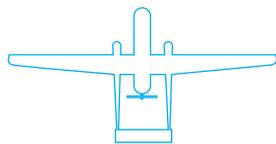
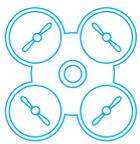


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**UNICEF GUIDANCE ON
THE USE OF DRONES
IN SUPPLY CHAINS**

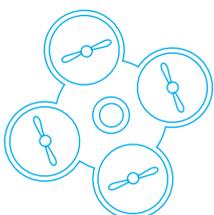
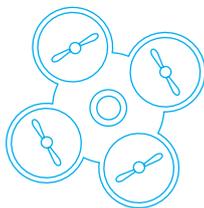
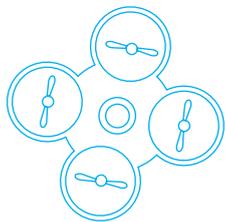


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1. Rationale, applicability and scope

An uncrewed aircraft system (UAS), commonly known as a drone, is a remotely piloted aircraft system without a pilot on board, which can be pre-programmed to perform automated or autonomous flights. This innovative technology provides organizations and governments with a new tool for in-country delivery of health commodities in access-constrained situations. Drones can also help quickly collect aerial data for emergency preparedness and response.

With the growing interest of governments, donors and humanitarian organizations in UAS, there is a need to strengthen the knowledge, operational practices and support mechanisms that enable UNICEF and partners to source and procure appropriate drone logistics services.

The purpose of this guidance document is to provide UNICEF partners with a resource for implementing and procuring drone logistics services for the delivery of health products, emergency supplies and other commodities, either as a part of regular in-country logistics and programme delivery in access-constrained environments or in emergency settings.

The document presents the key use cases and considerations for drones, introduces different service models and transport modalities, and provides guidance and tools for procuring drone delivery services.

Drones can be useful tools that fill existing gaps within the national health and emergency supply chains, especially in serving the most disadvantaged, remote, sparsely populated or otherwise underserved communities, areas and facilities. Drones have been used in geographies and contexts that have limited road and transport infrastructure, and where in-country commuting, delivery and distribution is challenging, taking a disproportionate amount of time and effort. They have been used to deliver medical commodities and diagnostic samples to, and from, islands; hard-to-access (seasonally or year-round) rural health facilities; mountainous regions; and places affected by natural disasters.

UNICEF works and provides technical support to partners and governments in strengthening their capacity to operate efficient supply chains. Drones can play a significant role in complementing the existing transport services by responding to supply-chain bottlenecks, such as access, time and speed. This guidance for drone delivery procurement and implementation can be applicable within the scope of partner-controlled supply chains. The use of drones will be context specific, based on actual needs and demands arising from the in-country supply chain challenges and problems.

Partners are advised to consult and actively work with ministries of health, central/regional medical stores, regional/local health authorities, aviation regulatory authorities and other stakeholders to discuss feasibility, preferences and use cases of a drone delivery service, and ensure that the integration of this new transport modality improves the overall system outcomes and is driven by national strategies.

2. Use cases and prerequisites

This transformative technology has the potential to improve the way UNICEF and partners operate and support governments for in-country logistics and delivery of humanitarian aid, as summarized below:

- » Delivery of small cargo for health and emergency programmes. Drones can carry various health commodities (vaccines, medicines, diagnostic samples, blood products, medical products) and help extend the reach of the supply chain to communities and health centres that are in access-constrained areas, as part of either regular programming or emergency response.
- » Delivery of large cargo for emergency programmes. In emergency settings, drone platforms can be used to deliver critical humanitarian aid to places that are inaccessible owing to natural disasters or other emergencies where road infrastructure is significantly affected. The category of large payload drones is rapidly evolving and might be used for large air-drops of humanitarian aid.

