Unmanned Aircraft Systems: Product Profiles and Guidance

UNICEF Supply Division

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This brief provides background information on unmanned aircraft systems for use in health supply chain delivery. It highlights existing regulations and systems, as well as use cases for supply chain operations including from UNICEF. It offers elementary and essential information to consider when examining the potential use of unmanned aircraft systems in country programmes.

1. Summary

- UNICEF looks at unmanned aircraft systems (UAS), commonly known as “drones”, and their current use in humanitarian aid operations and supply chains, as well as their potential to reach communities requiring lifesaving essential supplies in difficult and isolated areas covering the “last mile”.
- UNICEF, the Interagency Supply Chain Group’s (ISG) UAS coordinating body, and donors, have been receiving an increasing number of requests for assistance from various UNICEF country offices expressing interest in operations using UAS.
- UNICEF unpacks the classification of UAS to provide a number of critical aspects for UNICEF country offices and partners to examine when considering UAS operations. UNICEF also looks into the overall regulatory background and context of current UAS use, technology, equipment, and some of its current applications in global health.
- UNICEF identifies a number of issues, challenges, and next steps UNICEF country offices should consider when examining the use of UAS in supply and logistics operations, as well as a list of useful resources (Annexe 1).
- Whilst the application of UAS can potentially offer a promising solution to address some of UNICEF’s biggest challenges to improve aspects of logistics and supply chain delivery in health, UNICEF recommends undertaking a detailed economic evaluation to study the cost-effectiveness and cost-efficiencies (Annexe 2) that considers the impact of UAS adoptions within the broader supply chain delivery system. This would inform countries to understand an operation’s viability and sustainability as options for consideration as so many variables exist in different regions and countries and help to articulate clearly identified needs and requirements of a country’s health system supply chain.

2. Background

Commonly known as drones, drones are a layman’s term used to cover a wide range and size of different categories of remote-controlled craft that can operate either in the air, on land, on sea, under water, or even be amphibious. An unmanned aircraft (UA) or unmanned aerial vehicle (UAV) is a flying machine or aircraft that is operated by remote control without a human pilot onboard. UAs or UAVs are one of the main components of an unmanned aircraft system (UAS), which also includes essential technological components such as a ground-control station (GCS), flight control software, global positioning system (GPS), and a communications system capable of operating with various degrees of autonomy either under the direct remote supervision and the control of a human operator, or without direct control via an autonomous onboard computer system (Figure 1, next page). A remotely piloted aircraft system (RPAS) is operated by remote control via a ground-based pilot, often using cutting-edge information technologies enabling the aircraft to travel across borders and in international airspace. For the purposes of this note, UNICEF uses the terms UAS, UAV, and RPAS when referring to “drones” as this note only refers to operations that use aerial crafts as part of a whole system.

1 The ISG UAS coordinating body is an informal coalition of seven donor agencies and foundations investing in improving public health systems and supply chain.
2 Interagency Supply Chain Group, Unmanned Aircraft Systems Coordination in Global Health, ISG, Boston, 2019.
3 An automated computer system refers to a system that was pre-programmed by a human to perform a specific task or operation without the pilot but that could be controlled or changed during flight if needed via a remote control. An autonomous system or operation refers to an unmanned aircraft that operates without a remote pilot being able to intervene, or with an advanced computer system able to perform its own inflight decisions and corrections. In aviation, from a regulator’s perspective, this is a higher-risk scenario, where the aircraft is no longer in control by a human and is performing self-made decisions with advanced machine learning or artificial intelligence features.
International regulations governing the use of UAVs have existed since 1929. It was barely ten years after the Wright Brothers made their ground-breaking inaugural twelve second flight in 1903, spanning a distance of 36 metres, did Orville Wright and Charles F. Kettering develop in 1918 a self-flying aircraft in response to the outbreak of World War 1. Called the “Kettering bug”, with a wingspan of 4.5 metres, weighing 240 kilos, and armed with a torpedo, it could be calibrated for precision flight for up to 120 kilometres. Its forerunner, and literally the earliest ever UAVs as per their definition, were the Austrian incendiary hot air balloons, which were filled with explosives and fitted with time fuses. They were used during the siege of Venice in 1849 by Austria, with limited effect, as they proved counterproductive when used against countervailing winds. But it was the invention by Nikola Tesla, in September 1898, when he demonstrated the use of remote control technology, showing how radio signals could be used to remotely trigger the switches that directed a boat’s movement across water without the use of wires, that caused a sensation that was unparalleled at the time. His technology inspired further development, and was used to control and guide the Ruston Proctor Aerial Target, which was cutting edge technology in 1916, together with the Hewitt-Sperry Automatic Airplane.

Consequently, the Convention Relating to the Regulation of Air Navigation held in Paris 1929, included Article 15 under Chapter VI, which noted that “no aircraft flown without a pilot can fly over the territory of another state without authorization”. It forbade any airborne craft from flying over another sovereign state’s territory without a pilot. This provision was updated at the Convention on International Civil Aviation, held in Chicago in 1944, which founded the International Civil Aviation Organization (ICAO), and included Article 8 that states: “No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization. Each contracting State undertakes to ensure that the flight of such aircraft without a pilot in regions open to civil aircraft shall be so controlled as to obviate danger to civil aircraft”.

3. UAS in International Aid and Development

Whereas UAVs have been primarily used in defence activities since the 1920s, including their use in international airspace settings for intelligence, surveillance, and reconnaissance (ISR) across theatres of war and conflict, their civil and commercial application did not take off until 2005. Technological developments in devices had improved significantly to now require the attention of civil aviation authorities with regards to licensure and the need to shape regulatory procedures and requirements. The advent of UAS is increasingly becoming a well-established fixture in public and commercial service sectors within countries, especially those systems that use cameras and sensors for aerial situational awareness, filming,
inspections, mapping, monitoring, patrolling perimeters, search and rescue, and surveying, amongst many other remote sensing applications. The use of UAS can also have a major role in development and humanitarian aid programmes, operations, and activities where they have already been increasingly used in post natural disasters since 2005 [e.g. Hurricane Katrina damage assessments]. Many UAS operations have also been piloted to establish proof of concepts within the public health domain over the past six years (Figure 2).\(^{11}\)

**Figure 2 Examples of UAS in Health Supply Chains**

Sources: USAID, UAVs in Global Health / UNICEF Supply Division / ISG UAS coordinating body

Until recently, the majority of development and humanitarian aid use cases (between 70-90 per cent) tended to have been focused on mapping and monitoring to gather real-time information to complement satellite data. UAS have been useful to capture and provide aerial data to inform and design aid projects, as they can quickly cover large surface areas, over a shorter period of time, at a higher resolution, at less cost, greater safety, using fewer resources, than relying only on field personnel and logistics, shortening the time taken to evaluate findings and inform planning.


### 3.1 United Nations Use of UAS

Various United Nations (UN) agencies have been using UAS in different operations. The UN Secretariat’s Department of Peace Operations (DPO), formerly the Department of Peacekeeping Operations (DPKO), and the Department of Operational Support (DOS), formerly the Department of Field Support (DFS), have been using UAS since 2013. They have been gathering high resolution (real-time) ISR imagery to complement satellite data to highlight dangers on the ground, identifying


improvised explosive devices (IEDs) and unexploded ordinance (UXO) to protect UN convoys through ‘top cover’, or to gather evidence on the violations of human rights, monitor border area movements, and illegal mining activity, amongst others.14

A number of other UN agencies, funds, and programmes (AFPs) have been using UAS for a wide range of activities in data collection for humanitarian interventions, including to monitor disaster affected areas such as floods, earthquakes, volcanic eruptions, and assist in logistical surveys, monitor the internal displacement of populations or refugee movements, search and rescue operations, secure facilities, site planning, and undertake geographical surveys.

UAS operations have also been piloted in many areas of work relevant to UNICEF, notably in support of emergency programme operations (EMOPS) for geospatial analysis (aerial imagery) in post natural disaster situations; water and sanitation and hygiene (WASH) programmes for planning the location of latrines or to site water points or sanitation structures; as well as nutrition, where UNICEF and partners supported using UAS for crop surveillance and the analysis of crop health amongst others. UNICEF illustrates some notable examples (Figure 3).

**Figure 3 Examples of UNICEF UAS Operations for Aerial Imagery**

- In Madagascar and Malawi, UNICEF and government operations regularly undertake post-flood mapping with the assistance of UAS to help authorities to identify infrastructure damage and what disaster preparedness and management efforts to improve towards disease outbreak management efforts. This is done by applying advanced data analytics machine learning algorithms to identify areas of high-risk of disease outbreaks such as cholera, or the location of stagnant water bodies that may be most prone to active mosquito breeding. It also performs crop assessments to monitor plant health and help manage any risks to crop production from drought, pests, or other factors.

- In Vanuatu, UNICEF supported the government with UAS to support the evacuation of communities from the island of Ambae after one of the island’s volcanic eruptions at the end of 2017. UAS provided aerial monitoring to assist with evacuation camp site planning and identify the most appropriate locations for sanitation structures.

