



WHITE PAPER  
**USING UAVS (UNMANNED  
AERIAL VEHICLES) IN THE  
PHARMA & HUMANITARIAN  
AIR CARGO SECTORS**

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## Introduction: Cargo Drones for Medical Transport

Cargo Drones have demonstrated an ability to provide low-cost, reliable and just-in-time delivery in hard-to-reach areas. These aspects are ideally suited to deliver medical goods for both routine public health needs, as well as for humanitarian emergency preparedness and response.

Considering that 3.4 billion people currently reside in remote areas<sup>1</sup>, the need for rural access to reliable healthcare services is increasing. The project conducted by Pharma.Aero and Humanitarian Logistics Association (HLA) introduces the potential use of UAVs (Unmanned Aerial Vehicles) in the Life Science and Medtech Airfreight industry. The main objective is to collaborate with all members of the supply-chain to reduce delivery times and to increase package security and the overall efficiency of pharma products using innovative solutions such as drones. Considering this new project, Pharma.Aero and HLA would like to link experiences from both worlds – pharma/humanitarian air cargo and UAVs – to evaluate the drone transport mode as a future solution for last mile delivery (pharma certified corridor for UAVs).

According to Levitate Capital<sup>2</sup>, from an estimated global drone economy of \$90 billion by 2030, \$33 billion is expected to be allocated to logistics applications. This scenario corroborates the need for further analysis and investments to adapt the current infrastructure and operation procedures to meet demands from UAVs. Thus, the present white paper aims to summarize and provide the main aspects associated with the deployment of UAVs in the Pharma and Humanitarian sectors.

This technical paper is subdivided into five sections, besides this introduction, which describe a competitor analysis with other modes of freight transportation and a cost-benefit analysis; providing the regulatory framework for drone operations; introducing use cases and presenting the expected characteristics from cargo drones to address the needs of both sectors. The conclusion is drawn from two online surveys conducted with members from Pharma.Aero and HLA, which shared their (and their organization's) expectations on the usage of drones to improve the medical, pharma and emergency supply chains.

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1 World Bank, World Development Indicators (2018).  
2 Levitate Capital (2020) The future of the Drone Economy.

## 1. Competitor and Cost-Benefit Analysis

In view of the existing different freight transport modes (maritime, river, air, railway, road, pipeline), the focus of the present white paper is to explore the last-mile delivery for pharma cargo. UAVs are seen as unique solutions as they enable responsive logistics operations, rather than using exclusively predictive models<sup>3</sup>. On one hand, predictive models are desired to foresee and plan constant smooth supply chain operations. On the other hand, considering responsive transportation logistics enables the supply chain to react with greater flexibility and readiness to unexpected changes and dynamic situations. This characteristic is in line with medical and humanitarian needs, which commonly value readiness and promptness in transportation means.

However, understanding the circumstances in which drones are cost-effective can be tricky, especially when compared to other modes. Traditional logistics models usually take into account the acquisition costs, operation and maintenance, transit time, transportation infrastructure conditions, warehousing and staff. Most of these parameters are different between drones and traditional ground transportation and there is little to no historical data due to the novelty of drones. Besides, rather than considering transportation infrastructure conditions, cost-effective drone models should nevertheless take into account meteorological conditions. Lastly, given that UAVs can considerably speed up deliveries, medical and humanitarian transportation purposes may not necessarily be financially measured as life-saving medical supplies can be quickly and safely delivered<sup>3</sup>.