For drones to become a cost-effective and impactful addition to the supply chain system, several aspects must be considered before implementation:

- » A thorough understanding of the local supply chain system and its bottlenecks is essential for integrating drones into a context where their use contributes to supply chain performance, health outcomes, and cost-effectiveness or other improvements of local transportation and distribution networks. To do so, partners are encouraged to conduct a demand and needs assessment. This serves to determine the specific bottlenecks and helps to analyse in which scenarios drones could be used to address them. Such an assessment has to consider four different elements:
 - Geography and transport networks (such as climate, topography, seasonality, existing transport modalities, quality of the network, accessibility to health facilities, density of health facilities)
 - Product demand and health indicators (such as baseline data, including facility-level health and supply chain data)
 - Drone characteristics (such as range, payload, cost)
 - Economic feasibility (such as cost-benefit and cost-effectiveness analysis of introduction of drone delivery, cost comparison between drone delivery and existing transport solutions)
- » The use of drone technology in any country is dependent on an enabling environment, such as the regulatory regime, the local skills, project management capacities, financial and human resources, and the social and political acceptance of the technology.
- » Selection and procurement of the solution is an important step during the implementation of the drone logistics programme, and the subsequent guidance in this document provides insights into the service models and transport modalities that currently exist, the procurement procedures that are advised to be followed, and the difference

between outsourcing and insourcing of drone services. The guidance also provides sample Terms of Reference (see paragraph 28.2) for drone logistics services for the use of Country Offices.

Some factors help to improve the cost-effectiveness of drone delivery, such as:

- » High number of flights per day
- » High density of facilities within the drone's range
- » Increased value (health impact) of the commodities
- » Increased range and automation of drones
- » Combining different health commodities for drone delivery (therapeutic, immunization, diagnostics, emergency, and other health and nutritional commodities)
- » Expanding the list of use cases beyond the health supply chain, such as potential cross-subsidization of drone delivery by other services, including mapping, emergency response, postal service, or similar

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3. Drone technology considerations

The selection of drones depends on a use case, intended weight and volume of a payload, distance, connectivity, weather, and other operational factors. Drones come in varied sizes and configurations. There are primarily three types of drones used in supply chain delivery.

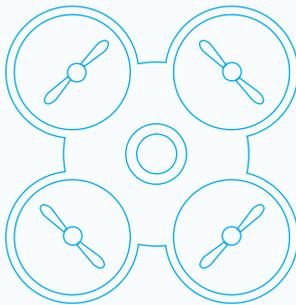
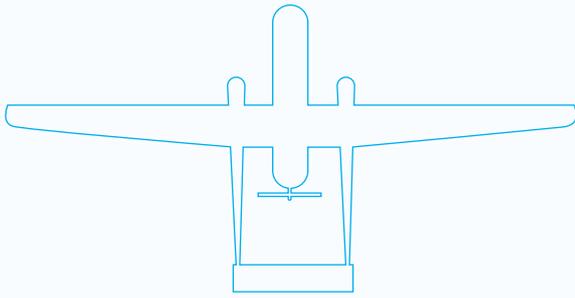
- » Fixed-wing drones use a wing, like a normal aeroplane, to provide the lift, and are therefore more efficient than other types of drones. They can cover longer distances, but the main downside of fixed-wing drones is their inability to hover in one spot, which makes launching and landing them more complicated, as they might need a runway, catapult launcher or a special net to launch and recover them safely. In addition, they might require more operational infrastructure.
- » Vertical take-off and landing (VTOL) fixed-wing drones merge the benefits of fixed-wing drones with the ability to take off and land vertically, and hover in one spot. This category of drones can take off and land vertically, which gives them an important advantage in serving remote communities where landing a drone might be required.
- » VTOL rotorcraft drones have more than two rotors; the advantage with this type of drone is the simpler rotor mechanics required for flight control. However, their limited endurance and speed make them less suitable for large-payload, long-distance delivery flights, and they are therefore used mainly for short-trip, local supply chain delivery.

