Cargo Drones: Still a Distant Reality!

EE 786: Case Study Assignment

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820 Words, and 5 Pages

Case Topic: Will light cargo drones replace the incumbent human based delivery?

26th April, 2021

ABSTRACT

In this case study, we examine the current state of affairs of light cargo drones and the required measures for speeding up their adoption. Drones have evolved from pet projects of hardcore enthusiasts into serious contenders for payload delivery and a host of other use cases. Companies like DJI have an extensive lineup of drones for various tasks and price ranges. We focus on the key technological factors which the companies need to innovate upon and the legal hurdles faced by this upcoming industry. A back-of-the-envelope calculation sheds some light on scalability issues and the potential market for drone-based deliveries. We also compare the performance of various players in the market as of April 2021.

1. INTRODUCTION

Drone technology is improving at a rapid pace. Drones are being increasingly used for infrastructure inspection, public surveillance, dangerous military missions, photography, agriculture, etc. [1]

In this case study, we focus on a specific application: light cargo drones for payload delivery. They refer to unmanned aerial vehicles which can transport light goods such as books, medicines, etc. There is no consensus on the exact definition of *light* but anything under 5 pounds is a good enough candidate for such deliveries. Such drones are increasingly being used for last-mile delivery, which refers to the very last step of the delivery process when a parcel is moved from a transportation hub to its final destination - which, usually, is a personal residence or retail store. It accounts for about 53% of the total shipping cost, which is a significant chunk [2].

Why drones? At a high-level, utilising the vacant airspace for transporting light goods is a promising idea. By using drones, we can cut down on roadway congestion, reduce delivery times by increased route flexibility, reach remote places where road infrastructure is poor and aim for zero greenhouse emissions. However, there are a few limitations. To name a few: limited size of the payload, setting up a complete air traffic controller infrastructure, constrained flight times due to limited battery capacity and safety issues related to unpredictable weather and vandalism/sabotage [3].

Before we proceed, it is important to distinguish between drone manufacturers and logistics companies. Some firms such as DJI solely focus on building the best drones. On the other hand, companies like UPS are purely involved in the logistics; they import drone technology from firms like DJI. Finally, companies like Amazon focus on the entire pipeline: from RnD for improving drone technology to handling the actual dispatch of packages.

2. Current Scenario and Challenges

2.1. Technology

Mass adoption of drones hinges upon 3 crucial technological factors - battery capacity, speed and payload capacity. Figure 1 compares the specifications of these 3 key factors across companies.

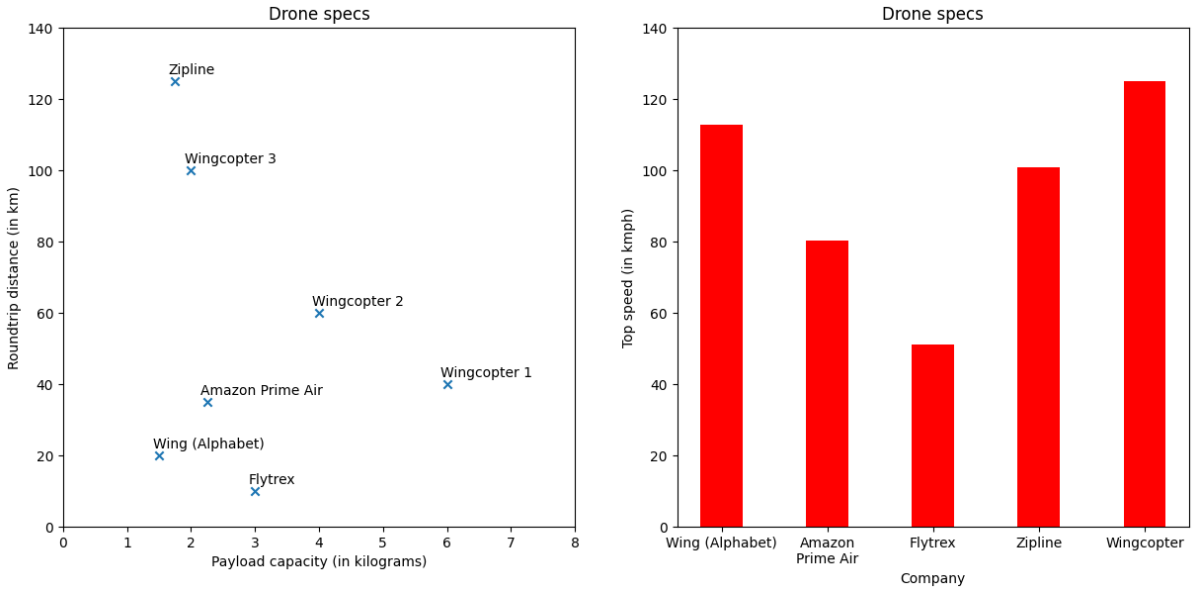


Figure 1. Round-trip distance, payload capacity and cruising speed of various drones in the market. Note that *Wingcopter* provides 3 operating points at different payloads. Higher the better for all 3 parameters.

