Innovative Solution: Use of unmanned aircraft vehicles to deliver life-saving medicines and supplies
Innovative Solution: Use of unmanned aircraft vehicles - to deliver life-saving medicines and supplies
USAID | DELIVER PROJECT, Task Order 4
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Recommended citation

Abstract
For several years, the global public health community has been exploring the use of unmanned aerial vehicles (UAV) to advance health goals. In this summary we share experiences from countries testing the use of UAV to deliver essential medicines and health supplies to hard-to-reach places, as well as considerations for future use in Latin America and the Caribbean. This document includes an overview of UAV, their definition, a few of the models available, some of the country pilots, as well as supply chain considerations and challenges to implement this innovative technology in the future.

Cover: Photo Credit to Vayu, Inc.

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1. Introduction

Photo: Courtesy of Zipline
"The UAV are very useful, both commercially and to improve services in the health sector. We are happy to have launched this innovative technology and to continue working with partners who will further develop it, “

Paul Kagame, 
Presidente de Ruanda, Octubre 2016.

Universal health coverage will become a reality when all segments of the population receive essential medicines and medical supplies when and where they need them, in every country. One of the possible solutions to resolve the challenges that still exist to transport medicines (especially those medicines that save lives) in a timely manner, to hard-to-reach places, could be the use of technology such as unmanned aerial vehicles (UAV) or drones. In this brief, we will provide basic information about UAV, what they are, the different models, features, countries that are implementing pilot programs, a pilot experience in some countries, including the Dominican Republic, and future use in public health.

In the global context, the United States Agency for International Development (USAID), the World Health Organization, UNFPA, UNICEF, as well as several non-governmental organizations (NGOs) are paying close attention to the use of UAV in public health.
2. What is an Unmanned Aerial Vehicle?
An unmanned aircraft system (UAS), sometimes called a drone, is an aircraft without a human pilot onboard – instead, the UAS is controlled from an operator on the ground. (*)

For the purposes of this brief, UAS will be referred as Unmanned Aerial Vehicle (UAV)

https://www.faa.gov/uas/
### Table 1: Some models of UAVs and features

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Model</th>
<th>Transport mode</th>
<th>Distance</th>
<th>Payload</th>
<th>Countries piloting its use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vayu, Inc.</td>
<td>Photo: Vayu, Inc. in Madagascar</td>
<td>It lands and returns</td>
<td>55 km</td>
<td>2.2 kg (5 lbs.)</td>
<td>Madagascar</td>
</tr>
<tr>
<td>Matternet</td>
<td>Photo: Matternet, Modelo M2</td>
<td>It lands and returns</td>
<td>20 km</td>
<td>2 kg (4.4 lbs.)</td>
<td>Butan, Switzerland, Malawi,</td>
</tr>
<tr>
<td>Zipline</td>
<td>Photo: Zipline Overview</td>
<td>Air drops; does not land</td>
<td>75 kms.</td>
<td>1.5 kg (3.3 lbs.)</td>
<td>Rwanda</td>
</tr>
<tr>
<td>Flirtey</td>
<td>Tether</td>
<td>32 kms.</td>
<td>5.5 lbs.</td>
<td>United States, New Zealand, Australia</td>
<td></td>
</tr>
</tbody>
</table>

Robotictrends.com  
http://flirtey.com/  
http://www.robotictrends.com/article/watch_the_first_legal_drone_delivery_in_us_history
Regardless of the model, UAV flights are being tested to transport health supplies that do not exceed the weight indicated by the model and basically works as follows: a distribution center is required, with the necessary mobile, IT, and flight equipment (Smartphone, flight application, and ICloud) as well as the staff responsible for monitoring the arrival and return of the UAV.

Take-off and landing areas are ideally located near a laboratory, public health warehouse or health facility. The use of UAV is currently being evaluated as proof of concepts to resolve last mile delivery of life saving commodities in hard to reach areas.

Some of the UAV manufacturers and companies that offer UAV contracting services have different business models. For example, Vayu, Inc. manufactures and sells UAVs; Zipline and Matternet offer contracting services. The way to implement a proof of concept will depend on the context, health model, public policies, financial and human resources available in each country.

Advantages of UAV

- **Affordable**: Prices of unmanned aerial vehicles continue to fall dramatically, making them more affordable. UAV can also be built relatively inexpensively by technology enthusiasts, using low-cost electronics. Consumer-level quadcopters like the DJI Phantom 3 can now be acquired for up to $500. (*)

- **Ease of use**: UAV are easier to use than traditional remote controlled airplanes, because they require less manual control and, therefore, less training. Most modern UAV have multiple fail-safe mechanisms and these security-focused features have been improved after several iterations.

