones for Health Commission was established by the Ministry of Public Health (MoH), with representatives of the Civil Aviation Authority (CAA), the Ministry of Interior and Security, the Secretary General for Health, the Expanded Programme on Immunization (EPI), and PNAM (Programme National d’Approvisionnement en Médicaments Essentiels), among others. This National Commission met three times (quarterly), beginning in January 2019, developed terms of reference and received updates on the project. It sent representatives to Equateur to witness both the initial test flights and official demonstration flights. After the demonstration flights, the National Commission made a unanimous recommendation to continue to Phase 2 of the project. An extension of this Commission was created at the provincial level in Equateur, called the Drones for Health Working Group, which also involves broad and multi-disciplinary representation. The provincial working group is presided over by the Governor of Equateur, with close backing and support from the Provincial Minister of Health, the Provincial Health Division (Division Provinciale de la Santé/DPS) and the Equateur EPI team. This working group also met quarterly, with an additional ad-hoc meeting in August 2019.

In collaboration with the DRC MoH, VillageReach conducted a stakeholder and community perceptions study, which included focus group discussions (FGDs) and key informant interviews (KIs) with national, provincial, and local authorities, as well as health personnel and community leaders and members. These discussions showed very low awareness of drones at the local level prior to the flights, but high acceptability for the idea of using drones to transport vaccines and other health commodities at all levels. The study yielded important insights into stakeholders’ concerns and recommendations, all of which informed the community outreach campaign and public communications materials circulated before the flights.

2. Successful Drone Demonstration Flights and Product Deliveries

VillageReach engaged with the DRC Civil Aviation Authority (CAA), who further involved the National Intelligence Agency ANR (Agence Nationale de Renseignements) in the approval process. Following a competitive global selection process and the submission of all necessary documentation, VillageReach and the DRC CAA selected Swoop Aero as the drone supplier and operator. An official authorization to import and use the drones in DRC was granted by the CAA in May 2019.
This critical milestone led to the successful completion of initial test flights on 29 June-1 July 2019, in the presence of CAA and the MoH, including EPI. The official demonstration flights took place from 5-8 August 2019, transporting commodities between the EPI vaccine distribution center in Mbandaka, capital of Equateur, and a rural health center in Bikoro health zone, called Widjifake. Over a 5-day period, 50 flights to and from Widjifake were conducted, for a total of 20 hours of flight time, using two drones that covered 2000 km in the air. The flights carried more than 25 kg of primarily vaccines and syringes, but also medicines and supplies. From Widjifake, the products were further distributed by trained EPI staff, on motorcycle, to an additional four health centers in the neighboring villages. The Swoop Aero fixed-wing, electric drones flew the 80 km from Mbandaka to Widjifake and back on a single battery charge. Swoop Aero’s drones have vertical take-off and landing (VTOL) capability, enabling the drones to return from the health center to the EPI vaccine distribution center with data collection forms, reports, and blood samples.

With two drones flying at the same time in opposite directions, we demonstrated the ability of Swoop Aero’s system to scale operations to a number of health centers and to decrease delivery time. This success is due to identifying a drone partner with a proven safety and performance record and our joint commitment to train provincial and local health staff on flight operations. Swoop Aero and VillageReach involved local Ministry of Health staff in the day-to-day and minute-by-minute operations, and during the official ceremony, the EPI and health center staff were the ones leading the demonstration. Our commitment to local capacity building continued through the conduct of a preliminary capacity assessment, which consisted of interviews with a range of stakeholders, to understand the existing capability for operating and maintaining drones, as well as needs for future training in DRC.

The success of the demonstration flights is largely due to strong partnerships that were formed, in a relatively small period of time, with the national and provincial governments, local health center staff and communities, in a country that had close to zero experience with cargo drones for health or humanitarian purposes. We exceeded our goal of conducting successful drone demonstration flights by responding to real needs on the ground, and followed existing procedures to show that seamless integration of drones into the Equateur immunization supply chain is indeed possible.

**Next Steps: Phase 2 and 3 Scale-up and Integration**

With Phase 1 now complete, and great enthusiasm and commitment generated among all key stakeholders in DRC, VillageReach submitted to Gavi a proposal for Phase 2 to conduct “Routine Use and Validation” in remote health centers throughout Equateur province. Additionally, MoH is interested in a long-term Phase 3 in order to “Expand the Impact” of this promising new technology to additional provinces, settings and commodities, as identified by EPI in the latest Health System Strengthening funding submission to Gavi.
Recent and Overall Progress

Implementation of Phase 1 was organized into five work streams: Governance, Aviation and Health Regulations, Evidence Generation, Technology and Acceptability, each with their own set of deliverables. This framework, presented in its original version below, has slightly evolved over the course of the project – the latest version is captured in French in Annex A.

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**Governance**

The national Drone Commission (Commission Drone Santé), established by ministerial decree in January 2019 in connection with this project, met for its third quarterly meeting on 6 September 2019 in Kinshasa. The meeting, presided over by the Secretary General for Health’s office, saw representatives from across the Ministry of Health and EPI, PNAM and Ministry of Interior and Security receiving an in-depth presentation from VillageReach on all Phase 1 activities and results, by work stream. The presentation then led into a discussion of the Go/No Go framework that the Commission had validated earlier in the year and to a unanimous decision to proceed with scaling up the project and moving into Phase 2 (see Deliverables 1.1, 1.3 and 1.4 in separate document).

The Commission also discussed the proposed strategy and plans for Phase 2, which stemmed from earlier discussions that had taken place at a joint meeting of national, provincial and local decision-makers in
Mbandaka, Equateur, on 9 August 2019, the day after the successful drone flights had concluded. The Secretary General for Health, Head of EPI Logistics, PNAM Director, Interim Governor of Equateur, along with many other officials had participated in the Mbandaka meeting and voiced their opinions after observing the drone flights in person. National officials’ travel to Equateur was organized by VillageReach.

A third quarterly meeting of the provincial Drones Working Group in Equateur also took place in late September in Mbandaka, and mirrored the discussions on Phase 1 outcomes and Phase 2 plans that had been done at the national Commission level. The provincial authorities, from the Governor’s office, Provincial Minister of Health, DPS and EPI as well as from Health Zone level in Equateur, gave their green light as well for Phase 2 scale up. Moreover, the DPS developed a list of difficult-to-access health areas that could be served by drones throughout Equateur province. While 46 health centers are currently on this list, which was also validated by the provincial Health Supply Chain Working Group, around 25 will ultimately be selected after a site assessment trip by the MoH and VillageReach, based on the following criteria:

- Most remote or difficult-to-access from the Mbandaka provincial vaccine distribution center,
- Have functioning cold chain equipment (are designated as vaccine storage sites for neighboring health centers),
- Low availability of vaccines and/or low utilization of services, to maximize impact, and
- Spread across the various Health Zones in Equateur province, for equity reasons.