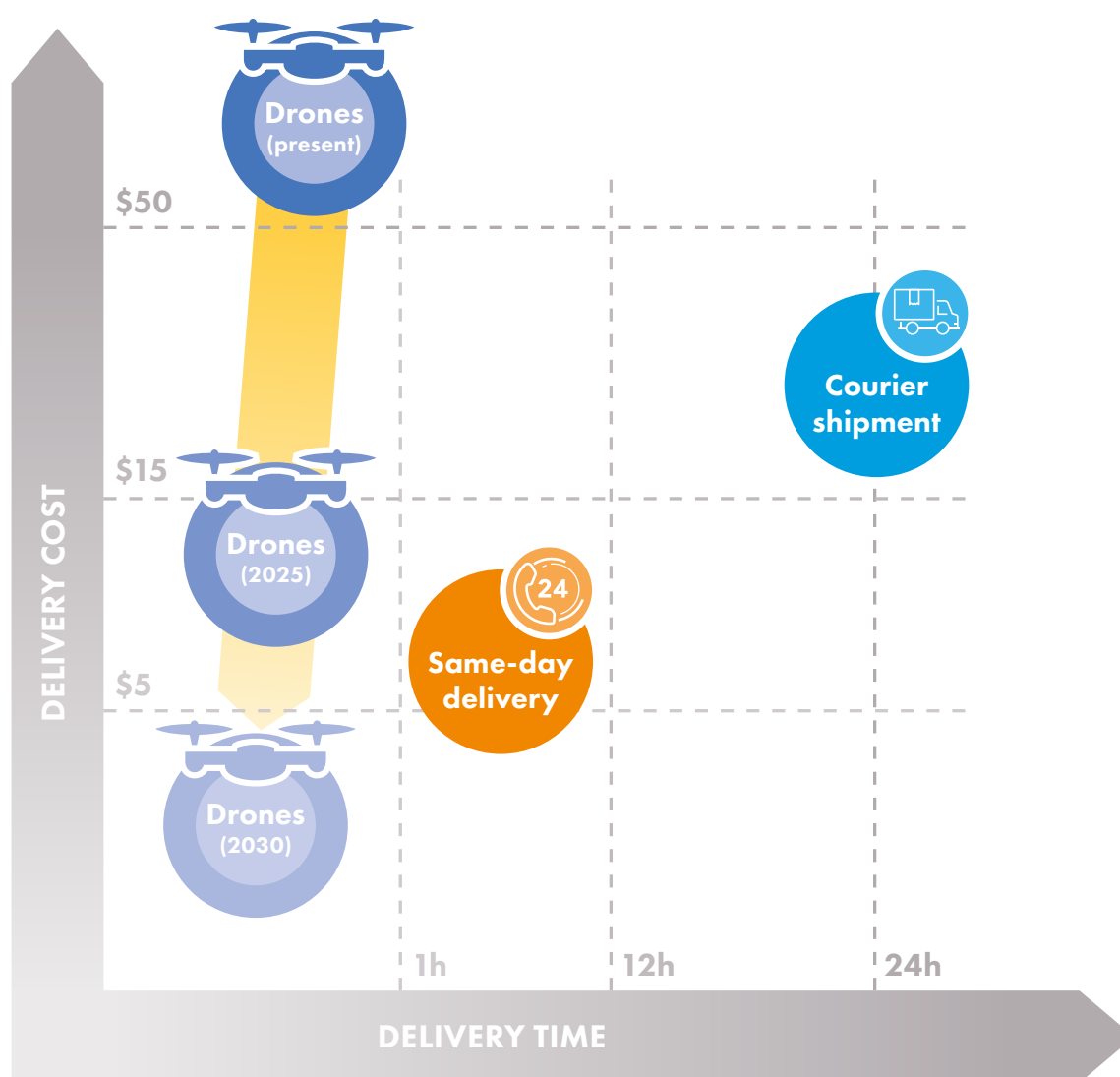


Figure 1 – Existing competitors vs drone as freight transportation



Shipping companies are constantly seeking speedy and efficient operations. Levitate Capital discusses that seven-day deliveries, common in the past decade, have been replaced by a two-day delivery standard. Hence, it is no surprise that consumers now expect next-day or same-day delivery of essential items. This scenario makes room for autonomous drones, which are able to deliver packages faster than conventional ground shipping at lower costs per mile. In addition, Levitate Capital estimates that the future cost of drone delivery will be up to 80% lower than current charges for next-day delivery<sup>4</sup>.

In addition, according to Levitate Capital, drones are the most favorable transportation mode for reaching remote areas, especially when considering X2C (Customer to Business) interaction for deliveries on the same day and with high reliability. Despite this, considering the constraints of using a fleet composed exclusively of UAVs, especially due to the trade-offs between weight, distance, and costs, drones can complement traditional supply chains<sup>5</sup>.

In financial terms, according to Wright et al.<sup>6</sup>, the costs associated with different platforms and dimensions of UAVs are mostly with an order of magnitude of 100 USD\*ton/km.

A general picture of the total cost composition, subdivided into five categories is presented in Figure 2.