- **Rapid deployment and results**: When trained people that manage UAV are available, UAV can be deployed in minutes or hours to transport medicines, blood, lab tests, documents, information, and other supplies.

3. Why are UAV important for Achieving Public Health Goals and Universal Health Coverage?
For decades, governments in Latin America and the Caribbean have been investing efforts and resources to reduce inequities in access to health services, especially in rural, marginalized, and remote areas. Despite such efforts, large gaps prevail, one of which is difficult geographic access to health services to deliver essential medicines, supplies, vaccines, micronutrients, and contraceptives to and where people need them.

Supply chain management is key for delivering medicines through the entire public health service network, thus, transportation and distribution efficiency plays a crucial role in narrowing the access gaps. Transport and distribution management continue to be one of the bottlenecks that governments have not been able to fully resolve.

One of the potential solutions is the use of UAV or drones that can deliver essential health supplies, especially those that save lives and which timely delivery is vital.
4. Which Countries are Testing the Use of UAV to Deliver Public Health Supplies?
Dominican Republic

Starting in 2016, the innovation program of the Inter-American Development Bank, the Multilateral Investment Fund (MIF), the NGO EMPRENDE, Matternet and other local partners have formed an alliance to implement a proof of concept on the use of drones for public health. The initiative seeks to establish a complementary network for the transport of laboratory samples and medicines to 8 primary health care service delivery sites and 2 hospitals in the regions of Bohechío and Los Fríos, in San Juan de la Maguana province.

Among expected results are: (I) a greater number of diagnoses and transport of laboratory results; (II) increased transport of pap smears and blood samples; (III) increased availability of emergency and biological medicines; and (iv) the establishment of a drone innovation center. Currently, the partnership is designing and mapping the route network and expect that flights will start in early 2017. The proof of concept will last six months and it is expected to benefit approximately 23,168 people in the San Juan de la Maguana province.

Costa Rica

The Costa Rican Social Security Institute (CCSS) plans to start using UAV in 2017 to supply medicines to indigenous communities living in remote areas. The plan is to deliver needed medical supplies in a timelier manner and over a wider area of the mountainous region of the Caribbean province of Limón. The program will benefit patients from eight indigenous communities who currently receive health and medical services at two community clinics. It is estimated that each delivery will take 30-45 minutes. Currently, depending on weather conditions, it takes three hours to three days to deliver the medicine to both clinics.
In Tanzania, John Snow, Inc. is implementing a project that analyzes how UAV technology can play a role in augmenting the distribution options of the government to improve availability of blood, medicines, and vaccines.

As in many countries, transporting blood units by land from the blood bank to peripheral health centers using traditional means of transportation is often impossible or very costly.

Among the activities that JSI is performing are: identify when it is appropriate to use UAV, in what way can it be replicated, generate evidence about the feasibility, cost, impact and integrating UAV into the existing public health supply chain, determine the products with frequent stockouts, verify the compatibility between the process of transporting supplies using UAV with the rest of the supply chain system.

In October 2016, Rwanda President Paul Kagame inaugurated the first blood delivery service using UAV at a ceremony in the country's central district of Muhanga. Beginning in October, the Rwandan government will begin using UAV or drones to make up to 150 deliveries of blood on demand to 21 health facilities in the western region. Although deliveries through UAV are initially to transport blood, it is expected that through the alliance between UPS, the Global Vaccine Alliance (GAVI) and Zipline, the country will rapidly expand to other types of health supplies, such as essential medicines and vaccines. Zipline was contracted to provide the UAV and the technical services for the implementation of the flights.
Ghana

With the support of UNFPA, public health specialists in Ghana created a project called “Dr. One”, which was a proof of concept to use UAV to deliver contraceptives to women living in remote rural areas of Ghana. The Dr. One project was a joint effort by Ghana Health Services, UNFPA and the Government of the Netherlands and has allowed transportation to test delivery of condoms and other medical supplies to rural areas of Ghana.

The UAV travel independently and automatically with supplies to rural areas of difficult access, where health staff is alerted via a telephone text message about the arrival of the UAV so that they are ready for pick up in the designated area. UAV may be useful for reducing the cost of ground transport as one UAV can cover multiple journeys per day. The proof of concept demonstrated reductions of up to 30% of the cost of transportation at the lowest level in Ghana.

Some of the lessons learned in Ghana are: a) use of UAVs is not a silver bullet to solve all supply chain challenges, b) the solutions must fit into the community based health care systems and work to complement other interventions to address challenges in supply chain; c) it is very important to find broad support for such UAV initiatives at the political level, within the Ministry of Health, and at the regional and community levels, as well as maintaining transparent and trust communications from the project.