Taken together, these meetings as well as individual discussions with key government officials at all levels, helped to refine the concept for scale up of immunization product deliveries by drone to remote facilities throughout Equateur province — and ultimately the Phase 2 proposal that was submitted to Gavi. A roadmap or work plan for Phase 2 was one of the deliverables of Phase 1 (see Deliverable 1.4).

It is important to note that in addition to Phase 2 scale-up in Equateur, which would start in early 2020, EPI has expressed interest in expanding drone deliveries of immunization products to new provinces as part of a longer-term Phase 3, that would start in mid-2021, and has requested budget estimates from VillageReach and Swoop Aero for this purpose. Moreover, the Secretary General for Health and PNAM Director have articulated an even broader vision of integrating drones into the supply chain in DRC for additional medical commodities (such as essential medicines, malaria, HIV, TB commodities, lab samples and reagents) and in additional settings (for example, urban areas like Kinshasa) or for emergency products (i.e. blood for
transfusion, oxytocin for post-partum hemorrhage, surgical equipment, or supplies needed for outbreaks). At the September 2019 National Drones for Health Commission meeting, PNAM indicated that drones have already been included in the National Plan for Health Development (Plan National de Développement Sanitaire 2020-2022). In addition, VillageReach started exploring a public-private partnership to scale and sustain drone operations during the Phase 3 of the initiative.

It is worth noting that in order to provide a broader perspective for DRC government officials, in late 2019, VillageReach had supported the drones focal point from DRC Civil Aviation and a representative of the Ministry of Health to attend the Lake Victoria Challenge and associated African Drone Leader Symposium in Tanzania. And in March 2019, VillageReach supported a member of the Ministry of Health and Interior along with the VillageReach Drones Project Manager in DRC to conduct a learning visit to Malawi; during this visit, they observed drone flights during another VillageReach project and met with government counterparts in a country that is very progressive on drone regulations and testing (see Deliverable 1.2).

Aviation and Health Regulations

Aviation: In late 2018, VillageReach shared examples of existing drone regulations with the DRC Civil Aviation Authority (CAA) from several countries that had recently established such regulations. Developing national regulations is a long process that sometimes takes years, and the DRC CAA indicated that they have started the process internally and will involve national defense agencies. In the meantime, CAA designed application forms that would allow our project to move forward, in the absence of national regulations (see Deliverable 2.1).

In late May 2019, following a series of meetings between VillageReach and the DRC Civil Aviation Authority (CAA), the last of which included a formal presentation of Swoop Aero’s technical capabilities and safety mechanisms and the submission of a full documentation package by Swoop Aero, CAA issued an official authorization to import and use the drones in connection with the Drones for Health project in Equateur (see Deliverable 2.3).
In late June/early July 2019, during Swoop Aero’s first visit to DRC, CAA representatives in Kinshasa had a first encounter with the drones and got to exchange in person with Swoop Aero’s CEO, COO and Control Systems Lead at the CAA headquarters in Kinshasa. CAA nominated the drones focal point and a senior inspector to travel to Equateur and observe both the initial test flights that took place on 29 June and 1 July 2019, and the subsequent demonstration flights that took place from 5-8 August 2019. Prior to both operations, VillageReach and Swoop Aero submitted the formal applications that had been designed by CAA with specific details about the flight routes – over the Congo River and in populated areas between urban Mbandaka and Widjifake rural health area. On both occasions, VillageReach coordinated a meeting between CAA – the national regulatory body, – the local Air Traffic Control at Mbandaka airport (Régie des Voies Aériennes or RVA), and the drone operators of Swoop Aero; at these meetings, the flight routes, communication processes, and emergency procedures were agreed upon and validated. MoH representatives were present at all discussions, and the World Health Organization (WHO) office in Mbandaka stored the drones in between flight operations.

As mentioned above, VillageReach and Swoop Aero worked together on designing an Emergency response protocol with procedures in case of any incident or accident related to the drones (see Deliverable 2.1). Swoop Aero conducted a joint team meeting with members of the core ‘flight operations team’ each morning, to review these procedures, at both the drone take-off location (the EPI vaccine distribution center in Mbandaka) and at the landing location (at the Widjifake rural health center). The ‘flight operations team’ consisted of a small number of representatives from Swoop Aero, VillageReach, MoH (EPI/DPS in Mbandaka and Nurse-In-Charge in Widjifake), CAA, and an MoH ambulance team of doctor and nurses with a dedicated driver as well as a boat on stand-by on the shore of Congo River since half of the flight route was over water, and half over land. Please note that all drone flights concluded safely and emergency procedures were never initiated.

Due to lack of cell phone towers in Widjifake, the team leads kept in touch by sending text messages via satellite phones, especially to coordinate take-off and landing times. The team lead in Mbandaka also notified the Air Traffic Control station at the airport prior to any flight operations commencing or ending for the day, to coordinate aerial traffic in the vicinity of the airport. For the August flights, VillageReach procured a tablet for Air Traffic Control so they could follow the drone flight path in real time on a website provided by Swoop Aero. The VillageReach team lead in Mbandaka also sent out regular updates about
the flights and product deliveries via Whatsapp to a broader group of government officials that were directly involved or interested to receive such updates for further reporting to their respective ministries and agencies.

Following direct observation of drone operations, including simultaneous flights by two drones flying in opposite directions, CAA committed to providing the necessary approvals for Phase 2 and to working closely with Swoop Aero and VillageReach on identifying the best aerial routes from Mbandaka to all selected health facilities and any intermediary stops, such as the Health Zone offices.

Health: Regarding Ministry of Health and EPI procedures and protocols for the transport of immunization products by drone, EPI at the national level had provided guidance in early 2019 that was similar for drone deliveries as other existing transport methods, with the same type of data being collected, for seamless integration. At the provincial level, VillageReach’s Provincial Coordinator and Supply Chain Advisor to the DPS and EPI, worked closely with EPI on obtaining stock status data from Widjifake health center and neighboring health centers, and determined the vaccine and syringe quantities required for a 2-month supply plus 1 month of buffer stock, based on their average monthly consumption and remaining stock balance (standard procedure under the New Generation for Supply Chains (NGCA) initiative. For more on NGCA, please visit: https://www.villagereach.org/wp-content/uploads/2018/09/Increasing-Access-to-Health-Products-in-the-DRC.pdf

VillageReach and EPI also worked together on step-by-step standard operating procedures (SOPs) to be followed for the packaging of vaccines, with ice packs, digital thermometers and fridge tags, into standard-size WHO vaccine carriers that were then loaded into the drone by the EPI Provincial Director, Logistician or Assistant.