As expected, heavier the payload, lower the round-trip distance capacity. Technology-wise, Zipline and Wingcopter seem to be the most superior drones.

According to the current technology, operational costs can be lowered by almost 70%, as compared to traditional van-based delivery service since autonomous drones offer lower cost per mile and higher speeds in last-mile delivery [4]. In crowded urban areas, the delivery time can be cut down from 40 minutes to just 8 minutes! However, scalability is a separate issue, which is discussed in section 2.3.

Currently, almost all drones are powered by batteries. As the world moves towards green alternatives, it is also important to ensure that the entire charging infrastructure is powered by clean energy. Drones directly powered by solar energy instead of batteries can reduce the number of required charging stations.

2.2. Legal

Legal regulations and standards may prove to be the biggest hurdle for mass adoption. The most significant regulatory development for accelerating adoption is the roll-out of drone-specific air traffic control systems called unmanned traffic management (UTM) systems. These technologies provide air traffic controllers full visibility over who uses the airspace, as well as automates processes to handle associated flight requests and permissions [4]. Moreover, technical standards for communication between drone operators (5G?) will need to be established. We need to also be careful about investments in infrastructure for drone landing pads and charging stations.

Company	Notes
Wing (Alphabet) [6]	First to get Air Carrier certification from the FAA. $>$ 100,000 flights completed. Operating in 4 cities across 3 continents in partnership with FedEx and Walgreens.
Amazon Prime Air [7]	Received FAA approval in August 2020. Still carrying out extensive testing.
Flytrex [8]	Participant of the FAA pilot program. Walmart partnership for pilot program, supplying medicines in US.
Wingcopter [9]	Preparing entry into US for FAA certification. Successfully carried out vaccine delivery in remote areas of Ireland.
Zipline [10]	Delivered hundreds of thousands of shipments of life-saving blood and medical supplies to hospitals and health facilities in Rwanda and Ghana. Gearing up for vaccine distribution in US. Partnered with Walmart for delivery of medicines.
UPS [3]	Tested drones launched from moving vehicles, particularly effective in rural areas with no distribution centres. Received approval in October 2019 to begin drone deliveries in the air over people, out of line of sight, and with packages weighing more than 55 pounds.

Table 1. Various players in the current drone market.

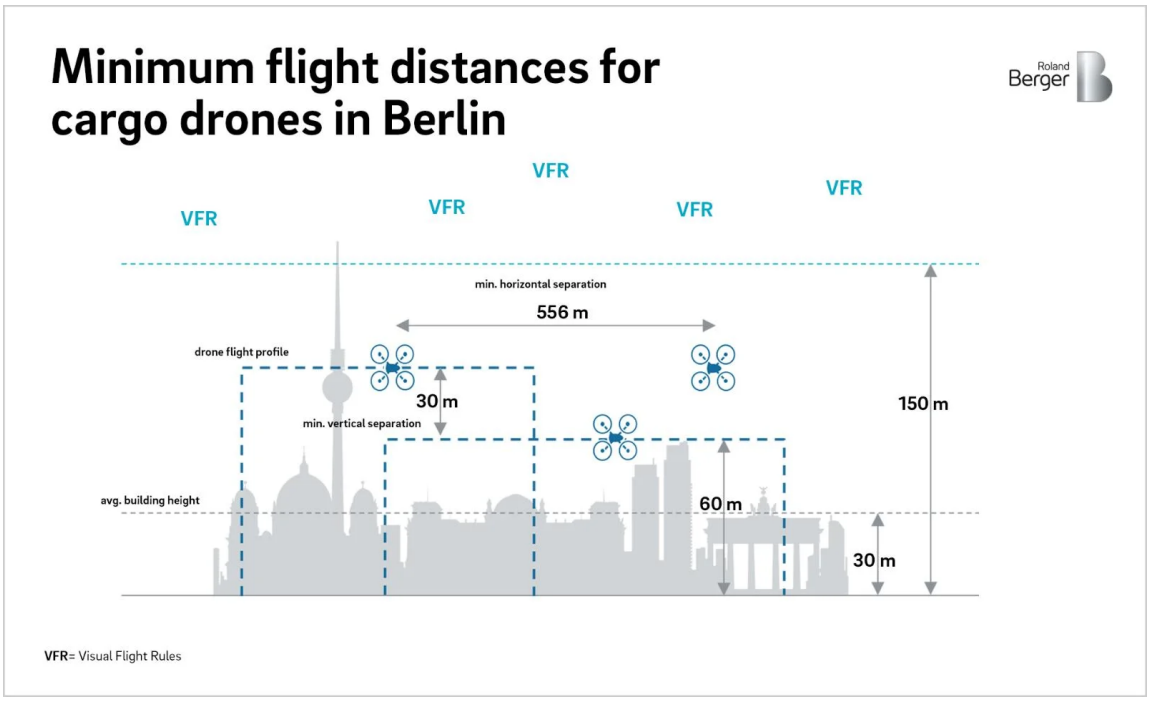
Table 1 discusses the regulatory approvals received by various companies and progress made so far [5]. [4] expects that routine, large-scale autonomous drone flights will not be feasible before 2025!