Source: UNICEF Supply Division


Additional information on the use of UAS in UNICEF country programmes, including their use in collecting geospatial (aerial) data and their use for social good, was compiled at a UNICEF Office of Innovation conference held in New York in April 2019,15 and is available here: [https://www.unicef.org/innovation/stories/drones-social-good](https://www.unicef.org/innovation/stories/drones-social-good)

### 3.2 UAS in Health Supply Chain Management

One of UNICEF’s biggest challenges, and one faced by many agencies, is how to effectively deliver assistance over the “last mile” to hard to reach communities. The type of challenges many countries face in last mile logistics supply chains can include, but are not limited to, some or all of the following:

- **Poor Infrastructure**, especially in rural resource-limited settings with poor transport infrastructure, requiring long travelling distances over inefficient routes that translate into higher costs and time.
- **Meteorological conditions** and heavy seasonal changes that can affect and undermine poor quality, fragile network infrastructure and year-round access.

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• Inefficient means of transport and the lack of access to appropriate transport technology, whether road-worthy vehicles, motorbikes, planes, or boats, with respective limited capacity and cost ratios per weight transported.

• Low population densities, which as the number decreases and the spatial spread of a population’s distribution increases, their proximity to service centres decreases making it an even greater challenge to establish close and regular contact with health services. Traditional logistical distribution networks tend to concentrate their services on centres strategically focused on those few places that offer higher cost-efficiencies and better economies of scale. Areas of higher population concentration, both in terms of delivery and distribution times, reduce transactional costs and time.

• Communication, and being able to keep in touch with communities to ensure the timely exchange of information and notifications related to service delivery, processes, and transactions help ensure satisfactory, efficient, and effective service delivery. Notifications on dispatch, transit, delivery, as well as feedback on accuracy is equally essential and necessary to take any timely corrective or remedial measures.

One promising area of activity that UNICEF sees can benefit from the use of UAS is in health programmes and in support of supply chains and health systems strengthening, notably its potential role in disease surveillance, emergencies, expanded programmes on immunization (EPI), and the delivery of critical household or clinic medical supplies. In particular there is the need to access hard to reach communities over the “last mile” in remote geographies and settings that have limited resources. The first documented instance of a UAS being used to focus on the delivery of medical supplies was in 2014 by Médecins Sans Frontières (MSF) in Papua New Guinea. There have since been a growing number of operations using UAS in the health sector (see Figure 2, preceding page 3).

In 2017, MSF released a study based on a qualitative interview evaluation of all their humanitarian interventions using UAS to carry cargo. They concluded that the most important use-cases for UAS cargo operations, considering the technology at the time, were for small ✓, individual ✓, time-bound ✓, quick responses ✓, to a specific need ✓, as well as for the regular supply of remote health care facilities ✓.

Whereas the use of UAS were considered more effective than alternative comparative options in terms of cost and weight capacity (i.e. the use of motorbikes), their use was also very context dependent, notably after natural disasters, or during epidemics where there were no alternative means or options available. Costs are secondary to saving life, as the “right to humanitarian aid” underpins MSF’s engagement principles. They entirely exclude their use in conflict settings and any post-conflict settings where UAS were associated with conflict.

The United States Agency for International Development (USAID) undertook a preliminary analysis of UAS operations in 2018 to identify opportunities and challenges for UAS to develop and bring to scale operations in a global health context. It lays out a possible roadmap for donors to strategically coordinate their investments to shape and accelerate this market segment.

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20 Ibid., p. 6.
The Boston Consulting Group took this work further to prioritize a shortlist of potential UAS use cases in global health and detail the requirements to begin operationalizing these cases. \(^{21}\) Technological advancements made in UAS technology and their use through a growing number of sectors and fields can potentially offer a promising solution to improve efficiencies in some aspects of logistics and supply chain services to cover the “last-mile”. They can notably:

- Speed up patient access to appropriate and timely effective care, for example access to point of care (POC) diagnostics and treatment;
- Improve the efficiency of disease surveillance monitoring via the timely transportation of patient blood and sputum samples;
- Increase the timely delivery of high value cold chain commodities or essential and vital medical supplies to places that are hard to access, or where well-developed transport infrastructure is limited, or in post-disaster affected areas, or areas with a high concentration of displaced people.

UNICEF is tracking the implementation of UAS in operations (as outlined in Figure 2, page 3). Notably Madagascar and Malawi have trialled patient sample deliveries for tuberculosis (TB) diagnosis. The UNICEF country office in Malawi also trialled the transport of dried blood spots (DBS) for early-infant HIV diagnosis (EID), to prove if shortening the waiting time would increase the likelihood of mothers returning for results and respective treatment using UAS delivery.

UNICEF in Madagascar explored how to support patients during the plague outbreak to improve the rate of diagnosis and reducing the time patients waited to receive treatment medications once the disease was diagnosed. Currently, five UNICEF country offices have been trialling UAS for a number of transport use cases (Figure 4).

**Figure 4 Examples of UAS in Health Operations Involving UNICEF Country Offices**

- **In Kazakhstan**, the government and UNICEF recently launched a joint initiative to test UAS for emergency preparedness and response at two designated UAS testing corridors. Medical aid survival kit deliveries are envisioned to be trialed for search and rescue operations (i.e. post-avalanches).
- **In Vanuatu**, UAS used to support the country’s EPI have been coordinated by UNICEF since 2017. From December 2018 to May 2019, on-demand delivery services by UAS took place via two companies contracted by the Ministry of Health (MoH) as part of their EPI in three island locations. The range of commodities extended from eight vaccines to other commodities to include malaria rapid diagnostic tests (RDTs), RDT kits, oxytocin (used for labour induction), asthmatic tablets, iron-containing supplements, antibiotics, safety syringes, and alcohol swabs, in addition to important health documents. The return delivery of official documents and the removal of waitlist from outposts has also proven to be useful.
- **In Sierra Leone**, UNICEF in partnership with the Government’s civil aviation authority, plans to establish a UAS testing corridor, which aims to also enable health use cases and on-demand deliveries.
- **In Malawi**, since 2016, UAS are being used to transport patient referral laboratory samples for TB disease diagnosis as well as dried blood spots for early diagnosis of HIV in infants.
- **In Madagascar**, in 2016, UAS were used to transport and deliver patient referral laboratory samples for TB disease diagnosis in order to establish proof of concept.

Source: UNICEF Supply Division, Office of Innovation

In 2018, VillageReach, a non-governmental organization (NGO) that seeks to address the unique needs of weak health systems with an emphasis on strengthening the “last mile” in healthcare delivery,\(^ {22}\) and the Boston Consulting Group, with

\(^{21}\) Interagency Supply Chain Group UAS coordinating body, *UAVs in Global Health: Use Case Prioritization* ISG, Boston, December 2018.

the support of the ISG UAS coordinating body, assessed 26 UAS operation use cases in global health. They established a shortlist to prioritize and detail the requirements necessary to operationalize those UAS operations found to be most relevant to UNICEF. Those considered most relevant according to UNICEF’s priority framework were:

- The supply of vaccines for scheduled campaigns under EPI.
- The transport of patient samples to and from primary, secondary, and tertiary health clinics, and laboratories, contributing to the response management of diseases and outbreaks.
- The delivery of products that have a high lifesaving impact such as blood transfusions, antiretroviral medicines, antivenom serums, oxytocin, amongst others that can respond to the critical needs of individual patients.

4. **Different Classification of UAS and Considerations**

4.1 **Types of UAVs**

The importance of analysing data beforehand cannot be underestimated. Using the “right” type of UAS depends on the needs of operation and the type of programme. The equipment depends on aspects such as distances and the geography to be covered, the size and weight of products to be lifted, and possible supporting infrastructure. John Snow Inc.’s (JSI) Research and Training Institute, together with Llamasoft and InSupply Health, an affiliate of JSI’s Research and Training Institute, and an independent, supply chain advisory firm based in East Africa, produced a white paper discussing what programmes should deliver by UAS, and the role of geography, product, in prioritizing deliveries by UAS.

Table 1 Representative Summary of Different UAVs, Performance, and Specifications

<table>
<thead>
<tr>
<th>Agility / Fault-tolerance</th>
<th>Endurance / Payload</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operational Footprint / Speed</strong></td>
<td><strong>Power Source</strong></td>
</tr>
<tr>
<td>Multirotor</td>
<td>Single Rotor</td>
</tr>
<tr>
<td>Small / quick</td>
<td>Medium / quick</td>
</tr>
<tr>
<td>Electric</td>
<td>Electric / Combustion</td>
</tr>
<tr>
<td>10-50' (electric)</td>
<td>1-4.5 h (combustion)</td>
</tr>
<tr>
<td>≤10 kg</td>
<td>≤8 kg (electric)</td>
</tr>
<tr>
<td>≤75 km/h</td>
<td>≤75 km/h</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>6 cm-1.6 m</td>
<td>0.5 m-2 m</td>
</tr>
<tr>
<td>Landing</td>
<td>Landing or air drop by automated release</td>
</tr>
<tr>
<td>2-5%</td>
<td>5-10%</td>
</tr>
<tr>
<td>Field logistician or health worker</td>
<td>Trained UAV operator</td>
</tr>
</tbody>
</table>

Source: EASA, UNICEF Supply Division

Notes: Express in minutes (') and hours (h). Depending on payload and time spent cruising or hovering (when rotor aircraft).