Standard product delivery and receipt forms were completed and signed at both ends, along with NGCA reporting forms, and exchanged by drone (see Deliverable 2.2).

Moreover, EPI weighed the products and checked temperature at both ends, and the drone became a conduit of information between the vaccine distribution center and the receiving health center. Please note that all vaccines stayed in the required temperature range, with no concerns raised during the approximately 20-23 minute drone trip from Mbandaka to the health center.

In addition to 20 drone flights carrying immunization products (vaccines and syringes), 5 flights demonstrated that other medical commodities could be flown just as easily. Per request from the Widjifake
health center, the Provincial Health Director approved drone deliveries of essential medicines and supplies, and - on one return flight from the health center - two blood samples for measles and yellow fever were flown to EPI in Mbandaka, and later routed by EPI to the national laboratory in Kinshasa for analysis.

REGULATIONS: KEY SUCCESSES

* DRC Civil Aviation Authority (CAA) provided approvals for importation and flight operations of Swoop Aero’s drones.

* Direct participation in the drone flights by CAA, and coordination with local Air Traffic Control led to commitment for future collaboration in Phase 2.

* Emergency protocols were established, but never had to be put in practice (no safety issues).

* EPI and VillageReach followed standard operating procedures for the resupply, transport and reporting of immunization product deliveries by drone.

Evidence Generation

Site selection: In collaboration with the Equateur DPS and EPI, VillageReach had identified Widjifake health center in Bikoro Health Zone as the drone landing site for the Phase 1 demonstration flights (see Deliverable 3.1). Widjifake is a rural health area composed of several villages, located 45 km by road from Mbandaka, the capital of Equateur, however the road to the village is unpaved, and the journey by car can take up to 3 hours each way. The road becomes difficult or impassable during the rains, and there are no cell phone towers in the area, making communication difficult. While there are more remote areas than Widjifake in Equateur, it was selected because the difficulty of access make it representative of the province but the distance was still fairly reasonable so the project team and officials could reach the village for trainings of health center workers, community sensitizations and the ceremonies that surrounded the Phase 1 demonstration flights.

Moreover, 4 additional health areas neighboring Widjifake benefited from drone deliveries that landed at Widjifake. They were Indjolo, Bobala, Penzele and Kalamba, with a total population of 47,065 people. VillageReach had recently trained EPI and Bikoro zone health personnel on the NGCA initiative, and one EPI trained staff member was responsible for transferring the vaccines and syringes from Widjifake to the

Nurse-in-Charge at Widjifake health center fills out standard product receipt forms after receiving vaccines by drone. Photo: Henry Sempangi Sanyule

Widjifake health center receives one of its first vaccine deliveries by drone. Photo by Luciana Maxim (VillageReach)
adjacent health centers by motorcycle, and for returning the completed data collection forms. All product receipt forms and NGCA data collection tools made their way back by drone to the provincial EPI office in Mbandaka.

**Research protocol**: A protocol with questionnaires for a **stakeholder perceptions and use case study** at the national, provincial, and local level was developed in early 2019 and shared with Gavi. It received the **approval of the Secretary General for Health**, whose office oversees the ethics committee, and a MoH senior Co-Investigator directly participated in all focus group discussions and key informant interviews in both Kinshasa and Equateur province (See Deliverable 3.2). Most of these interviews took place in May-June 2019, and a summary of the results was included in the June 2019 interim report. However, as per protocol, a small number of additional interviews was conducted by the VillageReach program manager and the MoH Co-investigator during/after the August 2019 demonstration flights. The intent was to assess perceptions and opinions among health personnel and community leaders and members, not only before, but also after they had a chance to observe the drone flights and better assess how drones might or might not benefit their communities.

The stakeholder and community perceptions study included specific questions on use cases for the drones and whether there were any concerns around the quality of vaccines; the study showed that in general, stakeholders expect vaccine quality to be better when delivered by drones. Discussions with EPI at the national and province level also revealed no concerns, and vaccine quality/temperature was checked according to normal procedures during the flights, revealing no issues. A **full report** is included as Deliverable 3.3, with overall very positive perceptions recorded and many priority use cases identified for drones, especially related to the transport of medical products.

**Quality assurance results**: As per the standard operations procedures (SOPs) agreed upon with EPI, the quality of the vaccines was ensured and checked in several ways:

- Vaccines were pre-packaged by the EPI logistics team into WHO-approved Styrofoam boxes; the boxes contained two WHO standard ice packs, a fridge tag, and a digital thermometer (data logger) that would record temperature continuously during the drone flights.
- EPI staff weighed the box and attached to it the completed product delivery form in duplicate, with quantities of each product contained in the box.
- EPI staff only removed the pre-packaged box from the refrigerator a few minutes before drone take-off, at the signal of the drone operator, at which point the departing temperature was recorded, and the data logger was turned on.
- The box was placed in the payload compartment of the drone, which served as an extra layer of packaging.
- Upon arrival at the health center, the fridge tag temperature was checked and recorded on the product receipt form, and notes were made regarding the general condition of the package. Product receipt forms were signed by the Nurse-in-Charge or his assistant, and sent back to EPI Mbandaka by drone. Vaccines were immediately stored in the health center refrigerator.
- Upon return of the drone to Mbandaka, the files from the data logger were also checked.
EPI provincial team members, including Logistician and Assistant prepare the vaccines and product delivery forms for departure.

The overall results are that on all drone flights, both vaccines and syringes arrived in good condition, and the vaccines stayed within the required temperature range of +2 °C to +8 °C. While these were fairly short flights of up to 20-25 minutes one-way, EPI had no concerns even for longer flights (note that Swoop’s drone can be in the air for 1 hour at a time before having to land and swap their pod/battery for a newly charged one).

The graph below provides an example of the fairly constant temperature inside the Swoop Aero container during flights. In the graph below, temperature on the digital data logger initially declines as the container is prepared and placed in the fridge. Temperature then stays fairly constant during the drone flights, but immediately spikes once the box is opened at the receiving health center. This is because the data logger normally tracks the temperature of the outside environment, which in Equateur is around 35-37 °C.

Dissemination of overall results: Key results from the Phase 1 drone flights are included below, and they were presented to national, provincial and local health authorities as well as other government institutions represented at the national and provincial working group meetings (Deliverable 1.4). More generally, the Phase 1 drone flights in Equateur were heavily publicized by the DRC MoH, VillageReach, Swoop Aero and Gavi (key press articles are listed in Annex B).