Drones that are capable of VTOL are most often used for reverse logistics of commodities; i.e., delivering commodities by landing on the grounds of a destination facility, where it then picks up a package, which it returns to a main base. This design enables the drone to pick up, for instance, diagnostic samples from remote health clinics and deliver them to a diagnostics lab. Another advantage of VTOL drones is that they provide agility and flexibility, meaning that a distribution facility does not need a specific launch and retrieval mechanism or runway, which might require higher set-up costs and might not be able to serve some areas. VTOL drones, nevertheless, can also deliver without landing – in such cases, a drone uses a cable to lower a payload, and after it reaches the ground, the cable retracts, and the drone returns to a home base. Some VTOL drones have multiple-drop functionality, delivering several packages to different locations in a single trip.

The fixed-wing drones mostly use parachute airdrop mechanisms to deliver commodities and goods without landing at a delivery site, as this would require special infrastructure at each destination (runway or a catapult/retrieve system). Fixed-wing drones that are capable of delivering commodities only one way can fly longer distances and can thus serve larger geographical areas. However, they have the limitation of not being able to pick up packages from a destination (e.g., diagnostic samples).

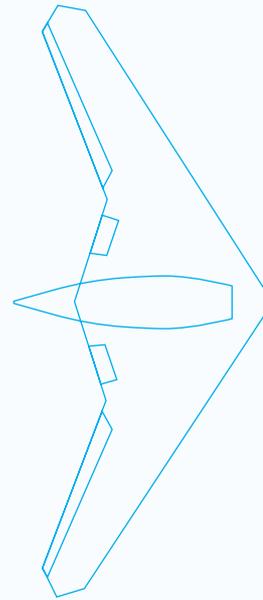
All types of drone (VTOL fixed-wing, VTOL rotorcraft, or fixed-wing) differ in range (distance, flight time) and payload capacity (volume and weight). They might also have different communication technologies and different tolerances to adverse weather.

Delivery and Pick-up



VTOL fixed-wing (up) and VTOL rotorcraft (down) drones that are capable of reverse logistics (delivery and pick-up)

Delivery only



Fixed-wing drone capable of one-way logistics (delivery only)

The range and payload capabilities of drones are predetermined by their size and the power source they use. Most drones rely on electric engines that use lithium polymer (LiPo) batteries. Some drones have combustion engines that use regular fuel. There is an increasing trend toward using hydrogen fuel or other alternative sources of power that can extend the flight time and operational range of drones. Gasoline-powered drones provide greater range, which can lead to better cost-effectiveness; however, noise, pollution, and consistent supply and quality of fuel have to be considered when choosing such a platform. Battery-powered drones are more environmentally friendly; however, they have limitations in terms of range. Additionally, stable electricity supply, battery-charging capabilities and battery swapping at different destinations (e.g., health facility, outreach post) are important considerations to ensure that drones can operate without interruption. As battery technology is improving, it is expected that in the future, the range gap will be closed between battery-powered and gasoline-powered drones.

An important consideration when choosing a drone platform is cold-chain capacity. Most to-date drone projects use passive cooling (insulated cargo boxes that use icepacks or cool water packs) to maintain vaccine temperatures (2-8 degrees Celsius) during flights. Evidence shows that passive cooling has been sufficient to maintain cold chains within acceptable limits. Temperature loggers are often used to monitor the temperature inside the box. Active cooling systems could also be used as a cold-chain solution and could be particularly important in ultra-cold-chain scenarios.

- » **Maintenance and repairs:** Given that the overall supply chain in resource-constrained environments is challenging, it often takes an exceptionally long time to get spare parts for drones from outside a country. Therefore, systems that have low-maintenance requirements, a low operational footprint, and spare parts that are easily available (or

can even be sourced or produced locally) have huge advantages. Also, it is especially important to ensure that there is a robust training programme for repairs and maintenance of a drone to ensure that local staff can efficiently maintain it.