Notes: A return flight is assumed. When the UAS are equipped with satellite communication, a one-way flight range can be extended.

Notes: VTOL: vertical take-off and landing capability.

There is currently no one standard of UAV classification, as different countries, civil aviation authorities, and military agencies, have their own classification standards, which are all still evolving. There exists a wide range of UAVs with

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23 Interagency Supply Chain Group UAS coordinating body, UAVs in Global Health: Use Case Prioritization ISG, Boston, December 2018.

significant differences in sizes and capabilities. Commonly, UAVs are classified by type, size, maximum take-off weight, flying range (autonomy / endurance), maximum operating altitude (whether above ground or above sea level), payload capacity, power source, take-off and landing modality, maximum flying speed, amongst many others. UAV’s can be classified very differently in accordance with the different specifications and priority focus areas (Table 1, preceding page).

4.2 Type of Operation

Similarly, as with the standard of UAV classification, there is currently no one standard to classify the different types of UAS operations. As an example, the European Aviation Safety Agency (EASA) recently issued legislation for RPAS classification, which is the class used in many civil and commercial activities. The legislation issued by EASA classifies the operating environment of RPAS taking into account their operation around people and crowds. It defines more clearly the different classes of RPAS, some of their technical requirements, and their operational environments across Europe (Table 2).

Table 2 European Aviation Safety Agency Classification of RPAS Under Open Category - 2018

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Operation</th>
<th>Competency Requirements</th>
<th>Class</th>
<th>MTOM*/ Joule (J)</th>
<th>UAS Technical Requirements (CE)</th>
<th>Electric ID / Geo-awareness</th>
<th>Operator Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Fly over people</td>
<td>Must be far from aerodromes / max. height of 120 m</td>
<td>- Consumer information</td>
<td>C0</td>
<td>&lt;0.25 kg</td>
<td>- Consumer information; toy directive; &lt;19 m/s; no sharp edges; selectable height limit</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>You can fly over uninvolved people, but not over crowds</td>
<td>- Online training</td>
<td>- Online test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>Fly close to people</td>
<td>You can fly at a safe distance from uninvolved people</td>
<td>- Consumer information</td>
<td>- Online training</td>
<td>- Online test</td>
<td>Theoretical test in an aviation authority recognized centre</td>
<td>C2</td>
</tr>
<tr>
<td>A3</td>
<td>Fly far from people</td>
<td>You should not fly were uninvolved people can be endangered and keep a distance from any urban areas</td>
<td>- Consumer information</td>
<td>- Online training</td>
<td>- Online test</td>
<td>Privately built</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>C4</td>
</tr>
</tbody>
</table>

Source: EASA

Note*: MTOM: maximum take-off mass.

The classifications correspond to a low-risk “Open Category” and does not include operations close to people or over built up urban areas, which is what would be mostly required and necessary for the delivery of health products to public health facilities in development and humanitarian aid programmes. These would be classed under a medium-risk “Specific Category” according to the new regulations, even if the aircraft have a maximum take-off weight of less than 25 kg.

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Countries need to also consider a secondary level of RPAS classification, based on their flight range capability and operational mechanism with regards to their means of control and management. These are based their line of sight and line of radio communication, or whether they are beyond each (Table 3). For UNICEF health supply chain use cases, UAS operations would most likely be based on beyond visual line of site (BVLOS) conditions, rather than on visual line of sight (VLOS), yet often still within direct radio line of sight (RLOS). This distinction will more clearly determine the procurement process, type of UAV device, performance criteria, propulsion system (battery / engine / fuel), type of operation, capability, and type of certification required. While some contexts in complex geographies may require to operate UAS with BRLOS capability, it should be noted that the need for a satcom link system or ground repeater stations to overcome BRLOS, would also increase costs.

Table 3 Different Flight Range Capabilities of UAS and Operational Parameter Definitions

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Operations with pilot maintaining a direct unaided visual of the aircraft by remote control.</td>
<td>Operations flying beyond the visual line of sight of an operator. It can imply a complex UAS operation including the ability to conduct unmanned take-off, flight, and landing.</td>
<td>Operations using a transmitter and receiver with mutual link coverage. In ideal high-altitude settings, operations can achieve distances up to 150 km in range, after which one has to take into consideration the effects of the earth’s curvature.</td>
<td>Operations using a transmitter and receiver, not within a mutual link coverage, requiring possibly a satcom link, or the use of a ground station via terrestrial network system. This is normally required for complex geographic settings.</td>
<td></td>
</tr>
</tbody>
</table>

Source: ICAO, Manual on Remotely Piloted Aircraft Systems

The class of UAVs to be used in an operation has to be based on a needs assessment that defines the operational requirements, conditions, and settings (e.g. population density, and whether in urban or rural context), and would define the operations objective and purpose. Operations would not be based on defining the type and classification of UAV to be used.

UAS operations would also more than likely be either remotely piloted or under automated control inside a country’s territory in “low” airspace (with a controlled safe flight altitude following the ground level). UNICEF would currently not likely engage in any cross-border operations, except under very special circumstances, or if there were an existing agreement for the joint use of airspace between neighbouring countries, or a joint cross-country authorization process in place in certain regions near the border.

5. Current Market Situation

The commercial UAS market is evolving and growing rapidly at an exponential rate as they are increasingly being used in several major market sectors. These range from defence to consumer electronics, leisure, toys, as well as agriculture, oil and gas, real estate, photography, and construction, amongst many others. Business Insider reported that the global UAS market reached revenues of USD 4.5 billion in 2016 USD. However, at the end of 2017, the market reported revenues worth USD 17.82 billion, representing a compound annual growth rate (CAGR) of 296 per cent. Even if allowances are made for major discrepancies in market reports and industry with regards to the different sources of information, and the different “drone” segments, terms, and definitions they use by what they mean by “drones”. For example, some segments use a very narrow

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30 UNICEF’s country office in Malawi together with the Government’s Department of Disaster Management Affairs and the Malawi Red Cross recently provided assistance using UAS to the National Emergency Bureau to undertake a post-flood assessment after Cyclone Idai, in the southern district of Nsanje. As it its proximity is close to the border with Mozambique, which had jurisdiction over the affected region’s airspace where the UAS operation was planned, flight permissions were requested from Mozambique’s Civil Aviation Authority and not from Malawi.
32 Ford, Justin, Commercial Drone Market Dronethusiast, Kansas City, December 2018.
definition that only includes UAS that connect over to the Internet. Others only include UAS that weigh under 250 grams, and don’t process data or register with the United States of America’s (US) Federal Aviation Administration (FAA). Nevertheless, it still represents a major growth trend, which could reach between USD 50 and 100 billion by 2020. Goldman Sachs identified the defence sector to be the largest segment with expenditure reaching over USD 70 billion between 2016 and 2020, followed by the consumer markets sector with expenditure reaching approximately USD 17 billion, and significant growth driven by construction with USD 11 billion, and agriculture with USD 6 billion.

In Europe, Single European Sky Air Traffic Management Research (SESAR) report that the UAS market could reach USD 11 billion by 2035, and possibly USD 15 billion by 2050, of which more than half could be from agriculture, energy, and delivery related services. Most of the commercial demand will be in both rural and urban areas based on BVLOS, and will include the three main sectors of agriculture, delivery, and surveillance. A 2019 report by Drone Industry Insights (Droneii) reports that the service sector will continue to lead the UAS industry, and software development will be the fastest growing segment, with India being the fastest growing commercial UAS market globally, becoming the third largest commercial UAS market by 2024.

6. Key Considerations

UNICEF identifies a list of key considerations that UNICEF country offices and governments should consider when examining the options of whether to implement a programme using UAS.

6.1 Articulating the Need and a Solution

There are many different ways to build a UAS programme, which would be dependent and subject to geography, the objectives, local human resource capacity, choice of technology, the availability of supporting services, the procurement of services versus equipment, amongst others. For there to be a viable business case for UAS service providers to offer solutions to the logistics challenges faced by aid agencies and governments, aid agencies and governments need to clearly identify and articulate the needs, priorities, and desired outcomes with benchmark indicators, without prescribing or identifying UAS product specifications and requirements. Governments and partners should to the extent possible articulate:

- The challenge to be addressed,
- The type and nature of the products, specifications, and weights, to be transported,
- The overall volumes to be delivered,
- The geography and operating environment,
- The target caseload,
- The performance indicators UNICEF identifies to track,
- Timeframe,
- An understanding of the interdependencies across the supply chain system and costs,
- What anticipated effects and impact on health programmes and staff resources, healthcare workers, or mobile outreach teams the programme could have. i.e. whether it improves or changes how they do their job. For example, they no longer have to carry vaccines, healthcare workers can spend more time with patients and following up on treatment adherence.