The most significant costs are observed from personnel, from both piloting and ground operations. The following major costs are due to the infrastructure necessary for the operation. The latter costs are from equipment (aircraft and accessories), financing, maintenance, and energy costs. Hence, the total cost estimated for different drone platforms would not significantly vary in comparison to this general representation, given that the cost driver relies mostly on personnel rather than on the maintenance, energy costs, equipment and financing and infrastructure.

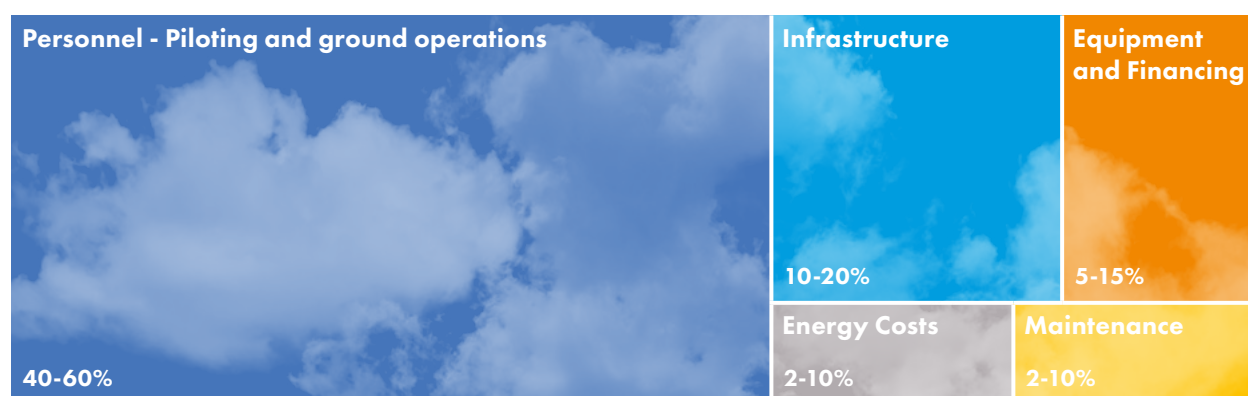


Figure 2 – UAV Cost Composition

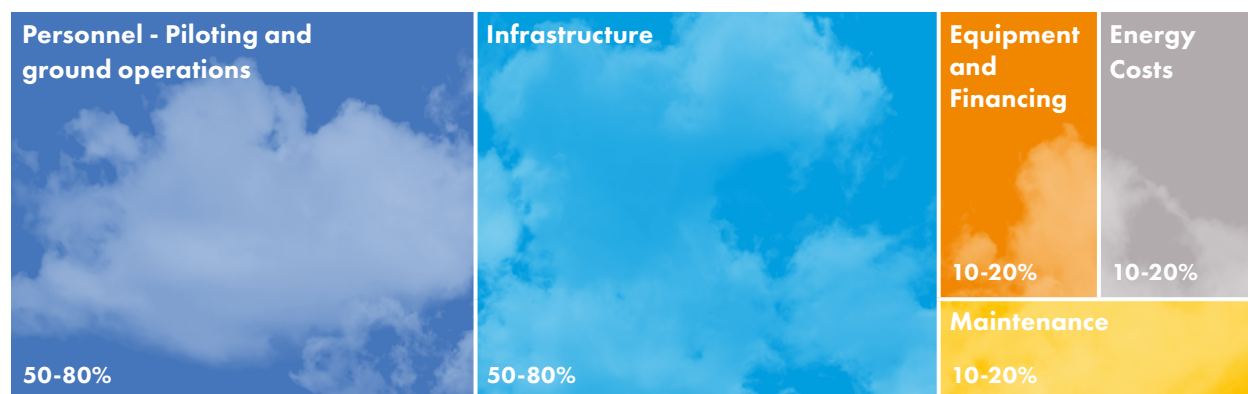


Figure 3 – Potential cost decrease over the next 10 years

<sup>4</sup> Levitate Capital (2020) The future of the Drone Economy.

<sup>5</sup> Hutchinson G. (2019) Drones in your biopharmaceutical supply chain—are you ready?

<sup>6</sup> Wright C., Rupani S., Nichols K., Chandani Y., Machagge M. (2018) What should you deliver by unmanned aerial systems?

