Unmanned Aerial Vehicles for Freight and Logistics

DETAILS

SECTOR | Transport

STAGE | Operations and Maintenance

TECHNOLOGIES | Unmanned Aerial Vehicles (UAVs), LiDAR, CCTV

SUMMARY

Unmanned Aerial Vehicles (UAVs), sometimes referred to as drones, are aircrafts without an onboard pilot. UAVs operate with varying degrees of autonomy, such as remotely controlled by a human operator or autonomously by onboard computers. They operate using a combination of technologies, including computer vision from CCTV, Artificial Intelligence (AI) and object avoidance (LiDAR) technology. UAVs are powered by electricity that is stored in an onboard battery.

UAVs have been successfully used for military applications for decades and are now increasingly being adopted by the freight and logistics industry. Freight UAVs are currently being developed by an array of companies including start-ups like Natilus and Sabrewing, and major players like Amazon, FedEx, DHL, and UPS. Each prototype varies in shape and size, with Boeing's cargo air vehicle weighing 338kg (747 lb) and carrying a 227kg (500 lb) payload[1], versus Wing's 5kg (11 lb) drone that can carry 1.4kg (3 lb) payloads[2].

UAVs can perform several tasks across the freight sector, including warehouse operations, last-mile delivery and as unmanned air cargo planes. Cargo UAVs will be large enough to carry hundreds of pounds of goods across hundreds of kilometres, with the potential to replace cargo airplanes and even shipping vessels in some scenarios. Cargo UAVs could also shuttle goods between distribution centres in rural areas. They would be able to ship fewer items more frequently. Smaller UAVs can be used to deliver individual orders to customers' doorsteps in suburban and urban areas, in place of road delivery trucks, and would be unimpeded by road congestion. Both examples would have a lower environmental impact compared to their traditional counterparts.

This use case focuses on the adoption of UAVs for last mile delivery services. Two types of UAVs are being tested to perform last mile delivery. These are multi-rotors and hybrid fixed-wing drones. The multi-rotor UAV is proving to be the most popular options due to its increased manoeuvrability. Currently they can carry payloads of up to 5kg and can travel up to 20km before needing to be charged. They can travel at speeds of up to 60km per hour at an altitude of 100m to 400m. They can deliver packages by landing at a location or they can do an "in-air delivery" (via a mechanized wire system so the drone can release a wire from height for delivery rather than needing to land).

[1] "Giant cargo drones will deliver packages farther and faster", The Verge, Accessed 17 May 2020.

[2] "Google's Wing has landed the FAA's first approval for drone delivery", Vox, Accessed 17 May 2020.

In 2019, the first UAV delivery was made in the US state of Virginia by Google's start-up Wing. Wing also launched its first air service in Australia in 2019 which let users place orders for food, coffee and pharmacy items through a phone application, and delivered those items to their homes by UAV within minutes[3]. In October 2019, UPS became the first FAA-approved UAV airline in the US, following a successful trial of its service on a WakeMed hospital campus[4]. The trial saw the UAVs transport medical samples and specimens around the campus. UPS plans to expand its UAV delivery service to US hospitals and expand outside of the healthcare sector.

UAVs are predicted to make up 80% of deliveries in the future[5], with NASA estimating that 2.6 million commercial UAVs will be operating in 2020[6]. This rapid uptake of the technology is a result of the significant benefits it can offer freight operators, including the fast and reliable delivery of goods, lower costs of operation and environmentally friendly technology. The last mile of delivery is currently the least efficient part of the logistics supply chain. Today, 50% of the total cost to deliver a shipment is attributed to the last mile of delivery[7]. This is due to the cost associated with driver salaries, delays due to congestion and issues in locating addresses, and the rigidity of a fixed delivery schedule that means if the delivery of one package is delayed, all subsequent deliveries will be impacted.

VALUE CREATED

Improving efficiency and reducing costs:

- Reduce operating and maintenance costs for freight and delivery by using automated or remotely controlled aerial vehicles.
- Increase freight service offering with solutions that can be operated out of usual working hours and potential to increase efficiency due to the predictability and exact timetabling of automated transportation.
- Reduction in damage to and maintenance required for road infrastructure as many heavy vehicles could be taken off the road in favour of UAVs.

Enhancing economic, social and environmental value:

- Increase efficiency enabling cheaper delivery services and shorter waiting times for deliveries through automated real-time optimisation of delivery routes, and less pressure and congestion on the road network.
- Reduce emissions and pollution, as road vehicles are replaced by UAVs powered by electricity.
- Improve road safety by reducing the number of freight vehicles on the road and replacing them with aerial vehicles in a dedicated aerial space.

POLICY TOOLS AND LEVERS

Legislation and regulation: Regulations need to be developed for the safe use of UAVs. This should include a detailed list of requirements for the safe development and use of driverless vehicles in freight and delivery including a system malfunction plan.

Effective institutions: Specific accreditations should be given to ensure vehicles compliance with safety and operations requirements. Those accreditations must be delivered by specific institutions with staff trained to follow the accreditation processes. Testing and validation must also be delivered either by those institutions or by specifically nominated partners.

[3] "The Evolution of Delivery Drones in Logistics", Transmetrics, Accessed 17 May 2020.
[4] "The Evolution of Delivery Drones in Logistics", Transmetrics, Accessed 17 May 2020.
[5] "The Evolution of Delivery Drones in Logistics", Transmetrics, Accessed 17 May 2020.
[6] "The Evolution of Delivery Drones in Logistics", Transmetrics, Accessed 17 May 2020.
[7] "The Evolution of Delivery Drones in Logistics", Transmetrics, Accessed 17 May 2020.