The government of Vanuatu has issued a report detailing its UAS tender process. It offers a very good example of what tender documents and considerations countries should consider when planning to tender for a UAS operation.

6.2 Evidence-based Data

The experience gained from global applications in health supply chains have to date demonstrated that UAS technology can in principle operationally meet programme requirements. However, despite important efforts to highlight and promote the

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34 SESAR, European Drones Outlook Study: Unlocking the Value for Europe, p. 4.
advantages of UAS technologies through pilot operations and various product exhibitions, there is still insufficient long-term evidence-based data to accurately assess solutions using UAS and their comparative advantages and cost-efficiencies over other options, which could inform country decisions to invest in new and alternative operations. The UAS market has not yet received a convincing signal from the international aid community, and health sector in particular, that aid agencies and/or host governments can support UAS operations beyond proof of concept, nor has the UAS market proposed sustainable UAS operations as a component of a broader distribution strategy towards solving last-mile supply chain challenges. The evidence and data have also not yet been shared that demonstrates that UAS operators offer a cost-effective and cost-efficient solution to deliver cargo addressing specific logistics challenges beyond emergency time limited frameworks.

Operationally, the concept has been demonstrated to work, but further details are required to ensure that it can be financially and sustainably viable. Most UAS service providers are currently focused on industries that have proven market volumes and the means of financing that can afford higher operating costs, for example in the construction, oil and gas, and agriculture industries. Transport industries and e-commerce also currently offer financially attractive sectors. Developing countries depend on external sources of funding for some of their budget share, and as such have limited health budgets. Therefore, any programme component would have to be subject to a health budget analysis and an opportunity cost assessment, which is the value of the next best alternative option, or the cost of making an alternative choice.

Health systems are also structured vertically, which does not always lend itself to easily implementing programmes across horizontal departmental approaches that could offer complementary products and services to a community. UAS operations will not always find it easy to offer services financed by a particular department’s budget to include the delivery of commodities from different services, even though it would increase and optimize the operational benefits of service delivery and cost-effectiveness beyond a commodity group.

### 6.3 UAS Operations as Part of a Supply Chain System

Growing evidence suggests that UAS may only be considered as part of a complementary transport modality within an existing supply chain network or system. UAS may only provide real efficiencies in a supply chain if it is integrated holistically into a national system (where conditions and contexts are appropriate) and are country-led and articulated in national supply chain policies and action plans. It will likely require a longer-term supply chain system redesign and reconfiguration that includes local development capacity, knowledge and skills transfer, as part of a larger health systems strengthening development programme that offers complementary transport modalities to improve access to remote areas, possibly substituting or changing some national and local infrastructure development plans. Gavi, the Vaccine Alliance (Gavi) summarizes the potential for UAS operations to transform immunization supply chain systems for vaccine delivery using a system design approach that could transform immunization supply chain systems. It describes how such operations could be integrated into national immunization systems and offers a framework to assess the outcomes of UAS operations and their contributions to immunization and health care systems. In addition, there will need to be a health budget impact analysis and consideration of opportunity costs. This approach is still under a conception phase, and as such, an approach will need to be agreed prior to any donor funding being made available.

### 6.4 Human Resource Considerations

Human resource considerations will depend on the nature and type of operation, especially when considering the distinction between operating a service versus using a service provider. If a health system wants to establish its own service as part of its medical supply chain from central medical stores, it will need its own equipment and ability to manage, maintain, store, and ensure access to spares, and software, amongst others.

Incorporating UAS into low-infrastructure environments will require the development of local capacity, knowledge and skills transfer in order to operate, maintain, and repair equipment in the field, as well as to keep abreast of developments in

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38 Note: As of the date of this guidance note, Gavi’s UAS position paper is under review and not yet published. Once published, it will be available in the UAV for Payload Delivery Working Group’s resource library below:

technology. It would also require the additional training of health field staff with the skills training to interact with, and in some cases, such as bi-directional transport, use this new transport technology.

In addition, if there is a consideration to establish UAS operations as part of an integral component of national health systems, there may also be opportunity to partner with the private sector and develop initiatives and local industries as part of the economic development and social pillars of sustainable procurement (see page 20, section 6.13), to complement health systems strengthening.40

Secondary human resource benefits should also be considered, as the use of UAS can significantly optimize working hours of health staff, e.g. in cases when they may no longer need to travel long distances to deliver certain supplies and instead can focus their time on treating patients.

6.5 Regulatory Space

6.5.1 Regulatory Bodies

Currently, the pace and growth in UAS use is outpacing the ability of national regulatory authorities and frameworks to develop the rules and systems needed to govern their use. There are now wide-ranging discrepancies between the different documentation requirements according to each country. Some countries with the most developed and advanced regulations governing the use of UAS include Australia, the European Union, South Africa, the United Kingdom of Great Britain and Northern Ireland, and the US, amongst others. UNICEF highlights some of the most important regulatory bodies to be aware of, their role and function, and web links to their regulatory information on UAS (Table 4), in addition to some of the issues they are currently addressing.

Table 4 Different Regulatory Bodies and Task Forces Engaged in Regulating UAS Flight Operations – Continued overleaf

<table>
<thead>
<tr>
<th>Body</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Aviation Safety Agency (EASA)41</td>
<td>The EASA oversees and regulates the European Union’s (EU) aviation single market to ensure flight safety across all Member States. The EU-wide regulations governing the use of UAS are accessible here: <a href="https://www.easa.europa.eu/easa-and-you/civil-drones-rpas/drones-regulatory-framework-background">https://www.easa.europa.eu/easa-and-you/civil-drones-rpas/drones-regulatory-framework-background</a></td>
</tr>
<tr>
<td>European Organization for the Safety of Air Navigation (Eurocontrol)</td>
<td>Eurocontrol is not an EU agency and includes some non-EU Member States. It is mandated by the EU to regulate some aspects of the EU’s “Single European Sky” regulations and to harmonise some of the fragmented European air traffic management systems. It is the central organization for coordination and planning air traffic control for the whole of Europe and includes the EU itself as a member. The organization works with all Member State national aviation authorities, air navigation service providers, civil and military airspace users, airports, amongst others. Its oversight regulates all “gate-to-gate” aspects of air operations, strategy, management, training, regional airspace, applied technologies and procedures. Basically, it supports European aviation across the full spectrum of civil and military air traffic management. Information on Eurocontrol and its engagement on UAS is accessible here: <a href="https://www.eurocontrol.int/unmanned-aircraft-systems">https://www.eurocontrol.int/unmanned-aircraft-systems</a></td>
</tr>
<tr>
<td>International Civil Aviation Organization (ICAO)</td>
<td>ICAO is a United Nations agency. It governs the international regulation of all civilian aircraft for international and national regulators across 191-member states.42 For UAS, it is working to harmonise the recommended guidelines governing flight by instrumentation. Whereas its mandate was primarily focused on regulating flight in international airspace, it is increasing being relied upon to harmonise and regulate UAS regulations for use by national civil aviation authorities. In March 2018, ICAO formed the Task Force for UAS in Humanitarian Aid and Development (TF-UHAD). Helpful tools to assist countries to ensure the safe and effective use of UAS and operational guidance can be accessed here: <a href="https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx">https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx</a></td>
</tr>
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</table>

42The International Civil Aviation Organization, Member States, ICAO, Montreal, 2019.
<table>
<thead>
<tr>
<th>Body</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Authorities for Rulemaking of Unmanned Systems (JARUS)</td>
<td>JARUS is a group of regulatory aviation authority experts from 59 countries from all regions including Africa, Asia, and Latin America, and includes EASA, and Eurocontrol. It seeks to harmonise and recommend a joint set of technical, safety, and operational requirements that certify and integrate UAS into civil aviation. It provides guidance material to help inform, advise, and to facilitate aviation authorities in each country to legislate their UAS operating requirements, and avoid the need to duplicate efforts as well as the risk of inconstancies. It provides a single set of technical, safety, and operational rules and requirements for all aspects of UAS operations by reviewing and revising existing regulations and analysing the different specific tasks using UAS. Information on JARUS and their regulations governing the use of UAS is accessible here: <a href="http://jarus-eps.org/">http://jarus-eps.org/</a></td>
</tr>
<tr>
<td>Task Force for UAS in Humanitarian Aid and Development (TF-UHAD)</td>
<td>TF-UHAD, mentioned above under ICAO, includes UNICEF as a participating member. The TF-UHAD seeks to leverage the use of UAS for humanitarian aid and development purposes in the absence of clear enabling regulations at the national level. Information on TF-UHAD is accessible here: <a href="https://www.icao.int/safety/UA/Pages/Task-Force-on-Unmanned-Aircraft-Systems-for-Humanitarian-Aid-and-Development-(TF-UHAD).aspx">https://www.icao.int/safety/UA/Pages/Task-Force-on-Unmanned-Aircraft-Systems-for-Humanitarian-Aid-and-Development-(TF-UHAD).aspx</a></td>
</tr>
<tr>
<td>United Kingdom Civil Aviation Authority (UK CAA)</td>
<td>The UK’s regulations governing the use of UAS are accessible here: <a href="https://www.caa.co.uk/Consumers/Unmanned-aircraft-and-drones/">https://www.caa.co.uk/Consumers/Unmanned-aircraft-and-drones/</a></td>
</tr>
<tr>
<td>The US Federal Aviation Authority (FAA)</td>
<td>The FAA regulations governing the use of UAS are accessible here: <a href="https://www.faa.gov/uas/">https://www.faa.gov/uas/</a></td>
</tr>
</tbody>
</table>