Reductions in personnel and infrastructure costs may come from optimized operations, both in aircraft control and ground operations. Aircraft control is expected to be developed in ways that a command center will be responsible to manage multiple aircrafts simultaneously. Whereas for ground operations, scheduled operations will increase the utilization of ground crew.

Equipment and maintenance costs are expected to be reduced, according to production scalability and

improved airframe designs, respectively. Finally, energy costs can be reduced given the development of more efficient energy-power systems and the concomitant development of new solutions (e.g., fuel cells).

Considering that the most significant values associated with the cost of labor and infrastructure, are the costs that have the greatest potential for reduction, the mentioned advancements for general drone technology can bring costs down to 10 USD\*ton /km over a 10-year horizon.

## 2. Regulatory Framework for the Operation of UAVs

The increasing trend for drone cargo transportation, especially for commercial purposes, demonstrates the need for integrated air traffic management systems, universal safety regulation, and global drone communication standards<sup>7</sup>. Presently, the Civil Aviation Authority of each country is responsible for regulating and inspecting every flight within its jurisdiction. Besides, countries worldwide have been constantly evolving and updating their regulation for drone operations. This context has been leading to non-standardized cross-country operation rules.

Thus far, the European Union Aviation Safety Agency (EASA) has made an effort to set a framework for the safe operations of drones in European skies. EASA has been setting guidelines using a risk-based approach that characterizes drones in three categories: open; specific; and certified. Despite such efforts, standardizing worldwide regulations for drone operations has been seen as a major challenge. This situation occurs especially due to the differences between ethical criteria and safety parameters that each piece of legislation has. Tsiamis et al. compared the differences and similarities between 35 countries belonging to the Organization for Economic Co-operation and Development (OECD). Although most of the member countries are European, wide regulation diversity has been observed concerning the following parameters:



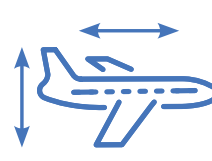
**pilot's license requirements**



**aircraft/flight registration requirements**



**liability insurance**



**vertical and horizontal constraints**



**restricted zones**





Regarding vertical and horizontal distances, regulations specify maximum distances between the operator and the drone varying from 30 to 500 meters. Existing regulations for maximum heights above ground level (AGL) have also been observed, which vary from 45 to 150 meters (as an observation, some countries do not specify regulations for maximum distances between the operator and the drone and for AGL height).

Concerning the restricted zones, safety distances from airports are mentioned for all policies and range from 1.5 to 15 kilometers. The countries that do not specify such distances refer to “keep a safety distance from airports”. Other mentioned safety distances consider populated areas, buildings and authority areas<sup>8</sup>.

In the European context, on 22nd April 2021, the European Commission reached a milestone by adopting the U-Space package. This regulatory package, which will become law in 2023 and will create the conditions necessary for both drones and manned aircraft to operate safely and efficiently. The definitive implementation of the U-Space package is expected to leverage worldwide harmonization of drone operations, considering the potential experiences and foreseen needs to connect with non-European countries.