The Unmanned Aerial Vehicles (UAV) for Payload Delivery Working Group (www.UPDWG.org) hosted a global webinar in early November that featured both VillageReach and UNICEF presenting on their experiences with introduction and integration of drones into immunization supply chains in DRC and Vanuatu, respectively. Additionally, VillageReach will exhibit a poster detailing the key data and lessons
learned from the DRC Phase 1 project at the Global Health Supply Chain Summit on November 21 in South Africa (see Deliverables 3.4).

Further sharing of experiences is expected at the African Drone Forum in Rwanda in February 2020 and through continuous dissemination as opportunities arise.

Vaccines and syringes were weighed prior to being placed in the drone; a fridge tag and digital thermometer were added for the vaccine flights.

**EVIDENCE: DRONE FLIGHTS**

* 50 drone flights each way, over 5 days (20 flight hours) for a total distance of 2000 km – in addition to 5 earlier test flights over the Congo River.
  * This is equivalent to 25 round-trips of 80 km in populated areas, with drone landing at the health center, and demonstrating **two-way transport**.
* 3-hour road trip cut down to ~ 20 min by drone, with drone flying at an average speed of 115 km/hr.
  * **Two drones flew at the same time**, in opposite directions and on parallel routes, proving ability to scale operations and product deliveries quickly.
  * **No safety concerns** during any of the flights, and drone flew in rainy and windy conditions.
  * **High level of acceptability** for drone deliveries among officials, health workers, communities.
  * Able to stay in the air for up to 1 hour (or 115 km) prior to recharging, then can continue as needed.

**EVIDENCE: MEDICAL DELIVERIES**

* 25 kg of mainly vaccines and syringes but also essential medicines and supplies flown by drone.
  * 5 rural health areas with a population of 47,000 received 2 months of stock + 1 month buffer to immunize ~ 470 children.
  * 7 babies in rural Widjifake become the first in Central Africa to receive vaccines flown by drone.
* **Cold chain conditions met**, with vaccines kept at between +2 °C to +8 °C during the drone flights.
  * **Reverse logistics**: On the return flights, health center sent product receipt forms, orders, reports, letters – and on one flight blood lab samples.
  * **Easy for EPI, health center staff**, and community members to learn how to interact with drone and conduct safe operations during take-off and landing.

* 2 kg per flight proven (3 kg possible); redesign after Phase 1 doubled the volume to 5,362.5 cm³.
Technology

As previously reported, the medical drone logistics provider Swoop Aero (www.swoop.aero) is a professional company that was competitively selected by VillageReach through a global request for proposals, in collaboration with unmanned aviation experts from Cyclops Air and WeRobotics, and after discussion and review of technical performance and safety documentation by the DRC Civil Aviation leadership team. Swoop Aero also received good references from UNICEF and Vanuatu Civil Aviation as they were the drone company that successfully delivered the world’s first vaccine by drone in the Pacific in late 2018. VillageReach signed a contract with Swoop Aero for Phase 1, which was shared with Gavi (Deliverable 4.1).

Swoop Aero’s fixed-wing hybrid electric drones are among the best-performing drones with vertical take-off and landing (VTOL) capability. In DRC, Swoop’s drones can fly at an average speed of 115 km/hour. Each battery charge lasts for approximately 1 hour of flying time, including a generous buffer, equating to a maximum flying distance of 115 km per battery charge. A minimum of 1.5 hours is estimated for a full battery charge, depending on electricity conditions. Even when allowing time for charging the battery multiple times per trip, delivery time can be reduced from days/weeks when using ground vehicles or boats, down to hours/days, when using the drones.

Swoop Aero’s drones are autonomous and fly from their take-off to their landing site based on pre-programmed flight routes, following GPS coordinates by communicating directly with satellites. Swoop Aero’s drones use L-Band SATCOM (satellite communication) which is more expensive and more reliable than systems used by other low-cost drones, which have to rely on ground radio frequencies or a mobile internet connection. While Swoop’s drones are highly autonomous, the drone pilots can still take remote control of the aircraft while in mid-flight, if needed, to return the drone to base or land it at a designated location. All Swoop Aero drone pilots are certified, and the DRC Civil Aviation has reviewed and accepted the certifications for operations in DRC.
Unlike other drone companies, Swoop Aero does not require any expensive infrastructure (such as a catapult) to operate, making their operations low-cost and quickly scalable. Swoop Aero is also unique in that it uses 3D printers to manufacture the drones, thus allowing for swift changes to the design of the drone, replacing parts or manufacturing new drones in the country of operation. For example, at the request of the DRC EPI, Swoop Aero increased the dimensions of the payload compartment after the demonstration flights in August 2019, doubling the volume of products that can be transported in Phase 2. This allows for the transport of more syringes per flight, since syringes are light but bulky.

Swoop Aero traveled with a team of three each time to DRC – on both occasions the CEO and Control Systems Lead were present, while the COO was replaced by the Director of Flight Operations for the second trip. Swoop Aero recorded exact GPS coordinates at both the initial test site (on the shore of Congo River) and in Mbandaka and Widjifake, to create precise flight routes. VillageReach then submitted application forms with the **flight plans/routes** to CAA and the local Air Traffic Control in advance of the flights since the drones were departing from the center of Mbandaka, and thus from within a controlled area in the vicinity of Mbandaka airport (see Deliverable 4.2 for the final approved flight route). CAA observed all flights but also guided them at times, for example either by requesting testing of certain safety mechanisms or allowing two drones to operate simultaneously after reviewing specifications such as the altitude and distance of the parallel flight paths proposed by Swoop Aero.

VillageReach’s team on the ground organized all logistics for the flights and for the highly-publicized ceremony on August 9, 2019 in Mbandaka, which reunited many government officials from the national, provincial and local level. A second ceremony for Health Zone, Administrative Territory leaders, and community leaders and members took place in parallel in Widjifake. These ceremonies were scheduled purposefully to coincide with the last day of flights, to better showcase the full results and capability of the drones. They were an opportunity for a much broader group of stakeholders, beyond the DPS and EPI teams that were directly involved, to observe the flights, interact with the drones and drone operators, ask questions, and make recommendations for the future. The officials got to follow the drone on its path (on the computer), and saw a video of 3D printers building the tail of a drone in Australia.
In Widjifake, health center personnel and community members coordinated operations, ensuring safe take-off and landing (left), while in Mbandaka a large ceremony took place simultaneously (right). Photos by VillageReach and Henry Sempangi Sanyulye