Source: UNICEF Supply Division

UNICEF anticipates ICAO to announce in September or October 2019 the issuance of new guidelines, during their next General Assembly, which will be made available online via the [ICAO UAS Toolkit](https://www.icao.int/safety/UA/Pages/Task-Force-on-Unmanned-Aircraft-Systems-for-Humanitarian-Aid-and-Development-(TF-UHAD).aspx). ICAO developed and made available this tool kit to assist member states and UAS operators with operational guidance to ensure safe domestic UAS operations (see tools under Annexe 1). One example of harmonizing rules is with regards to an aircraft’s weight. The FAA applies a performance-based navigation approach to using UAS. Companies must apply for an exemption to Section 333 for operations using UAS that are heavier than 55 lbs (greater than 25 kg). RAPS’ weighing less than 55 lbs have to comply with regulations under Part 107, which details the rules governing UAS operators. However, whereas an aircraft’s weight was previously an important determinant, it is now no longer the focus of consideration in using UAS, but rather the type of operation the UAS is being used for, and the associated risks that need to be regulated.

JARUS recommends applying a [specific operations risk assessment (SORA)](https://www.icao.int/safety/UA/Pages/Task-Force-on-Unmanned-Aircraft-Systems-for-Humanitarian-Aid-and-Development-(TF-UHAD).aspx) approach to each operation. SORA offers a methodology and a model guideline for operators and approving aviation authorities to use in assessing how to safely create, evaluate, and conduct a UAS operation using UAVs. Any operation or response requirement needing UAS should be based on an initial risk assessment to ensure defensible decision-making, including the implementation of appropriate control measures. A systematic approach to a risk assessment can provide the basis to prioritise actions to alleviate the consequences on affected populations. In a significant and recent related development, the European Commission (EC) issued new EU-wide rules in May 2019. These will gradually replace existing national rules in all EU Member States through 2022 to ensure that the increasing UAS traffic across Europe is safe, secure, and regulated for people on the ground and in the air.

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44 As of May 2019: Australia, Austria, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Croatia, Czech Republic, Denmark, EASA, Estonia, Eurocontrol, Finland, France, Georgia, Germany, Greece, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Kenya, Latvia, Luxembourg, Macedonia, Malaysia, Malta, Montenegro, New Zealand, Norway, Poland, Portugal, Qatar, Republic of Azerbaijan, Republic of Korea, Republic of Moldova, Romania, Russian Federation, Rwanda, Serbia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, The Netherlands, Trinidad And Tobago, Turkey, United Arab Emirates, United Kingdom, United States of America, Uruguay.
46 The International Civil Aviation Organization, *The ICAO UAS Tool Kit* ICAO, Montreal, 2019.
The new EU rules introduce three categories of operations: Open, Specific and Certified in accordance to the level of risk involved (Figure 5).

**Figure 5. European Aviation Safety Agency Classification of UAS Risk Category: Open, Specific and Certified**

Table 5 Some Key Areas and Aspects Currently Under Consideration by Regulatory Authorities

Current EU and US aviation regulations are moving towards a performance-based approach based on the level of risk of an operation that considers multiple factors beyond the weight of the aircraft. It is an attempt to harmonize the currently highly fragmented national rules and regulations, which used to be limited by weight to UAS below 25 kg or 55 lb.

The UAS market is growing exponentially and is subject to new challenges, including political, security, regulatory, technical, and economical questions. Dedicated working groups exist across the industry and various UN bodies to address these challenges.

UAS innovators are pushing the boundaries of technology, which are constantly changing and evolving, and outpace the ability of regulatory authorities to keep up.

New market entrants, service providers, and clients, are not always familiar with, or share, traditional aviation values, resulting in insufficient information and understanding, which also overwhelms regulators.

On a global scale, bodies like ICAO and International Organization for Standardization (ISO) are addressing the concerns over aviation safety and challenges establishing standards. As these evolve to accommodate new drone technologies, UNICEF and the healthcare sector will growingly be able to adopt these for transport of materials and supplies, particularly blood and blood products, specimens and vaccines.

Even though privacy concerns are not so relevant with regards to the use of UAS for the transport of goods as cargo, there are still some safety concerns. However, these are no different to similar challenges faced by the aviation industry, and there are specialized organizations like the International Air Transport Association (IATA), amongst others, working to solve these.

Source: UNICEF Supply Division
The new rules will apply to all professional and leisure UAS operators. UNICEF, via the ISG UAS coordinating body, keeps track of the ongoing efforts and progress made towards harmonizing the regulatory environment and framework in collaboration with ICAO, the World Bank Group, and WFP. This information is important because many countries in Africa tend to either adopt EU or US regulations, or a mix of both. Some countries in Africa have made efforts to harmonize their regulations, for example Kenya, Malawi, Rwanda, Senegal, South Africa, the United Republic of Tanzania, and Zimbabwe to name a few. However, in some cases countries apply unrealistic administrative requirements that hinder innovation, as they require too much administrative paper work, licences, and certificates as part of an authorization process to obtain a permission from civil aviation authorities to operate a UAS. Despite the work in progress, there are still some key areas of focus under consideration by regulatory authorities (Table 5).

6.5.2 Type of Cargo

In addition to the different considerations listed above, UAS operations will need to consider the composition of the products or substances they will transport as cargo and their potential risk to health, safety, property, the environment, and whether they are to be classified as dangerous goods (Table 6).\(^50\)

Contractors will have to take all necessary measures to comply with any relevant and detailed national provisions, or those contained in ICAO’s technical instructions for the safe transport of dangerous goods by air in accordance with its category of classification,\(^51\) and the International Air Transport Association’s (IATA) Dangerous Goods Regulations (DGR) follow up manual.\(^52\) This is the global standard for shipping dangerous goods by air, recognized by all airlines. The transportation of some substances will require a professional judgement, as well as the appropriate packaging and transport conditions (e.g. refrigeration requirements and the use of ice packs), as well as appropriate marking and labelling, risk assessment analysis, contingency plans, operational procedures, and appropriate documentation requirements according to the country.

<table>
<thead>
<tr>
<th>Hazardous</th>
<th>Cargo and Type of Goods Carried</th>
<th>Infectious Substances, Category A or B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosive</td>
<td>Explosive</td>
<td>Flammable</td>
</tr>
<tr>
<td>Harmful</td>
<td>Irritant</td>
<td>Toxic</td>
</tr>
<tr>
<td>Biological products</td>
<td>Clinical waste</td>
<td></td>
</tr>
<tr>
<td>Cultures</td>
<td>Medical products</td>
<td></td>
</tr>
<tr>
<td>Patient specimens</td>
<td>Potentially infectious to animals</td>
<td></td>
</tr>
<tr>
<td>Potentially infectious to humans</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: IATA

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category A</td>
<td>Infectious substances in a form to which exposure is capable of causing permanent disability or a life-threatening or fatal disease in otherwise healthy humans or animals. They are assigned corresponding UN numbers (UN\ 2814): Infectious substance affecting humans; or (UN\ 2900): Infectious substance affecting animals only. If there is any doubt as to whether or not a pathogen falls within this category, it must be transported as a Category A Infectious Substance. Clinical waste containing Category A infectious substances must be assigned to (UN\ 2814) or (UN\ 2900) as appropriate.</td>
</tr>
<tr>
<td>Category B</td>
<td>Infectious substances that do not meet the criteria for inclusion in Category A and are assigned the UN number (UN\ 3373): biological substance, category B. Any clinical waste containing Category B infectious substances must be assigned to (UN\ 3291).</td>
</tr>
</tbody>
</table>

Source: IATA

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\(^50\) Rooney, Annexe 18: The Safe Transport of Dangerous Goods by Air.


\(^52\) International Air Transport Association, Dangerous Goods Regulations (DGR) IATA, Montreal, January 2019.
As per IATA’s manual, infectious substances, defined as substances that are known to contain, or are reasonably expected to contain, pathogens such as patient specimens, fluid swabs or secretions, and unscreened blood, amongst others, are now classified either as Category A or Category B for transport purposes (Table 7, previous page). Patient specimens, reagent kits, and vaccines are normally classified under Category B, particularly if they contain any pathogens that have been neutralized or inactivated so that they no longer pose a health risk. However, these are also perishable goods that have to be transported at appropriate ambient temperature in order to be utilized as intended upon reaching their intended destination. Therefore, some considerations are needed to ensure the UAS are equipped with a suitable carrier or transport box that is airtight, temperature insulated, and secured enough to ensure that content can withstand any disruptive conditions, such as an eventual fall or UAV crash.