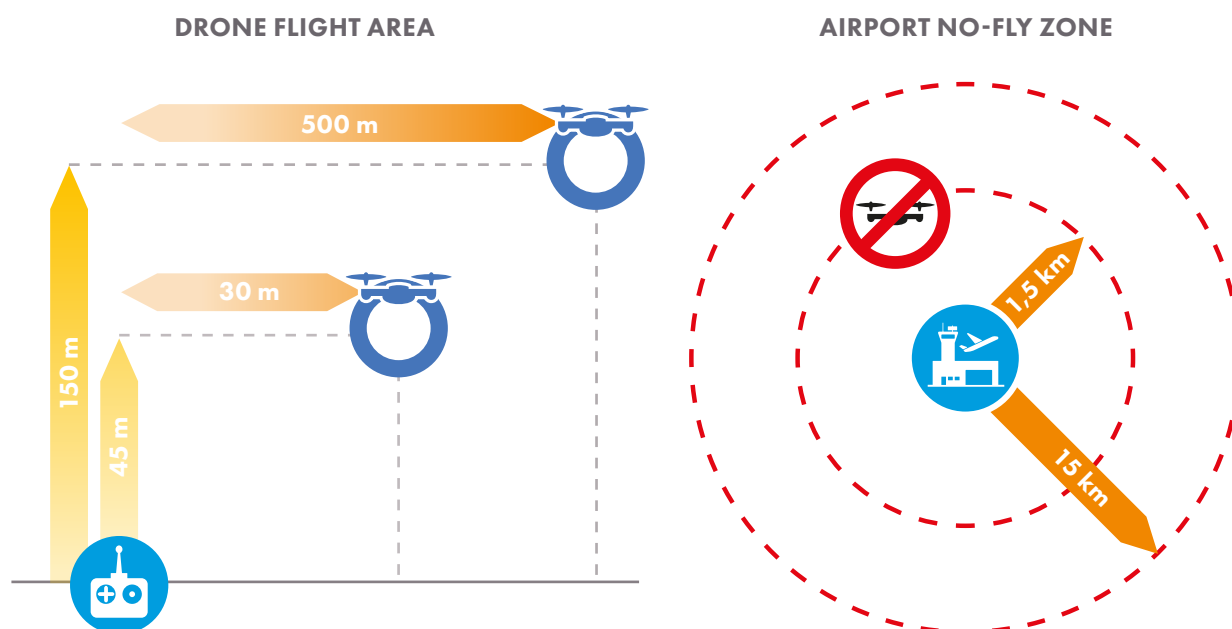


Figure 4 – Visual representation of regulated range of distances for drone operations (OECD countries)

Figure 4 represents the range of vertical and horizontal distances of the regulating agencies of OECD’s member countries, according to the research conducted by Tsiamis et al.

The American government entity FAA (Federal Aviation Administration), which is commonly seen to inspire worldwide regulations, took a first step to promote safety operations by launching the B4UFLY app. This application holds a database for the American airspace and includes interactive maps that provide information about controlled airspace, special use airspace, critical infrastructure, airports, national parks, military training routes and temporary flight restrictions<sup>9</sup>.

Both the B4UFLY app and the U-Space package are crucial for delineating further steps towards standardized worldwide drone operations. Meanwhile (and considering that there is still a need for such developments), current regulations can be found at the African Drone website ([www.africandrone.org](http://www.africandrone.org)), which shows updates, news on legal drone operations and the sources of information for different countries on a regular basis.

8 Tsiamis N., Efthymiou L., Tsagarakis K. P. (2019) A comparative analysis of the legislation evolution for drone use in OECD countries.

9 FAA, Federal Aviation Administration (2021) B4UFLY Mobile App



### 3. Use cases

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Given the current worldwide regulation and operation framework for drone deployment, some applications have been seen in the routine and experimental basis. Merkert and Bushell conducted an extensive literature review in which they classified four primary categories of use cases for drones: monitoring/inspection and data acquisition, photography, logistics (including passengers), and recreation. The authors also noticed that different pieces of research on 'drone delivery' have been recently increasing and gaining traction<sup>10 11</sup>.

In the Pharma and Humanitarian contexts, drone delivery is relatively new and has been analyzed and suggested for transporting medical supplies<sup>12</sup> and for organ deliveries<sup>13</sup>. Considering recent successful drone

applications, companies such as Zipline, Matternet, DHL Parcel and Alphabet's Wing have been leading BVLOS (Beyond Visual Line of Sight) operations to transport blood, laboratory specimens, over-the-counter medication, vaccines, Covid-test samples, defibrillators (for heart attacks), inhalers (for asthma attacks), general medical payload and supplies. The mentioned applications vary from remote to highly populated areas, thus validating the potential for further investment and research, especially considering the need for convergent worldwide aviation regulations that enable safe and optimized operations.

Nevertheless, according to Wright et al.<sup>14</sup>, the following scenarios can be advantageous when considering acquiring drones to assist logistics operations:



**High density of health facilities within the range of the UAV**



**Hard-to-access areas (for long periods)**



**Scarce, high-financial or high-health value products**



**Unpredictable demand products**



**Expensive, short-shelf-life, or difficult-to-store at last-mile products**

<sup>10</sup> Merkert R., Bushell J. (2020a) Revolution or epidemic? A systematic literature review on the effective control of airborne drones.

<sup>11</sup> Merkert R., Bushell, J. (2020b) Managing the drone revolution: A systematic literature review into the current use of airborne drones and future strategic directions for their effective control.