Weeks of preparation went into organizing the flights, the community sensitizations, and trainings of health center personnel, along with quantification of vaccine and syringe needs at the health center level, coordination of all parties involved across locations, even in the absence of cell phone connection in Widjifake, and further transfer of products by ground to four other health areas neighboring Widjifake. VillageReach had a strong representation in Equateur especially for the last day of the flights, but relied mainly on EPI, DPS staff and provincial and local authorities. Once it was decided that essential medicines and supplies were approved for transport as well, VillageReach coordinated with the Regional Medical Stores to obtain the products and seamlessly integrate them into the flight schedule:

<table>
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<th>1 July</th>
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<td>Demonstration flights in populated areas, two-way transport of health products: Mbandaka - Widjifake</td>
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<td>5 flights, dummy cargo</td>
<td>10 flights = 5 round-trips</td>
<td>10 flights = 5 round-trips</td>
<td>10 flights = 5 round-trips</td>
<td>12 flights = 6 round-trips</td>
<td>8 flights = 4 round-trips</td>
<td>50 flights = 25 round-trips</td>
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<tr>
<td>Round-trip, 72 km/41 min</td>
<td>Outbound: vaccines + ice packs, syringes</td>
<td>Outbound: vaccines + ice packs, syringes, reporting forms</td>
<td>Outbound: vaccines + ice packs, syringes</td>
<td>Outbound: vaccines + ice packs, syringes, medicines and supplies, packaging for lab samples</td>
<td>Outbound: vaccines + ice packs, syringes, medicines and supplies</td>
<td>8 flights – vaccines 11 flights – syringes 1 flight – vaccines and syringes 4 flights – essential medicines, supplies 1 flight – ice packs, reporting forms</td>
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<tr>
<td>Round-trip, 48 km/27 min</td>
<td>One-way, recall to base to test safety, 16 km/11 min</td>
<td>Return flights: ice packs, product receipt forms</td>
<td>Return flights: ice packs, receipt forms, orders, stock status</td>
<td>Return flights: ice packs, receipt forms</td>
<td>Return flights: lab samples, ice packs, product receipt forms</td>
<td>1 return flight – blood lab samples Other return flights – product receipt forms, orders, reports, ice packs</td>
</tr>
<tr>
<td>2 kg max, 5 kg total</td>
<td>4.8 kg total</td>
<td>3.2 kg total</td>
<td>4.6 kg total</td>
<td>8.4 kg total</td>
<td>4.1 kg total</td>
<td>25.1 kg of health products flown</td>
</tr>
</tbody>
</table>
**Local capacity building**: An important aspect of the demonstration flights was to show that EPI and health center personnel could easily become familiar with the requirements of drone operations. This goal indeed was achieved, as within just a couple of days of routine training, MoH staff was able to do the necessary tasks on their own, from packaging to loading/unloading the drone, placing the drone on the take-off strip in the proper position, pressing the button to send the drone back to base, educating the community members around keeping a safe distance during take-off and landing, completing the product delivery/receipt forms and checking the condition and temperature of the products as they normally would. They also became key members of the ‘flight operations team’ that was due to deploy in case of emergency. Swoop Aero’s certified drone pilots retained control of all flights, however EPI staff in Mbandaka and Health Center personnel in Widjifake became an integral part of the drone team in minimal time.
For Phase 2, due to the frequency of flights, and not to overburden EPI staff in Mbandaka, it is expected that Swoop Aero will hire several local Hub managers and Ground operators to support them. For safety reasons, the flights themselves would continue to be operated at first by Swoop’s team, with approval from CAA, but with the goal to train local staff over time to lead all drone operations.

A separate exercise that was conducted in August-September 2019 with an eye towards the future of drones in DRC was a preliminary assessment of existing and potential local capacity to operate and maintain drones. This consisted of a series of semi-structured interviews with public, private and academic stakeholders – mainly based in Kinshasa, but also Equateur – using a questionnaire designed in collaboration with WeRobotics. The assessment questionnaire and report are attached as Deliverable 4.5. It points to little existing capacity, but highlights academic institutions such as Institut Supérieur des Techniques Appliquées (ISTA) that could be supported to provide trainings on drones at the country level, even beyond transport of health products (for mapping, use in agricultural or natural resource management sector, etc.). This broader initiative, which goes beyond the Drones for Health project in Equateur, aims to jump start innovation and help sustain an emerging drone industry in DRC over time, which could be useful in different domains.

**TECHNOLOGY: KEY SUCCESSES**

* Global request for proposal led to the identification of a high-performing drone platform and the right partner for the DRC use case.
* Targeted stakeholder engagement at both the national and local level led to a successful logistics planning stage by VillageReach and MoH.
* Early local capacity building efforts prove that it is feasible to build new skills on the ground quickly.
* A preliminary, broader, local capacity assessment showed little existing capacity to operate and maintain drones in DRC, but much potential.

**Acceptability**

The stakeholder and community perceptions protocol was already mentioned in the Evidence Generation section, and the full report is attached in French, with a summary already provided to Gavi in English in the interim report (Deliverable 3.3/5.1). Although the study was low risk from an ethics perspective, as it was mainly an opinion poll to see what stakeholders at all levels think about the use of drones for medical transport and their potential/perceived benefits and risks, it was still submitted to and approved by the Secretary General for Health. All facilitators were trained on the questionnaires and best practices for qualitative data collection prior to the focus groups and key informant interviews.
The findings from this study led to the development of a comprehensive community sensitization strategy that included factual key messages for the public about drones and the project itself, education materials such as posters, flyers and banners, a joint press release between VillageReach, Swoop Aero, Gavi and the DRC MoH, radio programs, and direct outreach in the communities. The MoH sensitization team and local health promoters were trained prior to the sensitizations which took place in Mbandaka and Widjifake. The strategy (Deliverable 5.2) has been revised after the official demonstration flights based on lessons learned.

Additionally, during/after the drone flights in August, VillageReach and MoH went back to interview a small number of people to understand if and how their perceptions of the drones may have changed. Findings are very positive and detailed in the attached report.
Challenges and Mitigation Strategies

- The process of obtaining the permissions/waiver to import and use the drones took longer than expected, in the absence of established drone regulations, but a solution was found in May 2019 by the Ministry of Health, ANR, and Civil Aviation Authority (CAA), leading to a CAA formal authorization for the import and use of drones in DRC.

- Given the authorization delays, the timeline for bringing the drones into the country and conducting two separate sets of flights (the initial test flights and later the official demonstration flights) was condensed into just 3-4 months, making it challenging for VillageReach’s small team to conduct all related activities and coordinate a large number of stakeholders at both the national and provincial level. The team prioritized the flights and worked through the MoH to ensure completion of all activities on time. A no-cost extension of two months was also requested from Gavi to allow government decision-makers to solidify next steps for scale-up, and VillageReach to complete all the reporting requirements.