6.6 Regulatory Gaps

Operations using UAS and getting the appropriate authorization in humanitarian contexts is also a key challenge, as many developing countries do not yet have proper regulatory frameworks for UAS, or the ability to regulate the extent to which UAS operations are possible. Operators can check the latest regulatory landscape via a global UAS regulations database here: [www.droneregulations.info](http://www.droneregulations.info).

The database, launched in 2014 by UAViators, a humanitarian UAV network, covering humanitarian aid activities, provides aid agencies a directory and summaries of national UAS laws and relevant national regulations. There is also [https://uavcoach.com/drone-laws/](https://uavcoach.com/drone-laws/) which provides UAS laws and regulations by country, listed alphabetically, and which should be consulted in conjunction with ICAO’s UAS Toolkit, and the World Economic Forum (WEF) Advanced Drone Operations Toolkit.53

6.7 Operational Challenges

Figure 6: Some Key Challenges in UAS Operations

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Need for continued alignment and coordination across use cases (i.e. public health supply chain UAS coordination via the IGS donor group, of which UNICEF is a member) and regulatory framework efforts, (i.e. with ICAO, WHO, and WPP).

To understand, define and integrate these systems into a robust regulatory framework addressing safety and efficiency aspects.

To verify licensing and medical qualification of remote pilots and crew.

Allocation of available frequency spectra to ensure reliable radio-communication with the aircraft.

Protection from unintentional or unlawful interference.

Separation of standards from other manned aircraft.

Source: ICAO, Unmanned Aircraft Systems

One key finding of current interventions using UAS operations in humanitarian responses is that they need more experience and coordination. The industry and national authorities need to have clearer, coherent, and more harmonized regulations, as well as standards, oversight, guidelines on information sharing, data collection, and protection, integration, and airspace management. Service providers need to ensure that any staff they deploy are sufficiently trained, licensed, and experienced, to manage and operate efficiently in resource limited settings. Therefore, decision-makers should consider how to address operating challenges such as those listed above (Figure 6). UNICEF is collaborating with the Malawi CAA to establish a

Malawi-specific tool kit to respond to many of the below-mentioned operating challenges, in partnership with VillageReach, and other stakeholders.

6.8 UAS Project Roadmap and Phase Considerations

Most UAS projects involving the transportation of goods in public health contexts follow a phased approach (Figure 7). The first phase should start with a use case needs identification (for example to improve the availability and access to particular products for critical health care interventions at isolated points of are). The needs assessment should inform a business case design that should be based on a consultative process that includes the engagement of all local community and stakeholders from the onset. Any engagement including those that envisage achieving a viable and sustainable model, needs to have the participation of stakeholders and communities at the onset of conceptual planning and transition consideration. This would in turn require local capacity building and knowledge and skills transfer planning considerations to be included, also from the onset, which would ensure their engagement and commitment, which in turn would also support any programme to acquire any regulatory approvals. This could include local skill development such as the licensing of UAS operator pilots, operational safety and support services.

Figure 7 Typical UAS Project Roadmap and Phases

1. Needs assessment, community engagement, local capacity analysis, opportunity costs analysis
2. Business case design and technology platform considerations + Regulatory approvals and support requirements
3. Feasibility test caseover time bound period + sustainability considerations and local capacity engagement
4. Business case implementation + detailed economic analysis of cost-efficiency and effectiveness,
5. Evidence based results + data to inform transition, sustainability, planning and local capacity buildin. Opportunities for private sector engagement, and sustainable financing
6. Expanded delivery programme business case + detailed transition planning with stakeholders
7. Hand over transition

Source: UNICEF, adapted from VillageReach, ISG UAS coordinating body.

The second phase involves testing the UAS use case to generate sufficient evidence of its operational acceptability, feasibility, performance, and safety during a time-limited period over a geographically defined area. This phase should be able to demonstrate its operational efficiency, effectiveness, and impact. It is also critical that this stage includes an economic assessment of its cost-efficiency, cost-effectiveness, and cost-utility, which is the base evidence to justify any intervention’s viable sustainability. This information is fundamental to achieve the third phase and a decision to expand any UAS operation within a country to increase coverage and impact, and eventual transition hand over. However, typically, funding availability typically ends at the first or second phases.
6.9 Evaluating UAS Service Providers.

In order to assist countries with advice and suggestions how to evaluate UAS service providers, USAID’s global health supply chain programme’s procurement and supply management (GHSC-PSM) developed and published a guide to provide a list of general considerations to evaluate UAS manufacturers. It provides a thorough list of specifications and relevant questions for inclusion in any request for proposals (RFP), which could help UNICEF country offices to easily compare and analyse the offers from different UAV companies and service providers and determine which are the most qualified to meet the organization’s needs. They provide a sample short list of recommended criteria to use when visiting manufacturers or attending demonstrations.\(^{54}\)

6.10 Price Considerations and Cost-effectiveness (see Annexe 2)

Any price or cost considerations will depend on many factors as there are indeed many different ways to build an operation using UAVs. The costs will depend on the type and design of programme, the geography, the distances to be covered, and task at hand, the nature, type and weight of the cargo to be transported, the skill and capacity of local human resources, the choice of technology, the availability of services and parts, and whether the operation is based on procuring one’s own equipment and operating it, or contracting a service provider.

Currently, the funding of many UAS operations typically ends at the first or second phase (Figure 8), which can reach between approximately USD 200,000.00 (for a needs assessment and first phase) to USD 1.5 million (for first and second phases).\(^{55}\) UAS operations need to look at a programme’s cost-effectiveness and cost-efficiency to assess and examine if a business case can be considered sustainable and good value for money.\(^{56}\) Without such information to establish and test a concept’s financial viability with convincing data and evidence, it will be difficult to secure the funding to plan and consider any transition.

The cost-effectiveness of UAS operations can increase as the number of flights per health facility and health facility density increases within the operational range area, as it simply defrays fixed costs. The transportation of single-products may also not be the most optimal use of an operation, as layering multiple products and purposes could also increase cost-effectiveness;\(^{57}\) even though there are challenges related to health systems being structured vertically. All cases proposing the use of UAS must be examined within the context of the total system costs and wider supply chain objectives such as speed and availability to consider broader health benefits. Considerations of potential higher value-added use cases for UAS operations include:\(^{58}\)

- Areas where there is a high density of health facilities within a UAS flight range,
- Focusing on areas with poor to no to access by other means during large proportions of the year,
- Delivering high-value, scarce products that have a high lifesaving impact,
- Delivery of products that have unpredictable demand,
- Products that have a short shelf-life and that are difficult to store.

Between 2016 and 2018, UNICEF estimates the funding used through pilot UAS operations in country programmes in Madagascar, Malawi, Kazakhstan, and Vanuatu reached approximately USD 1.5 million, which excludes any costs of fixed-term consultants or staff. A major critical area of interest is the need to assess and evaluate the cost-effectiveness and costs-efficiency of current UAS operations and establish some sense of public health unit cost pricing comparisons according to the different components versus alternative interventions, and the degree of service delivery and level of sustainable improvement.

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\(^{55}\) Financial data based on UNICEF Vanuatu trial.

\(^{56}\) Value for Money:Annexe 1.

\(^{57}\) JSI, *What Should You Deliver by Unmanned Aerial Systems?*

\(^{58}\) Ibid.
Some of the upfront investment costs when considering the purchase of UAS (aircraft and ground equipment) can reach up to USD 36,000.00 for multirotors, and range between USD 60,000.00 to USD 150,000.00 for various hybrid systems, ranging from small electric to large, gas powered systems. Proposal submissions to the ISG UAS coordinating body see foreign UAS contract service costs (which include fixed costs as well as variable cost estimates) start at approximately USD 30,000.00 per month. However, proposal submissions are by no means the basis on which to assess the merits of the cost-efficiency or cost-effectiveness of UAS operations. One needs to assess real cost projections and expenditures, including secondary and tertiary effects beyond the cost of technology alone.

UNICEF to date has limited visibility to the financial data from country programmes and so cannot assess to what extent UAS services can be sustained beyond short-fixed term interventions to cover longer-term operations. Based on a current partial financial view, approximately 90 per cent of the costs of UAS operations are linked to fixed costs, such as staff costs and leasing equipment. There are very few if any consumable supplies for an operation (as these costs would exclude the costs of the cargo to be delivered). The “costs” per flight are largely dependent on the number of flights in a given period of time, and therefore, optimizing and securing the maximum number of cargo-carrying flights would be one way to ensure improved returns on cost-effectiveness and cost-efficiency, simply by reducing the cost per flight, and cost per beneficiary, and defraying fixed costs. However, as a large part of the costs are based on staff, leasing equipment, insurance and liability cover, there is room to negotiate and open the procurement of services to competitive tender that could include multi-modal distribution to a variety of facilities for a variety of health products, where UAS are one component of a broader distribution solution. National health services may wish to assess their different health programmes and services (EPI, national medical stores), as well as consult with other government ministries to see if there are any opportunities to co-share services based on identified needs.