<sup>12</sup> Prasad G., Abishek P., Karthick R. (2019) Influence of unmanned aerial vehicle in medical product transport.

<sup>13</sup> Balakrishnan N., Devaraj K., Rajan S., Seshadri G. (2016) Transportation of organs using UAV.

<sup>14</sup> Wright C., Rupani S., Nichols K., Chandani Y., Machagge M. (2018) What should you deliver by unmanned aerial systems?



## 4. Understanding the needs in Pharma and Humanitarian Air Cargo

Despite the mentioned use cases, there is still much room for improving and increasing the application of drones as freight transportation in the medical supply chain. In view of increasing the visibility of UAVs in the Pharma and Humanitarian sectors, one of the steps followed during the project set up by the partnership between Pharma. Aero and HLA (Humanitarian Logistics Association) consisted of collecting their members' opinions on key points for improving last mile delivery using drones within their organization. The information was collected using two approaches. The first approach consisted of asking interactive questions to participants during a webinar that took place on 15th June 2021. The second approach for collecting information used an online platform to conduct the survey. Both approaches aimed at understanding the characteristics of the participants' organizations – especially regarding last mile deliveries; and the opportunities for using drones as cargo transport. The questions from the second approach also focused on providing measurable logistics characteristics. The respondents were members of Pharma.Aero and HLA. The webinar results also included the participation of experts in Drone Technologies and Humanitarian sectors.

The webinar questionnaire involved the participation of 30 respondents and included 10 questions. In this approach, the most represented continent was Europe (56.5%), followed by North America (21.7%), Asia (13.1%) and Africa (8.7%). Regarding the participants' field of expertise, half of them were logisticians.

The participants were also involved in the Pharma, Humanitarian, Medical, Transportation and Drone sectors. The respondents affirmed that their organization handles an average 41% of refrigerated cargo and an average 44% of emergency cargo. For the members whose organizations were not related to drone businesses, their knowledge in drone technology was self-rated with an average of five, on a scale of one to ten, thus demonstrating that the drone knowledge and technology can potentially be well-disseminated within the pharma and humanitarian sectors.

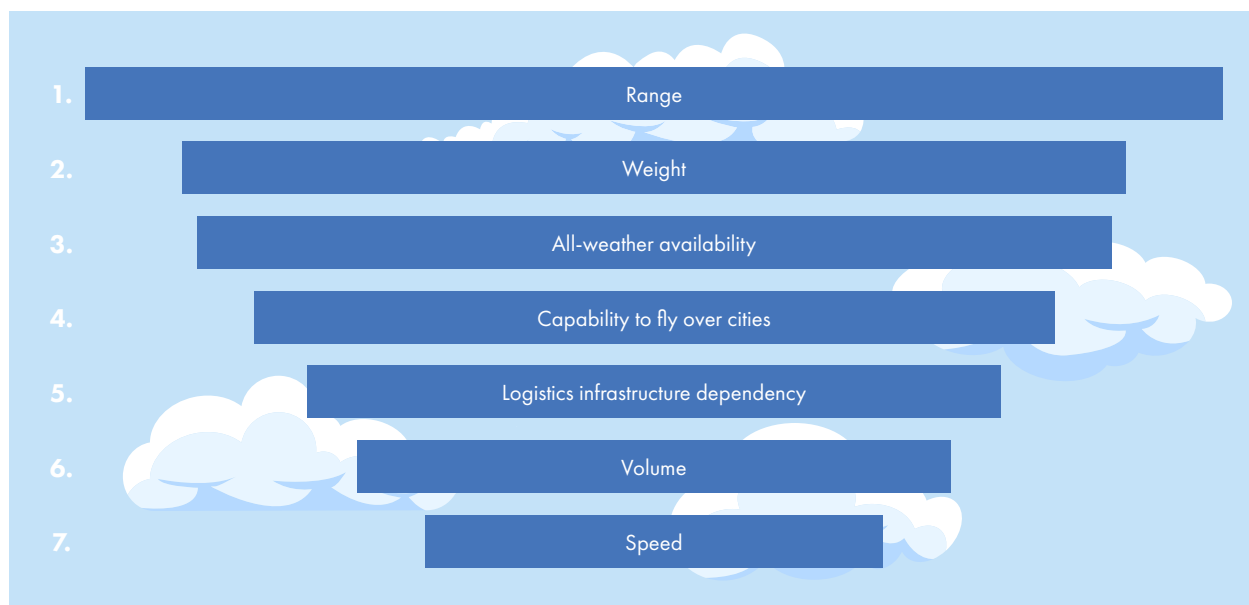
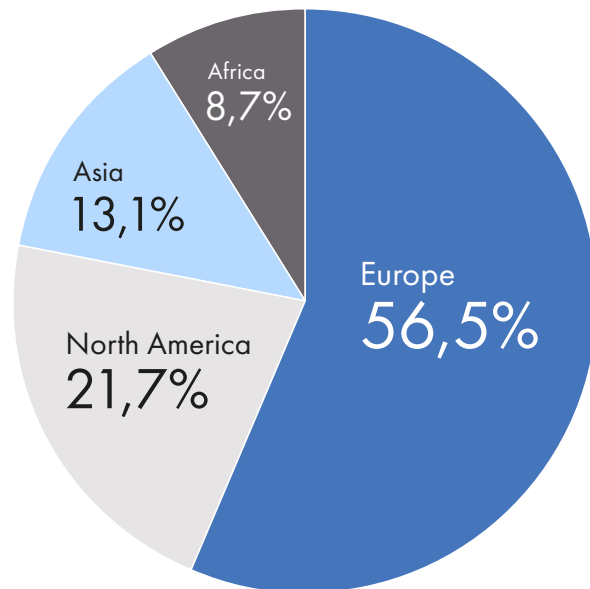