- There was great difficulty of communication, due to low or no mobile and internet connection even in Mbandaka, but especially in Widjifake. In addition to using a couple of satellite phones for text messages relaying the flight take-off and landing times, the drone became a quick substitute for ‘phones’ as it flew back and forth between Mbandaka and Widjifake, with various requests and letters, showing the potential for a satellite-linked drone to double-up as a modern means of communication to remote or isolated areas.

- As a drone was preparing for take-off from Widjifake on the second day of flights in August 2020, the triple redundancy software platform detected a minor technical issue during the mandatory pre-flight checks. If an issue is detected during pre-flight checks, the aircraft will not fulfill the take-off procedure. This is a decision by Swoop Aero to ensure maximum safety outcomes. The drone was brought back to Mbandaka by car to be checked by the Swoop Aero technicians and the issue was resolved.

ACCEPTABILITY: KEY SUCCESSES

* Stakeholder and community perceptions study approved by MoH, with focus groups and interviews conducted with > 100 people at national, provincial and local level showed low initial awareness but high acceptability of drones for medical transport.

* Findings from the study informed a comprehensive local community sensitization strategy and public communications campaign that included direct outreach in communities, plus radio and press.

* Our team and the MoH went back during/after the drone flights to re-assess perceptions and document lessons learned from the community sensitizations for future phases of the project.

The ultimate measure of acceptability: A mother holds her baby as he receives a vaccine delivered by drone in Widjifake. Photo by Dr. Olivier Defawe (VillageReach)
was resolved the same day. To make up for this return flight, the other drone took an extra round-trip without landing at the health center. Both drones then flew successfully during the next two days, completing full round-trips and flying simultaneously during the ceremony on the last day.

- Governance and relationship building can be tricky in a shifting political environment, after elections that result in major transitions of power, etc. The former Minister of Health had been a supporter of the project and met with VillageReach and the Swoop Aero team twice, before and after the initial test flights in June-July. The Minister was due to attend the official demonstration flights in August, but resigned just prior to the flights. Since our team had also worked closely with the Secretary General for Health’s office and all other relevant departments within the MoH, the demonstration flights still saw a large delegation from across MoH attending the flights.

- The Phase 1 project has ended on 31 October 2019, and VillageReach has already submitted a proposal to Gavi as well as other donors for Phase 2 scale-up in Equateur. VillageReach is actively fundraising with bilateral, multilateral and private sector organizations. However, the required funds for Phase 2 have not yet been fully secured, resulting in a gap in activities and thus postponing the time when drone operations can resume. We hope to secure enough funds to commence Phase 2 during Quarter 1 of 2020.

**Lessons Learned**

- Building strong relationships with the DRC government at all levels was key to the success of the drone demonstration flights and obtaining approval to scale up in Equateur and countrywide.

- For Phase 1, we identified a site/health center that was closer to the vaccine distribution center; it made it logistically easier for us to implement the project and show what was possible.

- There was initially a low level of awareness and familiarity with drones for medical transport in DRC, which means that we had to start from scratch in terms of bringing everyone on board and garnering commitment to implement the project.

- Community and stakeholder sensitizations were critical to success. We started by listening to the voices of stakeholders, understanding their perceptions, both positive and negative, and getting their input to properly explain the project and this new technology to a wider audience later on.

- One of the most important decision points of the project was the competitive selection of the drone partner through a global request for proposals. The rigorous selection process enabled us to select one of the best drone companies, Swoop Aero. There are not currently many other low-cost drone suppliers that can match their level of performance and safety, based on the global experience. The VTOL drone is also low-maintenance, does not require additional heavy infrastructure such as a catapult or drone port, is weather resilient, and can go the distance, making it an ideal candidate for delivering immunization products to remote areas of DRC.

- Drone projects can be risky, as seen in other countries. What we found is that if success is achieved, one must be ready to move forward quickly before losing momentum and stakeholder support. Funding gaps are challenging once expectations have been greatly raised on the ground.

- Drone projects are multi-sectoral by nature – they involve various MoH departments; Civil Aviation; in DRC the National Intelligence Agency (ANR), and the Ministry of Interior and Security, and the decentralized Provincial government with its own Governor, Provincial Minister of Health, Provincial Health Director, Provincial EPI Director, Health Zone leadership, Administrative Territory and Health centers. The more stakeholders are involved, the more time and effort are needed to ensure coordination, effective communication and concrete implementation.
• Once the stakeholders’ interest has peaked, we realized that there were misconceptions about the business model for the future: Many officials expected to be buying the drones and were concerned about learning quickly how to fly the drones and how much the drones alone would cost. However, most drone companies do not outsource their flight operations, since this is a niche transport industry, with increased safety risk for the population, and requiring remote pilots certified by Civil Aviation, similar to an airline. Actual costs and cost-efficiencies must be researched in depth during a longer-term implementation (Phase 2) and in the specific setting of DRC, otherwise they are simply rough estimates. While VillageReach and Swoop Aero have presented on business and pricing models, much work remains in terms of educating decision-makers and involving them in thinking of possible sustainability models for Phase 3.

• A simple, successful communication tool that kept everyone regularly updated (almost in real time) in Mbandaka, including a broader set of government officials, was through Whatsapp group messages. All other communications to Widjifake required satellite phones. Thinking ahead at Phase 2, one of the main benefits of using drones for fast, on-demand transport, could be lost if health facilities that need products and facilities that store products cannot communicate with each other. VillageReach and Swoop Aero are currently brainstorming options for telecommunications.

• In order to develop both an ambitious and realistic scale up plan for Phase 2, we had many conversations with stakeholders at the national, provincial, and local levels, and three formal meetings that culminated in the proposal that was submitted to Gavi. Most importantly, we aimed to respond to real needs on the ground, and depending on the level of funding that will ultimately be achieved, VillageReach will aim to integrate additional medical products into drone deliveries, to maximize impact for communities and cost-efficiencies.

Conclusions and Next Steps

In sum, during Phase 1, VillageReach worked at both the national and provincial levels to raise awareness of the use of drones and their potential benefits for the transport of vaccines and other medical commodities. This work was essential as the community perceptions study demonstrated that most people, especially at the local level, were unfamiliar with drones and in particular their uses in health. As a result of the successful demonstration flights and of a comprehensive outreach campaign conducted during Phase 1, many of the key stakeholders are now not only aware, but very supportive of drones for medical transport, and eager to scale up drone deliveries in additional provinces and for additional commodities. The next immediate steps are to continue to fundraise for the Phase 2 scale up project in Equateur and to conduct a site assessment and validation trip to remote health centers in collaboration with DPS/EPI – aiming to record exact GPS coordinates, plan specific flight routes with Swoop Aero, evaluate electricity and telecommunications capacity - and also collect basic data on immunization product availability – all elements that will be helpful for the initial System Design workshop that is planned early during Phase 2. In parallel, we are also trying to obtain approvals for the importation of a much larger fleet of drones plus batteries and equipment from CAA, Customs and to make plans for their transport to Equateur.