Transition of workforce capabilities: The control system for automated vehicles is significantly more complex than regular control systems, as a collection of interacting dynamic controls need to be governed under one complete system. Therefore, service providers need to ensure a fully integrated and useable control centre is developed for freight and logistic company use.

Once the automated vehicles have entered the delivery system, effective and structured maintenance plans must be developed and implemented, to ensure predictive and immediate detection of faults.

Funding and Financing: In funding models, the operational changes should be considered to understand how they impact operating costs as well as requirements for temporary 'parking' spaces or for depots management solutions.

Procurement and Contract Management: Operating UAVs in the aerial corridor is a relatively new concept and its use for freight purposes is very recent. Operations in these corridors will be subject to specific requirements concerning vehicle capacity, flight frequency and permitted flight hours. To ensure all operators adhere to these constraints, and to ensure their engagement, Key Performance Indicator regimes can be implemented in contracts. This will ensure the desired outcomes around safety, privacy, noise pollution etc. are met. Additionally, contracts should have specific requirements around the accreditations of the fleet of vehicles.

IMPLEMENTATION

Ease of Implementation 	Given the lack of regulation on the use of aerial corridors in urban environment and the complexity to implement these regulations without clear planning and institutions able to understand the technologies, such solutions are not going to be authorized to operate easily at a large scale. Once the policies and regulations are in place, permits and accreditations will be easier to get, and the implementation will be eased.
Cost 	The technologies still need to be researched to provide better performance, hence the investments costs are high. As the technology is continuing to advance, the costs associated are reducing. However, the operational costs associated with the technology have not reduced as the operational model has yet to be proven (as most implementations are very recent or at trial stage). Similarly, to develop adequate regulations investment is required, which has not been a priority on freight and transport agendas of most advanced and developing countries.
Country Readiness 	Most advanced countries have set strategic expectations for unmanned air freight logistics and are currently performing trials especially in low-density areas. However, the regulation still needs to be developed and validated. Developing countries are considering these options only for limited applications and the business cases do not always stack up as of today.
Technological Maturity 	Automated vehicle technology is continuously being developed in order to improve in reliability and safety, however more development still needs to take place with regards to the physical structure of the vehicle in order to reduce cost and the size of the vehicle, enabling more agile operating plans. The development of an overall control system, which can monitor all individual vehicles and feed information back to a single system, is necessary for the use of automated vehicles in freight and delivery

RISKS AND MITIGATIONS

Implementation risk

Risk: The technologies still need to perform better to enable efficient operations of those services in conjunction with the wider freight and logistics chains. Additionally, the regulations and accreditations need to be developed and validated to enable large-scale uses of UAVs for first and last mile freight.

Mitigation: Enable more trials and test beds; and develop the regulations according to the expected outcomes in terms of freight management and the performance of such solutions.

Social risk

Risk: User acceptance might not be easy given perceived safety issues with driverless solutions and the perception of people losing jobs to technology. There is also the potential that noise pollution and perceived privacy issues will lead to a rejection of the technology.

Mitigation: Public consultation and education prior to commercial application is essential. There needs to be clear communications on the applications of these solutions for first and last mile freight management as a complementary mode in the chain of delivery, explaining the benefits on city management for citizens but also the increase in freight supply that would not put jobs in this growing industry at risks. Existing workforces can be upskilled in an effort to transition staff to more technical roles.

Safety and (Cyber)security risk

Risk: The technology still needs to perform better with more efficient detection of obstacles, and safe operating systems meeting the set performance criteria.

Mitigation: As for implementation risks, there is a need for more research and trials to be performed in conjunction with more detailed performance requirements being developed and agreed on. Data management enabling individual data protection is a key element to add in the regulation.

Environmental risk

Risk: In some countries, air pollution can be considered as a risk. This can be the case in areas where air corridors are expected to be clear.

Mitigation: Understand the specific local context and expectations of cities, councils, countries, and set tailored operating plans responding to these expectations. Prospective UAV operators need to work with government to identify and resolve challenges regarding airspace.

EXAMPLES

Example	Implementation	Cost	Timeframe
Flirtey	Trials being undertaken in the US. Testing of technologies to operate in 95% of wind and weather conditions, making it highly reliable for flight.	USD 100 billion global last-mile drone delivery market estimated by Flirtey.	Received FAA approval to conduct drone deliveries and validated in 2020; test flights with Domino's Pizza, 7-Eleven, medical automatic defibrillators manufacturer.
Amazon Prime Air Delivery	Amazon Prime Air has development centres in the US, the UK, Austria, France and Israel. Research and development being undertaken with the objective to deliver customers' orders within 30	Large investments from Amazon as they see savings with less than two-day Prime shipping and two-hour Prime Now deliveries.	Trials being undertaken; no commercial services.

	minutes through its Prime Air delivery program.		
UPS Drone Delivery	Trials and limited operations taking place in the US. The US Federal Aviation Administration (FAA) approved UPS Flight Forward to become the first-ever drone service operating as a commercial airline.	Combined investments with CVS Pharmacy to develop the service, focusing on medical product delivery.	Implemented but only operating in suburban and rural regions.

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