- » **User interface:** Drones vary in how difficult they are to operate, but those that have built-in fail-safe features and user-friendly interfaces have advantages in ensuring that local staff can quickly learn how to operate them safely and efficiently.

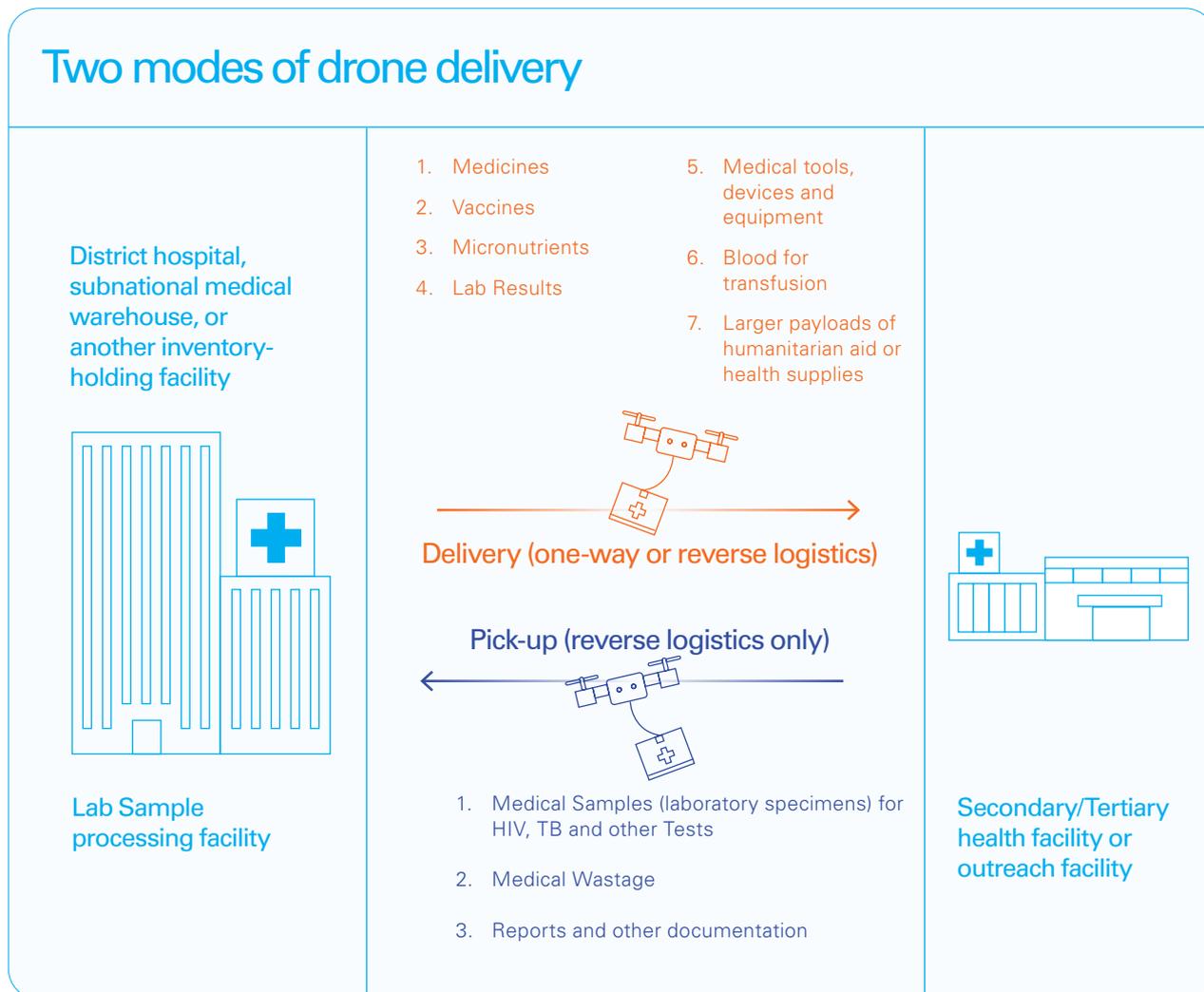
- » **Flight control and navigation:** It is important that a drone has robust and redundant navigation and other flight control systems (GPS, inertia measurement unit [IMU], and other) to ensure that it can maintain its orientation even under frequency jamming or other technical anomalies.