Figure 5 - Rank and graphical representation of the scores for the aspects with most room for improvement in drone technologies

The audience's opinion on where there is more room for development to use drones as freight transportation converged to developing their range. Wright et al. mentions that large fixed wing UAVs, which require runways for takeoff and landing, can reach up to 500 kilometers<sup>15</sup>. Meanwhile, multicopters can fly a range of 20 kilometers. Although the participants understand that UAVs have unique characteristics so that they cannot always directly compete with other modes, they are well accepted to become a complementary mode in the supply chain. The rank was followed by five other features, according to the representation of the rank and the respective scores in Figure 5. Despite the fact that speed was set as an option, none of the participants considered it for ranking the characteristics with most room for improvement.

In addition, the interactive questions conducted during the webinar demonstrated a bottleneck pointed out by 64% of the respondents, who claimed that the lack of infrastructure is a scenario in which organizations most struggle with.

**“64% claimed that their organization struggle with the lack of infrastructure.”**

On the other hand, the online platform reached 12 Pharma. Aero's and HLA members. This approach focused on complementing the former survey by quantifying significant attributes to understand how drones can be developed and integrated into solutions for pharma logistics. Among the participants, 58.3% responded that they see a medium-term horizon (1 to 5 years) for drone deployment within their organization. They also believe that drone missions are feasible for average distances of 122 kilometers.

Unlike the previous survey, the responses from the online platform showed an average of 18.2% of emergency cargo and an average of 39.2% for refrigerated cargo handled by the member's organizations. This observation is consistent with the fact that none of the participants represented any humanitarian sector, thus reducing the average proportion in emergency cargo of the results.

**“58,3% see a medium-term horizon (1-5 years) for drone deployment in their organization.”**

With regard to quantifying the participants' organization logistics aspects, the responses varied widely when questioned about the average transported weight, volume and distances. The participants shared their organizations' desired lead times for last mile deliveries, which are, on average, half of their current lead times (73 hours). Finally, they were asked about the most predominant transportation modes in their organizations for both actual and desired scenarios. Consistently, all participants expect to maintain the air transportation as one of the predominant modes. Rail transportation was also one of the most mentioned modes for desired transportation, despite not usually being mentioned as a current mode.