The Phase 2 proposal submitted to Gavi can be summarized as follows:
Project name | Routine Use and Validation of Drones for Vaccine Transport in the Democratic Republic of Congo – Phase 2
---|---
Phase 2 start and end date | Q1 2020 – Q2 2021 (12 months of routine drone deliveries)
Prime implementing partner | VillageReach – non-profit public health organization, DRC and USA
Governmental and private sector partners | (1) MoH at national, provincial and local level, DRC
(2) Swoop Aero – drone supplier and operator, Australia
(3) Other private sector partners
Geographic coverage | Drone deliveries to 25 hard-to-reach health centers throughout Equateur, with further product distribution by the government possible using land-based vehicles to neighboring health centers
Health focus | Transport of immunization products; additional medical commodities will be transported for cost-efficiency, as additional funding is secured.

The main objectives of Phase 2 are to:
1. Strengthen the enabling environment for the use of drones to deliver health products in DRC
2. Sustain routine drone deliveries of immunization and other health products in remote areas of Equateur, while building local capacity for drone operations
3. Inform strategic decision-making around the integration of drones into public health supply chains by generating evidence on performance and costs
4. Establish mechanisms for scale-up and sustainability of the use of drones to optimize health supply chains in DRC.

Report written by Luciana Maxim on behalf of the VillageReach DRC drones program team: Freddy Nkosi, Archimède Makaya, Olivier Defawe, Susie Truog, Dieudonné Nseleka Mwanza, Eomba Motomoke and Luciana Maxim.

Annexes

Annex A. Updated final work plan for Phase 1 (French)
Annex B. Compilation of press coverage of the successful Phase 1 drone flights in DRC
Deliverables. Deliverables 1.1 through 5.2 are provided in a separate document
Annex A: Chronogramme révisé – Phase 1

<table>
<thead>
<tr>
<th>Gouvernance</th>
<th>Activités</th>
<th>Livrables</th>
<th>Progrès</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A2. Organiser une visite d’apprentissage dans un pays où des projet drones ont déjà été lancés</td>
<td>1.2 Rapport de mission après visite d’apprentissage</td>
<td></td>
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<tr>
<td></td>
<td>A3. Soutenir le Comité du Pilotage dans l’élaboration d’un cadre décisionnel d’évaluation des résultats OK/stop</td>
<td>1.3 Cadre décisionnel d’évaluation des résultats &quot;OK/Stop&quot;</td>
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<tr>
<td></td>
<td>A4. Appuyer le Comité du Pilotage dans l’évaluation de l’accomplissement des résultats &quot;OK/Stop&quot; de la Phase 1 et fixer les étapes suivantes</td>
<td>1.4 Un rapport annuel et une feuille de route</td>
<td></td>
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<th>Réglementations</th>
<th>Activités</th>
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<tr>
<td></td>
<td>B2. Définir et répertorier les politiques et les normes de qualité pour le transport par drone des produits de vaccination</td>
<td>2.2 Protocole approuvé par ministère de la santé/PEV pour le transport par drone de vaccins conforme aux politiques et normes de qualité</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B3. Coopérer avec les autorités réglementaires pour l’importation et le vol des drones en RDC pour le cas d’utilisation retenu</td>
<td>2.3 Importation et acheminements réussus des drones en RDC et jusqu’a la zone de démonstration</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Génération d’Évidence</th>
<th>Activités</th>
<th>Livrables</th>
<th>Progrès</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C2. Développement d’un protocole de recherche pour les évaluations de cas d’utilisation et d’assurance de qualité</td>
<td>3.2 Protocole de recherche approuvé par le Comité de déontologie</td>
<td></td>
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<tr>
<td></td>
<td>C3. Recueil de données pour l’étude de cas d’utilisation et analyse des résultats tel que défini dans le protocole de recherche</td>
<td>3.3 Rapport des résultats de l’étude de cas d’utilisation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C4. Diffusion des résultats de l’étude d’assurance de qualité et le cas d’utilisation via les réunions du Comité du Pilotage et des conférences internationales</td>
<td>3.4 Présentations pour la diffusion des résultats</td>
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<tr>
<th>Activités</th>
<th>Livrables</th>
<th>Progrès</th>
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<tbody>
<tr>
<td><strong>Technologie</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1. Sélectionner un fournisseur des drones pour les vols de démonstrations</td>
<td>4.1 Contrat avec un fournisseur de drone pour les vols de démonstrations</td>
<td></td>
</tr>
<tr>
<td>D2. En coopération avec le fournisseur, concevoir les plans de vol et obtenir les autorisations pour les vols de démonstrations</td>
<td>4.2 Plans de vol approuvés</td>
<td></td>
</tr>
<tr>
<td>D3. Organiser et gérer la logistique sur le terrain pour les vols de démonstration</td>
<td>4.3 Rapport d’exécution pour les vols de démonstration</td>
<td></td>
</tr>
<tr>
<td>D4. Contrôler le respect du protocole d’assurance qualité des vaccins durant les vols et tester la qualité des vaccins après les vols</td>
<td>4.4 Résultats des tests d’assurance qualité, conformément au protocole de recherche</td>
<td></td>
</tr>
<tr>
<td>D5. Evaluer les capacités locales dans les secteurs privé et public pour continuer à utiliser les drones en RDC (formation, pilot, maintenance, etc.)</td>
<td>4.5 Evaluation préliminaire des capacités locales</td>
<td></td>
</tr>
<tr>
<td><strong>Acceptabilité</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E1. Développement d’un protocole de recherche pour l’étude de la mobilisation des parties prenantes et recueil de données pour l’étude de la mobilisation et analyser les résultats tel que défini dans le protocole de recherche</td>
<td>5.1 Rapport indiquant les résultats détaillés pour informer la stratégie de la sensibilisation communale</td>
<td></td>
</tr>
<tr>
<td>E2. Elaborer et appliquer des stratégies de communication et de mobilisation (basées sur les résultats de l’étude de la mobilisation des parties prenantes) avant, pendant et après les vols de démonstration</td>
<td>5.2 Archivage des enseignements pour les stratégies de communication futures</td>
<td></td>
</tr>
</tbody>
</table>
Annex B: Press Coverage – Phase 1 Successful Drone Flights in DRC


Highlighted here are some of the most influential stories. On social media, we utilized Twitter, LinkedIn and Facebook to share the news as well as our ongoing work in DRC. We garnered very high engagement across all channels, and notable individuals who posted the news and mentioned VillageReach were WHO Director General Dr. Tedros, Gavi CEO Seth Berkley, and Gavi Board Chair Ngozi Okonjo-Iwaela.