- » **Control and Command (C2) link:** This is the data link between a drone and a remote pilot station for the purpose of managing flight. The design, security and management of the C2 link have a variety of architectures and considerations, and given limitations of regular (or extended range) radio links, more platforms use cellular and satellite links. The quality of the link in such situations depends heavily on cellular network coverage, while satellite connections are still more expensive and usually employed as a stable backup. Drones that can operate in low-connectivity environments and provide redundant C2 link solutions have an advantage.

- » **Durability:** A drone's ability to withstand harsh weather conditions (capable of flight in rain or high wind, at high altitudes and in sub-zero temperatures, and are not susceptible to dust) is an important aspect when evaluating a platform. The best practice is to look at the platform's Ingress Protection (IP) rating, as well as a provider's flight safety record, to determine the level of a drone's durability.

4. Drone delivery as a service

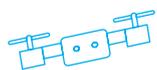
There are two main drone delivery modalities: forward logistics and reverse logistics.



One-way delivery (forward logistics) is often implemented by fixed-wing drones that do not land at the delivery site, but instead drop a payload to a recipient (e.g., health facility staff). This modality is most effective in a hub-and-spoke transport network, where several different beneficiaries (health facilities, households) are served from one central fulfilment centre. In such cases, the required infrastructure (a warehouse, a fulfilment centre, a launch/retrieval system, etc.) can either be attached to the existing hub (district hospital, subnational-level medical store or similar facility) or be a separate fulfilment and distribution centre.

Reverse logistics utilize VTOL fixed-wing or VTOL rotorcraft drones. This modality can function in both hub-and-spoke and point-to-point transport network models. Variations and extensions of those are possible because of the drones' capacity to land and take off at each destination, and the ability to use multiple-drop or winch mechanisms. For fixed-wing drones to be used for reverse logistics, infrastructure must be built at each delivery point, which requires substantial investment. Given that it requires less set-up infrastructure, drone delivery with reverse logistics capabilities can be more easily added to an existing supply chain, as just another transport modality.

There are two predominant Drone-Delivery-as-a-Service (DDaaS) models that are offered by private companies and service providers – the third party logistics (3PL) model and the carrier model. The major difference between the two is that in the 3PL model, a service provider manages multiple functions, such as procurement, warehousing, order management and transportation, and uses drones as a means of transport to complement the transport fleet. In the carrier model, a service provider is responsible for only one function: transportation. This model offers drone delivery between a hub and an end destination. The two models are presented in detail in the table below.



3PL drone delivery model

Carrier drone delivery model

How does it work?	3PL service providers offer integrated supply-chain services that include order management, inventory storage and management, picking and packing, contract management, IT solutions, human resources, and shipping and distribution, which are implemented by a drone fleet. The entire logistics function can be outsourced to a 3PL provider.	In the carrier model, only the transportation component of the supply chain is handled, dealing with the point-to-point delivery of commodities. Companies that provide such services often lease or charter their own transportation fleet – in this case, drones – as well as provide all related operational components, such as human resources, repairs, maintenance, liability coverage, or regulatory certifications.
Where it is currently in use?	Ghana, Rwanda	Malawi, Democratic Republic of Congo
Advantages	<ul style="list-style-type: none"> » Not limited to a transportation function, it can increase efficiency across multiple different supply-chain elements. » More centralized approach, enabling private sector outsourcing, increasing efficiency and professionalization 	<ul style="list-style-type: none"> » Flexible and adaptive integration into the existing supply chain, without a demand for extensive infrastructure » Less capital intensive and does not require high set-up costs
Disadvantages	<ul style="list-style-type: none"> » Establishment of a parallel distribution function might add additional complexities to already challenged supply chains » The majority of 3PL providers that offer drone delivery use only a single mode of transport within their service package and there is a lack of integration with other transport modalities 	<ul style="list-style-type: none"> » Focused only on transportation » Relies on the existing system and infrastructure, which might be poor and insufficient

