

TECHNOLOGY

Autonomous Drones: A Game Changer in Lightweight Delivery Services

by Mokter Hossain



Image Credit | Josh Sorenson

Unmanned aerial vehicles are becoming increasingly popular, carrying medicine, food, postal packages, and other light goods.

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Imagine, you placed an order online and received it in minutes. This is the future of drone delivery services. Customers can track the drone during its delivery trip via apps like Uber car. Some cities and even rural areas have already experienced such deliveries. A delivery drone is an unmanned aerial vehicle that is getting increasingly popular to carry packages, medicines, foods and postal mails, and other light goods. In recent years (2013 onwards), Companies such as 7-Eleven, Ali Baba, Amazon, DHL, Domino, FedEx, and Google started their experiment with drone delivery services. However, Flirtey is the first start-up that did drone delivery in the urban setting in the USA with the approval of the Federal Aviation Authority, USA. Japan with the help of German drone company Wing is planning to use drones for different delivery purposes. Wing has recently celebrated 100,000 deliveries with media fanfare. Its drones are autonomous and one operator can monitor several flights in parallel. It claims that the average delivery time is 10 minutes. On 19 November 2021, Sierra Leone in collaboration with the drone company UAVaid delivered medicines by drone for the first time. The trip took 13 minutes, which usually takes 2 hours by ground vehicles. Alphabet—Google’s parent company—is testing its services in Australia, Finland, and the US. A recent report pointed out that delivery drones are used or under trial to use at least in 26 countries across the world. Customers are also increasingly embracing drone delivery. A recent study found that customers’ preference to embrace drone delivery depends on factors such as price, commodity types, and their gender, age, and household income (Kim, 2020). I searched and collected more than 136 documents and dozens of YouTube videos from online sources that talk about drone delivery. I went through documents and videos to understand the current state of update delivery; many of these documents have been published in the last quarter of 2021 as drone delivery was picking up at this time. It is important to understand the state-of-the-art of drone delivery and this article aims to accomplish this purpose.

Dominant Industries

Drone delivery is growing for different purposes in sectors such as healthcare, food, posts, and shipping. Perhaps the biggest benefit of drones for healthcare deliveries is that they can fly into remote or otherwise inaccessible regions more easily and quicker than other forms of transportation. Another key benefit of drones in the healthcare industry is that they can deliver medical supplies to places that are not accessible for alternative

transports. Drones can reach a location that may not be accessible to trucks and motorbikes. In many areas, drones are used to deliver medical products such as vaccines, medicines, and blood, and even kidneys. For example, on April 19, 2019, in Southwestern Baltimore, a drone delivered a kidney to a nearby hospital, and surgeons successfully transplanted it into a critical patient. This 2.8-mile, 10-minute flight was considered the first to deliver an organ in human history. In some developing countries like Rwanda and Puerto Rico, drones are becoming common practice for emergency medical supplies. In the COVID-19 pandemic, drones are used in many countries including the USA, Israel, and Ghana. In 2016, in collaboration with the government of Rwanda, Zipline started its venture in Rwanda consisting of mountainous terrain, weak road, and rainy season so drones appear to be very cost-effective to deliver, compared to other alternatives. Zipline claims that it has made more than 1,623,851 deliveries while flying 16,122,188 miles. It is operating in several countries and exploring to start its services in other countries. Zipline is delivering medical supplies in the USA, blood in Rwanda, and vaccines for the COVID-19 in Ghana. Walmart and Zipline offer delivery services in Arkansas, USA. Cardinal Health is testing drone delivery of their medical supplies to U.S. pharmacies to cut transport costs and for speedy shipment. A start-up called TechEagle is delivering drugs in remote and isolated locations in India. China's startup Antwork started delivering medical supplies since the COVID-19 pandemic broke out.

Drones are used to deliver foods, such as pizzas, tacos, and beverages. A drone company Manna operates in a small city called Galway and the capital city Dublin in Ireland to deliver burgers, fries, ice cream, broccoli, melon, etc to customers through fully autonomous, suitcase-sized drones having 2000 -3000 fleets in a day with a typical speed of 50 miles an hour at an altitude of 150–200 feet. The CEO of Manna believes that the cost of drone delivery is one-tenth of that of the other options such as Uber Eats human delivery. Further, drone delivery time is significantly lower. Uber is also experimenting with autonomous drone delivery instead of its current human delivery.