Madagascar

In Madagascar, in July 2016, with the support of the United States Agency for International Development (USAID), the Global Health Institute of Stony Brook University, the Centre ValBio, and Vayu, Inc. partnered to test the use of UAV to transport laboratory samples from the rural area to the central laboratories of the two universities. With the support of the Government of Madagascar, approximately 10 pilot flights were carried out in the Ranomafana village to carry blood and laboratory samples for testing and analysis. UAV manufactured by Vayu, Inc. take off and land similarly to a helicopter and fly 55 kilometers. To obtain UAV flights approval, the empowerment of local organizations, the Ministry of Health and the community were key.
5. Exploring Other Uses of UAV in Public Health
Creativity to identify different uses of UAV to advance public health objectives is quite broad and dynamic. The UAV community of practice are regularly analyzing and exploring additional uses. For example, transporting essential Logistics Management Information System data, such as demand and stock on hand, either in digital or printed form, especially from health facilities that do not have internet connection or have other difficulties to send logistics information on time. In every case, it will be essential to analyze the cost effectiveness to use the same UAV to carry medicines and bring information back to optimize the cost of travel and installed capacity. These discussions are needed to avoid sending information through UAV as a parallel system, and to analyze legal and protocol restrictions that exist in each country.

In addition, UAV are currently used to map and collect research data - for example, mapping mosquito breeding, as has been done by RTI International, in collaboration with Del Valle University, to support Ministry of Health and Social Assistance in Guatemala as part of the Zika response. (*)

In all circumstances and for any future use, it is necessary to coordinate in a multidisciplinary and multi-sectorial team of experts to include all perspectives as well as the various facilitating and limiting factors in the launching of UAV flights. A series of challenges and considerations to consider are incorporated at the end of this summary. Based on the experiences being tested in several countries - some of them described here - UAV can be one of the potential solutions to improve delivery of critical health supplies and medicines, and by using them, contribute to optimizing the public health supply chain performance at the last mile. The use of UAV could help improve decentralized health systems, for example - to process HIV laboratory tests in a more complex hospital while enabling staff in health services to have more time to provide primary health care to clients. The benefit would be to have laboratory tests results in a shorter period and to have the medicines and health supplies when and where these are needed. Whether in centralized or decentralized health models, the use of UAV could help strengthening the distribution of essential medicines and supplies, and by doing so, contribute towards universal health coverage.

More Alternatives to Innovate

- Keep in mind that conventional transportation means used by the private sector are still efficient solutions to distribute essential medicines, even in hard to reach areas, with larger payload capacity than UAV.

- The concept of "VANS and UAV" could be an alternative, which consists of transporting the medical supplies in trucks or vans to an accessible point and from then on to transport them using an UAV to deliver medicines to inaccessible roads or hard to reach areas.

(*) Eyerman UAVs and Zika Present to UVG Drone Conference_Revised_4.20.16.pdf
6. Integrating UAV into the Public Health Supply Chain System

Photos: Courtesy of John Snow, Inc.
According to John Snow Inc.’s perspective, world leader in public health supply chain management, a wide range of factors are to be considered when planning the use of UAV and integrate them into the public health supply chain system of any given country.

For example, during the design of the proof of concept, the information system should be analyzed and determine how the UAV should be integrated into the Ministry of Health Logistics Management Information System (LMIS), analyze demand trends and product specifications to determine which categories are best suited for UAV transportation, adapting the use of UAV to the existing public health supply chain management system, as one of the solutions to the transportation problems in the last mile.

The planning process should include negotiation with local health levels to identify inclusion of changes in budget line items; for example, the cost of UAV, the cost of flight management, the cost of prepaid phone cards for smartphones, as well as changes in logistics process flows, and especially the approvals of civil aviation authorities to fly and land.

In relation to costing the use of UAV, JSI and Llamasoft in Tanzania recently carried out an optimization and cost analysis exercise which will be published in the coming months.

It is important to note that the use of UAV do not replace existing infrastructure of roads – either paved or dirt - in any given country. The use of UAV supplements the existing road infrastructure and conventional means of transportation, and strengthens the distribution of essential medicines (including vaccines, blood and blood samples) that are not yet reaching clients by existing transportation modes.
7. Challenges and Considerations for the Use of UAV as part of the Public Health Supply Chain
To guide future use of UAV to reach remote areas of countries in Latin America and the Caribbean, several challenges and considerations are listed and discussed in this section.