Some logistics companies have begun offering a hybrid model that combines 3PL and carrier, in which some commodities are delivered from a company-managed warehouse, while others are picked up from vendors (medical store, lab, hospital) and delivered straight to an end recipient.

The selection of a drone delivery modality (forward versus reverse logistics) and drone delivery business model (3PL or carrier) will depend on actual demands and needs of the health supply chain in country. Therefore, it is essential to do a thorough assessment and needs analysis and collect baseline data that enable the choice of the most cost-effective and impactful approach.

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5. Procurement of drone delivery and logistics services

The below table outlines the key considerations, advantages and disadvantages of procuring drones as an asset (fleet), versus outsourcing the drone delivery service to a logistics partner. The below considerations are applicable for both 3PL and carrier service models, while 3PL may incur higher set-up costs.

Resource elements	Insourcing	Outsourcing
Upfront investment	Medium to high	Low to medium*
Procurement of equipment	Needed	Not needed
Internal capacity for drone piloting and operations	Needed	Not needed
Internal capacity to manage regulatory compliance	Needed	Not needed
Internal capacity to maintain and repair drones	Needed	Not needed
Internal capacity to manage liability and insurance aspects	Needed	Not needed
Dedicated personnel to run the operations	Needed	Not needed
Dedicated project management staff	Needed	Needed
Individual insurance	Needed	Not needed
Risk of loss or appropriation of equipment	Likely	Unlikely
Savings/cost-efficiency	Long-term	Short/medium-term

UNICEF uses a few different transport management and contracting approaches, which are also applicable for drone delivery services:

- » 3PL service providers (in the case of drones: 3PL or carriers) can be contracted by a Country Office to provide logistics and transportation services.
- » A host government's transport assets can be used by a Country Office, where available and feasible.

- » A Country Office may arrange in-country transport through another UN organization or non-governmental organization (NGO) where this is cost-effective and includes all required security measures.

Procuring and operating organization's own transport assets (e.g., a fleet of delivery drones) will result in asset depreciation, infrastructure investments, maintenance and repairs, local capacity, liability and insurance costs. Outsourcing drone delivery is the most viable way of integrating drones into health supply chains.

It is advisable to make the use of a Request for Proposal of Services (RFPS) rather than an Invitation to Bid for Services (ITBS) procurement modality, to capture the complexity of drone delivery services.

When sourcing and contracting drone logistics service providers, partners can use the following tools and resources:

- [Drone delivery decision and solution tree, and implementation and planning checklist](#) (Annex 1)
- [Sample Terms of Reference for the Request for Proposals for in-country drone delivery service](#) (Annex 2)

There are several international drone service providers that offer 3PL, carrier and hybrid drone delivery services. The majority of these companies are originally drone manufacturers and only a limited number of them have actual 3PL and in-country logistics experience.