Information on operating costs from the different UAS country programmes should be shared between UNICEF country offices so that country programmes can assess how each respective programme and costs compare with alternative transport options and modalities, and under which contexts. This information would also be useful for UNICEF to assess and secure an understanding of their value for money, as all cases for using UAS must be examined within the context of the total system costs and wider supply chain objectives such as speed and availability to consider broader health benefits. The UAS industry has been trialling different technology through aid agencies, including UNICEF, since 2013. But it has not yet resulted in any programmes delivering cargo at scale, with the exception of the Governments of Rwanda and Ghana, both of which favoured a single source foreign vendor without public tender.

To support cost projections, VillageReach and InSupply Health provide guidance on supply chain management and design. In 2018 InSupply Health released a (Beta version) tool to assist countries to determine a financial “Use Case” for UAS through a cost simulation tool, based on proving data and metric inputs including geographic data and products to be transported:

InSupply Cost Simulation and Use Cases Determination Tool

6.11 Measuring Impact Indicators

Beyond supply chain metric delivery and cost indicators, programmes will need to define how UAS supported operations contribute to improving the programmatic outcomes of health care interventions, for example improvements in product availability, access, coverage, and utilization. This could include wastage rates, stock-outs, and oversupply. Monitoring and evaluation needs to look at the cost-efficiency and effectiveness of UAS pilot programmes and assess their conversion of inputs to outputs and at what cost, as well as their effectiveness to deliver outputs that translate into outcomes and establish their impact against measurable indicators, against alternative means of process delivery cost comparators. Any operation needs to be able to demonstrate that it is not doing the wrong thing very well (efficient but ineffective) nor the right thing but badly (effective but inefficient).

The logistics cluster provides guidance on how to monitor and evaluate logistics operations. Monitoring and evaluation link planning and implementation. Whereas monitoring activities focuses on outputs, evaluation focuses on the impact, outcome, and goals. The regular monitoring of logistics activity observes the degree to which targets are being met allowing for timely

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56 The Logistics Cluster, Monitoring and Evaluation, the Logistics Cluster, Rome, August 2015.
corrective actions, whereas evaluation analysis on progress allows an objective assessment of success or failure and provides direction for future plans.

The logistics cluster. led by WFP, coordinates and supports logistical and operational decision-making with information management to improve the operational predictability, timeliness, and efficiency of humanitarian emergency responses.60 This cluster is part of a wider coordination system adopted by the Inter-Agency Standing Committee (IASC) in 2005.61 It is part of an approach to address the gaps and weaknesses to improve international responses to humanitarian crises, and to strengthen the response capacities, coordination, accountability, and partnerships in a number of critical sectors.62 The IASC is an inter-agency forum comprised of UN and non-UN humanitarian partners that was established by the UN General Assembly in 1992 as the primary mechanism for inter-agency humanitarian coordination.63

The monitoring and evaluation framework for UAS operations will need to include public health metrics if in support of health systems strengthening, as well as be suitable and adapted to serve as a basis to harmonize the different approaches for the collection of data and indicators that implementers and stakeholders could use and share widely their experiences of different issues, challenges and solutions.

6.12 Privacy Concerns

Privacy concerns may not be obvious with regards to the use of UAS in public health for the transport of cargo, as cargo carrying UAS will normally not be equipped with any cameras. However, for those UAS equipped with geospatial technology, whilst there may be major advantages in using this, the data they gather can present privacy, security and ethical dilemmas depending on the operation, context, and location. The use of these technologies and the ownership of data needs to be critically assessed through an ethical lens prior to engaging in any partnership or implementing any programmes or analysis. UNICEF’s Office of Research-Innocenti, published a guidance on the “Ethical Considerations When Using Geospatial Technologies for Evidence Generation”, which examines these considerations, and offers a checklist that may be useful to support UNICEF country offices and partners to reflect on their assessment of UAS use cases.64

6.13 Sustainable Procurement

UAS operations and procurement have a potential to accommodate sustainable procurement considerations. Higher environmental impacts can be achieved using UAS when comparing the different environmental benefits of UAS-based delivery services against other options (i.e. motorcycles) depending on their delivery settings, and whether in urban and rural areas.65

In February 2018, UNICEF released its Procedure on SP [SUPPLY/PROCEDURE/2018/001]. The procedure constitutes UNICEF’s policy on SP and is applicable across all UNICEF offices engaged in supply planning and procurement, wherever feasible and applicable, whether for goods or services, or for programmes or office assets, and includes in-country distribution and logistics, read more here.

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60 The Logistics Cluster, About Us, WFP, Rome, 2019.
62 Other sectors under the IASC cluster approach includes: camp management and coordination; early recovery; education; emergency telecommunications; food; health; nutrition; protection; security; shelter; and water, sanitation, and hygiene (WASH).
63 The Inter-agency Standing Committee, Welcome to the IASC, IASC, Geneva, 2019.
Sustainable Procurement

Sustainable procurement (SP) is an approach to procurement that incorporates the three sustainability pillars of social, economic, and environmental impact considerations. It goes beyond the more familiar “green” public procurement, to ensure that all products and services procured support local economic and social development, with the least environmental impact, and the best value for money (VfM).

In implementing SP, UNICEF seeks to include green manufacturing quality management systems, and social and economic considerations as SP criteria in commercial tender evaluations, as well as specific supply targets to develop local industry capacity in programme countries.

In applying SP, many UNICEF procurement decisions will face trade-offs between SP’s three pillars (economic, social, and environmental) and present key operational challenges, especially between environmental and social considerations, with the latter often being more difficult to quantify. The absence of evidence to make any informed trade-off decisions will be part of the challenge. The other challenge will be the difficulty to make value judgments to prioritize one pillar over the other. However, solutions will be situation specific and priorities based on readiness, market influence, and targeted objectives.

Some SP elements, notably under the social pillar, may put some pressure on short-term costs that generate longer-term savings, such as investments in fairer employment working conditions, or health and safety, which would be offset by increased motivation, productivity, and reductions in work-related injury and absenteeism. To achieve higher tangible economic benefits and VfM, UNICEF and industry will strive to manage procurement decisions based on longer-term perspectives, considering the advantages of environmentally, socially sound products and services, and better performing staff, bring in the long-term.

Source: UNICEF Supply Division

7. Steps Forward for UNICEF

- **Assess the needs:** UNICEF, in collaboration with regional and country offices and partners should continue to assess operational needs and viable options and areas where public health system strengthening interventions could benefit from UAS operations as part of an approach to improve access to healthcare against the options of using alternative transport means in order to present a viable use case.

- **Articulate the requirements:** Should governments, partners, or UNICEF country offices identify a need to consider a UAS supported operation to deliver cargo, UNICEF county offices should to the extent possible articulate:

  ✓ The challenge to be addressed,
  ✓ The type and nature of the products, specifications, and weights, to be transported,
  ✓ The overall volumes to be delivered,
  ✓ The geography and operating environment,
  ✓ The target caseload,
  ✓ The performance indicators UNICEF identifies to track,
  ✓ The timeframe,
  ✓ An understanding of the interdependencies across the supply chain system and costs,
  ✓ The effects and impact on health programmes and staff resources, healthcare workers, or mobile outreach teams, and whether it improves or changes how they do their job. For example, they no longer have to carry vaccines, healthcare workers can spend more time with patients and following up on treatment adherence,
  ✓ The UAS operators should then identify the UAS performance requirements, functionality, design considerations, and offer a UAS product solution with a proposed budget which can then be assessed against other offers for cost-effectiveness.

- **Share information:** UNICEF encourages country offices to share information with each other through a shared web portal on operating costs, and other key information such as terms of references (ToRs), concept notes, memorandums of understanding (MoUs), amongst others, from the different UAS country programmes between UNICEF country offices considering UAS operations, so that country programmes can assess the respective programmes, costs, and different transport options and modalities, and operating contexts. This information would increase a country’s ability to understand the value of using UAS and their impact on the total system costs and wider supply chain objectives and mechanisms.

- UNICEF country offices should ensure that they undertake an extensive community outreach activity to include community participation and engagement in any UAS operation in order to ensure that local communities and authorities feel that they also “own” any endeavours, as well as to minimize any public misconceptions and misperceptions of the use of UAS. Any UAS operation should make provisions to ensure knowledge and skills transfer and capacity
development, such as building local skills in addition to community engagement. Some skills could include the licensing of UAS operator pilots, operational safety and support services.

- UNICEF should continue to engage and cooperate with the different UAS coordination bodies and mechanisms, to include ICAO, WFP, ISG UAS coordinating body, and other aviation-specialized groups to keep up to date with the technical, legal, and regulatory matters governing UAS operations.