### Social / Cultural
- Perceptions about UAV
  - Fear of accidents during flights
  - National and local security
  - Community involvement and acceptance
- Understanding the benefits of UAV

### Economic / Sustainability
- UAV cost analysis as part of the public health supply chain
  - Infrastructure, maintenance, and its operational and financial sustainability
  - Training of personnel
  - Mobile phone management and financing at the local level

### Technology / Specifications
- Product specifications and careful handling
  - Temperature requirements
  - Current payload of UAV versus load of life-saving medicines

### Policies / Norms
- Integrate UAV into the public health supply chain
- Regulations still incipient and restrictive
- Relationship of UAV/drones with military and espionage use

### Other
- Objects or persons that may interrupt the flight
- Weather conditions
- Unforeseen interference
Laws, Policies, and Norms

A. Existing laws regulating UAV flights are still being written, especially to restrict usage and flight areas. At the global level, there are important initiatives that will guide countries to use UAV safely and reliably. In the site below you will find a mapping of regulations by country.

Http://drones.newamerica.org/#regulations

B. Considering that each country, region, community, and culture is influenced by political, economic, social, and environmental factors. When exploring this technology, these factors must be carefully analyzed and incorporate them in the design of the proof of concept.

Public Health and Universal Health Coverage

A. Remember that every improvement and innovation contributes to the goal of achieving product availability and universal health coverage.

B. Public health objectives should prevail over the cost-benefit discussion of these technologies: the decision to use UAV should not focus solely on cost when it comes to saving lives.

C. Bear in mind that potential use of UAV will not solve the last mile challenges overnight. The process of change to introduce new technologies and new solutions takes time.

D. To secure availability of essential medicines requires leadership, management support, political will and transparent communication processes, as well as willingness to prioritize the solution of the current challenges of public health supply chains in every country.
Planning Use of UAV with a Systemic Approach

Each UAV model serves in different contexts and circumstances; therefore, it is necessary to first identify the problems of access and transport in the last mile (or last link of the supply chain). Once problems are identified, analyze with a comprehensive approach to determine if the use of UAV is the solution needed, what would be the UAV model that better suits the need, as well as the contracting mechanism for UAV flights.

COORDINATION

A. Once a multidisciplinary analysis process is completed, if the country decides to test the use of UAV, it is necessary to develop a proof of concept with the involvement and leadership of all actors, including the health sector at central and local levels.

B. Involving different sectors of the country and all disciplines is essential, including but not limited to: civil aeronautics authorities, lawyers knowledgeable in regulatory frameworks of aviation and public health, mid and high level management of Ministries of Health, such as the Directorate of Essential Medicines (i.e. Logistics Management Unit), technical advisors in public health supply chains, Ministry of Finance, technology and innovation institutions that may adapt and endorse the use of UAV, companies with UAV state-of-the-art technology, anthropologists and communicators that may lead social change in the community and in health facilities.

C. Coordinate, learn and understand each other’s perspective from multiple disciplines and sectors is key. For example, Ministry of Health does not normally interact with the civilian flight authority.

SPECIFICATIONS OF HEALTH SUPPLIES

A. Analyze specifications of products and medicines to determine which and under what circumstances can be transported by UAV, either routinely or on request, to attend emergencies or shipments on demand.

LOOK FOR INTEGRATED SOLUTION

A. Propose the use of UAV as part of an integrated set of solutions for the public health supply chain system - not as an isolated or parallel solution.

B. There are a variety of UAV models and different ways of contracting them - each option can best serve in different contexts. In some countries, the government may decide to buy UAV and operate them themselves; while in other countries, it will be better to hire a company that administers them through a government contract.

C. Consider the use of UAV as one of the different solutions to resolve the challenges of transporting essential medicines to hard-to-reach areas, but not as the only solution.

ECONOMIC ANALYSIS

A. Analyze the cost of using UAV and how these can be used at 100% capacity in round-trip flight time.

B. Include smartphone communications costs, so that the lack of funds for pre-paid phone cards is not an impediment to sending and receiving messages.
Conclusion

The use of UAV promises to be one of the contributions to different and innovative solutions that may help governments improve availability of life saving medicines for people living in areas hard-to-reach areas.

Countries testing this technology through proofs of concept will be able to share lessons learned and how to implement the use of UAV as effectively and securely as possible.
8. Additional Resources
UAV regulations. In these maps, you can find regulations by country
http://drones.newamerica.org/#regulations

UAV Code of Conduct, Humanitarian UAV Network
UAViators Code and Guidelines _ English.pdf

UAV Best Practices, Humanitarian UAV Network
HumanitarianUAVMissionsTowardsBestPractices.pdf

UAV – State of Play in Development, World Bank

Matternet 2:
https://drive.google.com/file/d/0BwuAVcz0Fd5bZFRfM1NOdTZQYjQ/view

Zipline in Rwanda:
https://www.youtube.com/watch?v=OnDpE8uSb7M

Vayu, Inc Madagascar
https://www.youtube.com/watch?v=g-Z0x0ZekTQ
For more information, please visit deliver.jsi.com.