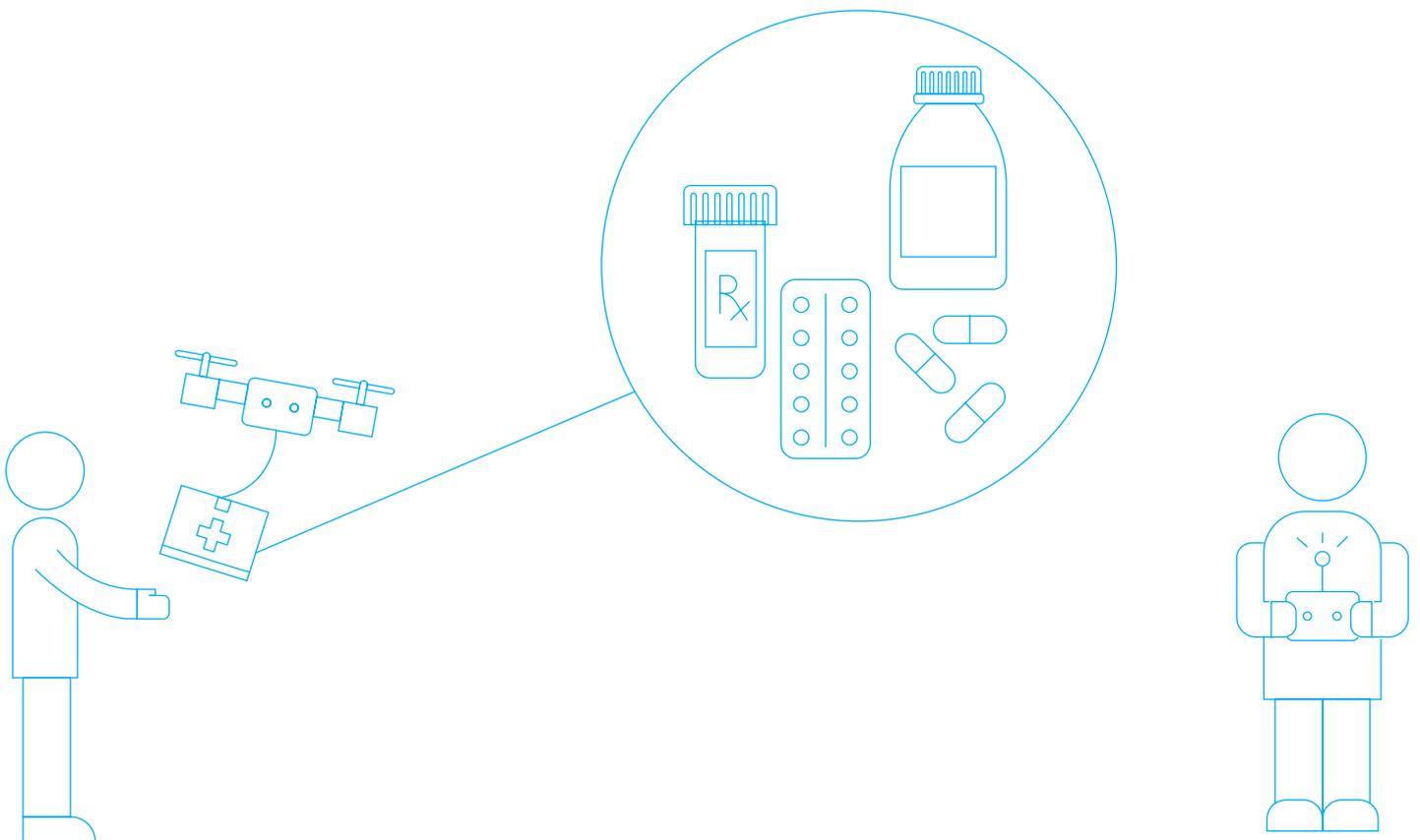
A market assessment, a survey of existing in-country logistics service providers, an industry consultation, a Request for Expressions of Interest, or a Request for Information can be considered as methods to identify whether drone delivery is a part of the existing service offerings directly or possible via subcontractual service offerings. This can help identify available or potential local solutions for fulfilling identified needs in drone delivery and can help inform the needs of market shaping and private sector engagement

6. Additional resources

For more information, please reach out to the Supply Division’s Supply Chain Strengthening Centre, at sc.strengthening@unicef.org and please visit <https://www.unicef.org/supply/leveraging-power-drones-reach-last-mile>

ANNEX 1: [Drone delivery decision and solution tree, and implementation and planning checklist](#)

ANNEX 2: [Sample Terms of Reference for the Request for Proposals for in-country drone delivery services](#)





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