For further questions or additional information, please contact:

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Other UNICEF information notes are found at [http://www.unicef.org/supply/index_54214.html](http://www.unicef.org/supply/index_54214.html).
Annexe 1: List of Useful Resources

### Tools

A cost simulation tool to assist countries to determine a “Use Case” scenario based on metrics including geographic data, product, transport: [InSupply Use Cases Determination Tool](https://www.icao.int/ioda/UseCases/)

Monitoring and evaluation guidance from the Logistics Cluster: [https://dlc.ilo.org/display/LOG/Monitoring+and+Evaluation](https://dlc.ilo.org/display/LOG/Monitoring+and+Evaluation)

Online narrative by ICAO, presenting UAS best practices, lessons learned and regulations: ICAO UAS Toolkit [https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx](https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx)

The government of Vanuatu’s report detailing its UAS tender process, which offers a very good example of what tender documents and considerations countries should consider when planning to tender for a UAS operation: [https://www.unicef.org/innovation/reports/vanuatu-drone-trial-report](https://www.unicef.org/innovation/reports/vanuatu-drone-trial-report)

UAV delivery readiness / decision making tool (beta version released by FH360, guidance aimed at health staff): [https://fh360.shinyapps.io/UVADeliveryDecisionTool/](https://fh360.shinyapps.io/UVADeliveryDecisionTool/)


### Regulatory documents

A directory of laws and regulations governing UAS use in different countries for humanitarian aid agencies: [www.droneregulations.info](http://www.droneregulations.info)

A manual published by the International Civil Aviation Organization (ICAO) on the use of RPAS: [Manual on Remotely-Piloted Aircraft Systems](https://www.icao.int/publications/Manual-Remotely-Piloted-Aircraft-Systems/Pages/default.aspx)

A publication by the European Aviation Safety Agency (EASA) introducing the regulatory framework UAS operations in open airspace and other specific categories: [New EASA Opinion Clarifies Drone Classifications, UTM Rules Roadmap](https://www.easa.europa.eu/publications/9334)

A study by Single European Sky Air Traffic Management Research (SESAR) on the outlook of UAS use in Europe: [European Drones Outlook Study: Unlocking the Value for Europe](https://www.esa.int/esaSM/SESN0Q1Y0G8YF Index.html)


EUROCONTROL, the European organization for the safety of air navigation: [Eurocontrol](https://www.eurocontrol.int)

Fact sheet by the United States (US) Federal Aviation Administration (FAA) on regulations governing the use of UAS: [Fact Sheet - Small Unmanned Aircraft Regulations (Part 107)](https://www.faa.gov/about/office_of_the_administrator/assetlib/107-08_011516.pdf)

Guidelines and risk assessment methodology by JARUS to confidently establish and conduct a UAS operation: [JARUS Guidelines on Specific Operations Risk Assessment (SORA)](https://www.jarus.org/)

IATA Dangerous Goods Regulations (DGR) manual: [https://www.iata.org/publications/dgr/Pages/index.aspx](https://www.iata.org/publications/dgr/Pages/index.aspx)

Information from ICAO on the broad principles governing the international transport of dangerous goods by air: [Technical Instructions for The Safe Transport of Dangerous Goods by Air (Doc 9484)](https://www.icao.int/publications/Pages/Doc9484.aspx)

JARUS providing information and documents on work to harmonise the rules governing the use of UAS: [The Joint Authorities for Rulemaking on Unmanned Systems](https://www.jarus.org)

### Examples of UAS in Humanitarian Aid and Development


A study of bi-directional drones to strengthen healthcare provision and the experiences and lessons from Madagascar, Malawi, and Senegal: [https://ph.bmj.com/content/4/4/e001541](https://ph.bmj.com/content/4/4/e001541)

ISG UAS coordination group: [Use Case Prioritization assessment](https://www.icao.int/ioda/UseCases/)


Power point presentation at ICAO by Ahmed, Ovais on United Nations use of UAS: [ICAO Second Remotely Piloted Aircraft System (RPAS) Symposium: United Nations RPAS Experience Setting the Stage, UN Aviation Safety Section](https://www.icao.int/ioda/UseCases/)

The Unmanned Payload for Delivery Working Group (UPDWG) online repository: [http://www.villagereach.org/drones-for-health/](http://www.villagereach.org/drones-for-health/)

### Market Research

A drone market report assessing the commercial drone market size and forecast over 2019-2024 by Drone Industry Insights: [https://www.dronenews.com/project/drone-market-report](https://www.dronenews.com/project/drone-market-report)


Market research on the growth trend of small commercial UAV: [Drone Market Shows Positive Outlook with Strong Industry Growth and Trends](https://www.icao.int/ioda/UseCases/)

Market research Single European Sky Air Traffic Management Research (SESAR) on the UAS industry: [European Drones Outlook Study: Unlocking the Value for Europe](https://www.icao.int/ioda/UseCases/)
Annexe 2: Value for Money

Any approach to establish Value for Money needs to undertake an economic evaluation, to measure how much money is spent to ensure access by patients for treatment over a specific period of time. In health, this is expressed “cost per treatment” or “costs per person per year”. For example, the cost of a full regimen (e.g. quality assured antiretroviral medicines), plus cost of delivery for a full treatment course. One also needs to include proper oversight to ensure the adherence to treatment compliance, as there is no point in “expensively” delivering medical services if they are not used properly in accordance with medical advice, as one needs to consider the principles of “doing no harm”. For an operation to be considered economically viable and good value for money, there needs to be a “detailed” economic assessment of the different components of the entire supply chain of operation.

Programme managers need to see how justifiable and financially sustainable an operation through a cost-evaluation analysis, a cost-benefit analysis, and a cost-utility analysis. It is one thing to justify costs in an emergency setting where the imperative to save lives outweighs any public health cost-effectiveness metrics, as there is often a case to justify covering a specific need, for a specific time, for a specific purpose (even though the cost-effectiveness analyses of different public health interventions compare incremental cost-effectiveness ratios (ICERs), meaning the differences in cost divided by the differences in health effects). And there is also often a case to be made to trial a pilot test case to establish a proof of concept or approach. However, it is a different case to justify and embed a new approach into a national public health system, owned by the Ministry of Health, which would ultimately have to self-finance and substitute alternative without looking at opportunity costs and a budget impact analysis.

One needs to look at the cost-efficiency and effectiveness of UAS pilot programmes and assess the conversion of inputs to outputs and at what cost, as well as their effectiveness to deliver outputs that translate into outcomes and establish their impact against measurable indicators, against alternative means of process delivery cost comparators, the initial cost investment, and operational overheads; as well as staff costs, amongst others. Any operation needs to be able to demonstrate that it is not doing the wrong thing very well (efficient but ineffective) nor the right thing but badly (effective but inefficient). For there to be a sustainable solution, there needs to be:

• An assessment of unit cost data per activity, component, programme, and partner in delivering goods, services, and utilities against comparators, so as to assess whether the costs compare favourably and are acceptable to a sustainable source of financing;
• Assess the implementation strategy against progress, targets, baselines, and measurable indicators to assess whether the programme was well implemented;
• Quantify and qualify whether the programme actually made a difference to the lives of beneficiaries and accomplished its intended purpose;
• Does the operation ultimately apply a major step increase to how public health systems achieve a cost-effective and cost-efficient results-based management approach and accountability compared with past efforts.

It needs to take into account the three stages of any programme cycle management:

• Budget analysis could include a triangulation of three different levels:
  ○ Unit Cost of inputs; (looking at budget line item goods, services and utilities).
  ○ Unit Cost of outputs; (costs of delivering completed activities, goods, services or utilities).
  ○ Overhead costs; (the actual costs partners take to manage and run the programme).

• Implementation efficiency: Implementation needs to look at:
  ○ Tracking the progress against targets such as beneficiary coverage and activity implementation rate.
  ○ Timeliness of programme delivery and appropriateness of strategy and design.
  ○ Monitoring framework and management of information ensuring progress and management of resources, ensuring correction, real time feedback and a “heads up” to technical advisors and programme managers about programme performance, partners, sectors and projects.

• Evaluation of impact and effectiveness: The approach goes beyond looking at the delivery of outputs (deliverable materials) and assesses if a result / outcome has had an impact, and whether it was effective. ‘Effectiveness’ (i.e. goods and services to beneficiaries delivered) must have a demonstrable and measurable result in terms of improving a beneficiary community’s level of wellbeing and dignity.

We need to establish first an assessment of the gains made by these actions against a reference baseline, threshold or indicator. The extent of change is then assessed in terms of what it means to a beneficiary’s life or livelihood and its continued need or dependence on outside support. One thing is to establish change, it is another to establish the scale or extent of that change and any improvement.

It can be further qualified in terms of any improvements to a person’s or community’s situation with regards to:

• Availability of care.
• Coverage of care;
• Quality of care;
• Utilization of care (adherence to treatment);
• Access to care;

The standards with regards to each one is set against the standards and references of a programme’s strategy. In absence of any such standards, reference can be made to current prevailing SPHERE guidelines. Basically, all five aspects mentioned above (ACQUA) need to register and either quantify or qualify positive gains for a programme to be considered effective.