- GOOD story and video: Villagers rejoice as they receive the first vaccines ever delivered via drone in the Congo: https://www.good.is/drone-vaccines-congo
- GAVI created a video about the drone flights: https://www.youtube.com/watch?v=Z_ptQ2-bCzo
- Geekwire wrote an article about the vaccine delivery by drones that occurred in DRC: https://www.geekwire.com/2019/drones-swoop-congo-strengthen-countrys-vaccine-supply-chain/
- An article written by sUAS News describes the August drone flight in DRC and shares the timeline of UAV work in the country.
- Unmanned Airspace published a short article describing the drone flights in DRC.
- Commercial Drone Professional published an article about the drone flights in DRC.
- AP Congo (French) published an article about the drone flights in DRC.
- Actualité (French) wrote an article about the DRC drone flights.
- The Australian Business Review highlighted the collaboration between Swoop Aero, Ministry of Health and VillageReach in the delivery of vaccines in DRC.

- It Takes a Village to Deliver the First Vaccines by Drone in DRC: Originally posted on The Medium, Olivier Defawe shares his experience working with partners to achieve the first vaccine delivery by drone in DRC: https://medium.com/@VillageReach/it-takes-a-village-to-deliver-the-first-vaccines-by-drone-in-drc-539257662c3c
# Complete List of Deliverables

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>Description in English</th>
<th>Name in French</th>
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</thead>
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<tr>
<td>1.1</td>
<td>Ministerial decree establishing the National Drones for Health Commission</td>
<td>Arrêté ministériel… portant création, organisation et fonctionnement du Comité national de pilotage du secteur de la santé en République Démocratique du Congo</td>
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<td></td>
<td>Terms for Reference – Drones for Health Commission</td>
<td>Règlement intérieur de la Commission Drone Santé en RDC</td>
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<tr>
<td>1.2</td>
<td>Learning visit report from Malawi, March 2019</td>
<td>Rapport du voyage d’apprentissage au Malawi, Mars 2019</td>
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<tr>
<td>1.3</td>
<td>Go/No go decision framework developed and used by Drones for Health Commission to make decision for scale-up (Phase 2)</td>
<td>Cadre décisionnel d’évaluation des résultats de la Phase 1 par la Comission Nationale « Drones pour la Santé »</td>
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<tr>
<td>1.4</td>
<td>Presentation to the National Drones for Health Commission and Provinical Drones Working Group in Equateur on the Achievements of Phase 1, and Plans for Phase 2</td>
<td>L’utilisation des drones pour la distribution des vaccins à l’Equateur, RDC, Septembre 2019, Kinshasa et Mbandaka</td>
</tr>
<tr>
<td></td>
<td>Phase 2 work plan summary</td>
<td>Note: Detailed version is available upon request in French and English</td>
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<tr>
<td><strong>Regulations</strong></td>
<td></td>
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<tr>
<td>2.1</td>
<td>Application forms developed by DRC Civil Aviation and completed by Swoop Aero and VillageReach prior to the initial test flights, and the official demonstration flights</td>
<td>Formulaire Demande d’autorisation spécifique pour la mise en oeuvre d’aéronefs télépilotés FOAAC-AIR-05-37</td>
</tr>
<tr>
<td></td>
<td>Emergency response plan for flights</td>
<td>Formulaire Demande d’utilisation des espaces aériens à statut particulier FOAAC-AIR-05-38</td>
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<tr>
<td></td>
<td></td>
<td>Note: French version is also available</td>
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</tbody>
</table>
| 2.2 | • EPI guidance document on data to be collected during transport of vaccines and other supplies by drone  
• Standard operating procedures (SOPs) established for drone transport and data collection with EPI provincial office | • Document de transport de vaccins et autres consommables par drone  
• Stratégie de collecte des données – Procédures opérationnelles standard |
| 2.3 | • Authorization for import and use of drones in DRC from Civil Aviation Authority | • Décision... autorisant l’importation des drones en République Démocratique du Congo |

### Evidence Generation

| 3.1 | • Potential drone landing sites, Bikoro Health Zone, Equateur province, DRC – Site visit report | • Note: French version is also available |
| 3.2 | • Stakeholder and Community Perceptions Study protocol  
• Approval of study by Secretary General for Health which provides oversight to ethics committee | • Perceptions de la communauté et des parties prenantes pour la distribution des vaccins par les drones  
• Lettre : Etude sur la perception de la communauté |
| 3.3 | • Final report for the Stakeholder and Community Perceptions Study | • Etude sur la perception des parties prenantes pour le transport de vaccins et autres intrants de santé par le drone – Rapport Final, Août 2019  
• Note: A summary of results in English was submitted to Gavi in the interim report, also detailing suggestions for use cases, June 2019 |
| 3.4 | • Poster on DRC Phase 1 results, Global Health Supply Chain Summit, Nov 2019, co-authored by VillageReach, DRC Ministry of Health and Swoop Aero  
• Global webinar presentation, UAV Payload for Delivery working group, November 2019 | • Demonstrating the Potential of Drones for Vaccine Transport to Remote Communities: Data and Lessons Learned from DR Congo (English)  
• Integrating Drones into the Immunization Supply Chains – DRC Case Study (English) |
| 4.1 | - Global request for proposals from drone companies  
- Contract signed with Swoop Aero | - RFP: Drone technology for vaccine transport demonstration flights in DRC (English)  
- Sub-agreement (English) |
| 4.2 | - Final approved flight route  
- Website shared with DRC Civil Aviation and Air Traffic Control to watch drone flights in real time | - Swoop Aero: Route de vol (Décollage...)  
- Swoop Aero: Suivi de vol en temps réel |
| 4.3 / 4.4 | - Information on preparations for drone flights and quality assurance are described in our reports | - See Interim report, submitted June 2019  
- See Final report, submitted Nov 2019 |
| 4.5 | - Preliminary assessment of local capacity for drones operations in DRC – questionnaire and findings | - Evaluation préliminaire des capacités locales - Rapport Synthèse |

**Acceptability**

| 5.1 | - Same as deliverables 3.2 and 3.3 |
| 5.2 | - Community Sensitization Strategy (revised after the drone flights) | - Stratégies de sensibilisation |