2.3. Scalability

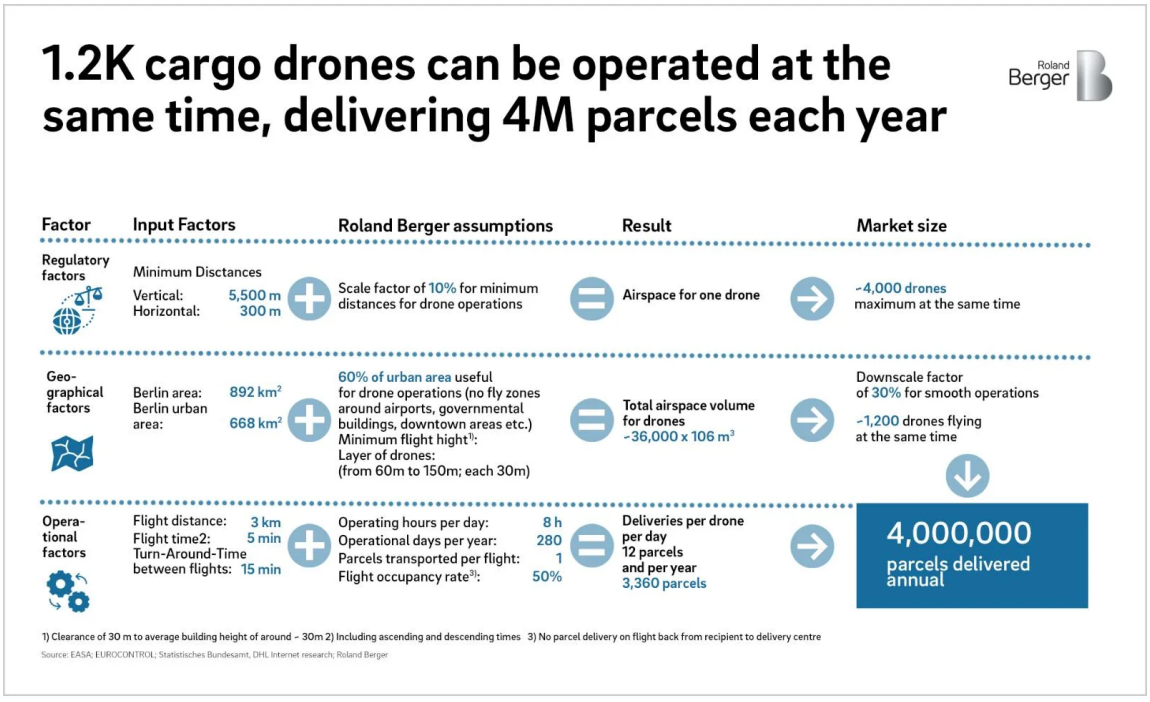
In [11], a back-of-the-envelope calculation is done to estimate the number of deliveries which can be served by drones. Safety factors such as minimum distance (both vertical and horizontal) between two drones, geographical factors such as usable airspace and operational factors such as flying speeds, payload capacity and re-charging times are considered.
About 110 million packages weighing less than 2 kg were delivered in Berlin in 2018. Thus, at maximum capacity drones could handle **only 3.6%** of parcel deliveries under 2 kg [11]. Clearly, this number is not large enough to attract logistics companies. There is a lot of scope for innovation: better algorithms which can reduce the airspace consumed by one drone, innovations in battery technologies which can reduce charging times and increase battery capacity, fully autonomous systems, etc.

3. Conclusion

The COVID-19 pandemic has accelerated the demand for cargo drones since they can safely, quickly transport medicines and other goods to urban and remote locations, with minimal impact on the environment. However, regulatory hurdles and setting up an infrastructure pose a key challenge. Moreover, in countries like India which are slow to adopt newer technologies, cargo drones may not see the light of day even by the end of this decade! Despite these challenges, it's clear that cargo drones have a distinct value proposition. To overcome the hurdles to large-scale implementation, the development of a collaborative ecosystem will be key. This should include national authorities, infrastructure providers and leading players to ensure standards and scaling across the industry [1].



(a)



(b)

Figure 2. Both graphics from [11] (a) Graphic depicting the space constraints imposed by urban infrastructure in Berlin. (b) Parameters used for calculation of parcels delivered per year by drones.

4. REFERENCES

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