***By far, the most significant characteristic was having a greater possibility to reach remote areas, among other six options, which were sequentially ranked according to the scores graphically represented in Figure 6.***

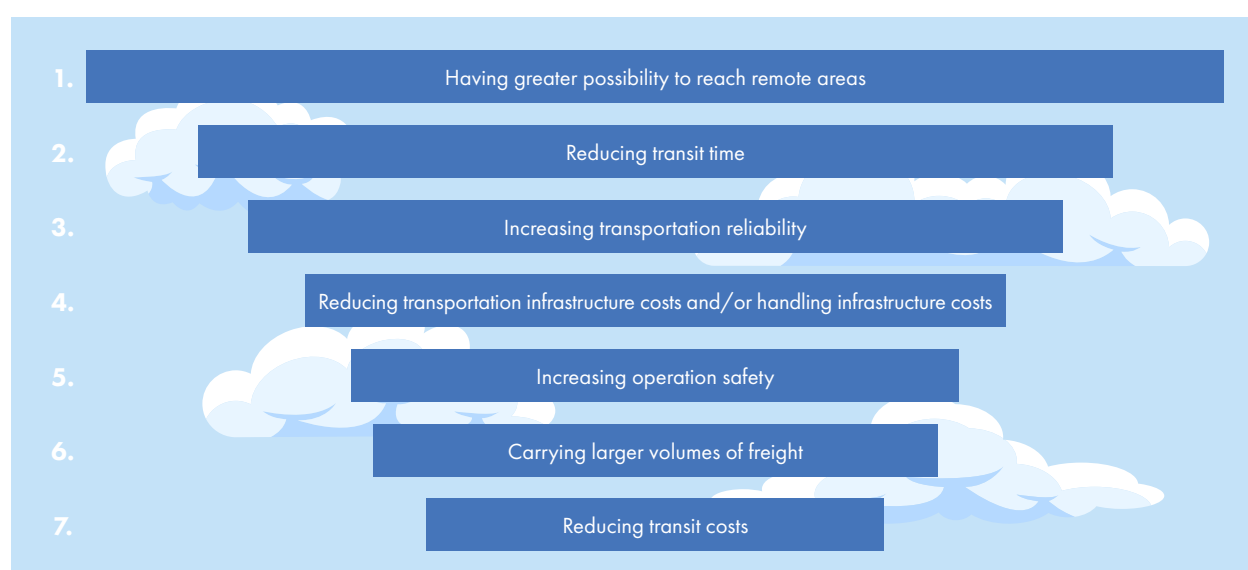


Figure 6 – Rank and graphical representation of the scores for the most valuable logistics characteristics

15 Wright C., Rupani S., Nichols K., Chandani Y., Machagge M. (2018) What should you deliver by unmanned aerial systems?



## 5. Conclusions

The need for further development in UAV technology is certain, regardless of its area of application. Changes in air traffic, operations and the coordination of flights have to follow up and adapt to the integration of such technologies in worldwide airspace.

Considering the context of Pharma and Humanitarian sectors, some challenges are additionally included for transporting products and services. This is due to the demands of keeping cargo well-refrigerated and due to the emergency in delivering. The outcome from the interactive survey conducted during the Webinar that took place on 15th June 2021 led us to conclude that higher density of health facilities, especially in hard-to-access areas, enable UAVs to work more efficiently, as shorter distances can be operated and as more flights can be made to meet demands. Furthermore, the online

survey showed that Pharma specialists are more prone to acknowledge the application of drones for distances over 122 kilometers.

The bottleneck pointed out by the majority of the respondents, who claimed that the lack of infrastructure is a scenario in which their organizations most struggle with, shows that specialists in the pharma sector show the need to establish different ways to reach remote areas. This characteristic was also first ranked as most valuable in terms of logistics. The specialists mentioned that they could address this issue by associating with reliable partners to extend reach and by adding last mile deliveries, which were not part of the scope of some HLA and Pharma.Aero's member organizations. This makes room for specializing in UAV technology and, thus for addressing this common aspect.

Another conclusion that can be drawn from the online survey is that rail transportation, which was mentioned several times by the respondents as a desired mode for last-mile deliveries, has some convenient advantages that can also be developed in UAV cargo delivery. It is unquestionable that rail transportation is feasible for heavy loads and for ensuring higher reliability (the third most valuable characteristic, according to the participants). This shows that the latter feature can be explored and further developed in drone technology by providing services that can be complementary to traditional freight modes.

Finally, it becomes important to highlight the cross-country regulation diversity seen in nationalities who already put effort into its development. This context alerts for the potential additional challenges faced by lower middle-income countries in securing safe operations due to financial investment restrictions and political clout. Thus, further development for harmonized and updated drone operations between worldwide countries are urged and recommended as next steps towards increasing UAVs deployment to freight transportation.





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