Many postal companies in Australia, New Zealand, Singapore, Switzerland, Ukraine, and the UK are using drone services for postal deliveries. In collaboration with Bharat Electronics Limited (India), DroneDek in the USA has come up with a smart mailbox for receiving, storing, and packing packages by drones. Mesa Air Group announced in October 2021 to launch drone delivery services for shipping.

Eastern Pacific Shipping and local start-up F-drones started the first drone delivery service in Singapore in 2020 carrying up to 11 lbs. of supplies traveling up to 5 km. They seem to deliver a parcel in seven minutes, which takes 2 hours in an existing option of diesel-powered launch boat delivery. More interestingly, F-drones operate at night too. They are expecting to carry 100 kg over 100 km in the coming years. A drone effectively deliver parcels to isolated sites in France where DPD France delivers a parcel by drones in 8 minutes against 30 minutes by a car traveling 20 km. It seems drone delivery is getting increasingly popular in many sectors.

Drone Configurations

The configurations of drones vary from one to another depending on the purpose of the delivery. Common configurations of delivery drones are fixed-wing design and multirotor. Drones with fixed-wing configurations have a higher range, higher speed, and less noise. However, this type of drone needs more space to take off and landing. On the other hand, drones with multirotor designs are less efficient and noisier. Typical delivery drones are equipped with brushless DC motors that are affordable, light, and powerful so that drones are stable in the air. Drone propeller blades maximize the strength. Some brushless DC motors are made from carbon-fiber composites or cheaper thermoplastics. Drones are equipped with inertial sensors, such as accelerometers to fly autonomously, lithium-ion chargeable batteries that provide energy, power, and navigation sensors such as GPS or magnetic sensors that enable drones into travel in a specific route; airflow sensors to measure density, airspeed; and temperature to keep the drones safe and sensors to estimate wind speed. On top of that, drones have a ground control system for operations.

Regulations

In 2014, the UAE announced plans to launch a drone fleet for civilian purposes such as passports, licenses, and ID cards. The US Federal Aviation Authority recently published regulatory directives with 107 rules for the drones to operate for commercial purposes. However, it permits each company individually to operate but maximum of 55 lbs. to fly a maximum altitude of 400 feet at a speed of below 100 miles per hour. In 2019, the Federal

Aviation Authority started issuing permission to drone delivery companies to operate their drones relaxing many previous restrictions. In December 2013, Amazon founder Jeff Bezos announced the use of UAVs to deliver packages through UAVs. However, the company shared that it was facing hurdles from federal and state regulatory bodies due to public safety, reliability, privacy, security, and logistical challenges. The CEO of Manna operating in Ireland feels that Europe and Canada have forward-looking regulators while the USA is more complex. For a wide use of drones, it is necessary to install battery charging stations, or automated battery swapping machines like electric cars, which need permission from different authorities (Cokyasar et al., 2021).

Drone Delivery Challenges

With the blessings of delivery drones, they possess concerns. Drones have limitations such as limited package weights, need collision avoidance systems, airspace control; avoid irregular and unpredictable events, and local restrictions. Many feel that drones may take human jobs. However, advocates of delivery drones argue that they create different types of jobs such as maintenance staff, ground control personnel, packers, programmers, software engineers, etc. Drones may create extra visual, noise pollution and other hazards to people. Autonomous accessible charging systems are necessary to develop as the use of drones increases. In the UK, Amazon has made over 100 employees redundant, and dozens of others were moved from its drone project to other projects. Therefore, the promise of Amazon's drone delivery is uncertain. Receiving a package via a drone includes more packaging materials. Drones may hit birds, pets, buildings, power lines, masts, and traffic. In addition, some of us may not be happy to live under a cloud of drones. A typical delivery drone is meant to carry lightweight parcels. For example, delivery drones are allowed to carry a maximum of 25 kilograms in the USA and Germany. Third-party liability insurance is necessary and in case of over 250 grams of the parcel, the owner details need to be marked with fireproof labeling. Drones have to have many trips to deliver items that may be delivered by a truck. Drones are needed supporting infrastructures such as landing pads, drop-off stations near homes and offices. Even though drones deliver goods autonomously, their smooth functioning depends on human laborers for monitoring flights, packers to prepare the parcels, and staff to manage hardware and software, all of which involve significant man-hour work.

Benefits of Delivery Drones

Drones are expected to reduce roadway congestion, reduce greenhouse gas, reduce roadway and bridge, improve safety, and greater route flexibility. They have great value for low cost, flexibility, and speed. They need less fueled-powered vehicles for deliveries. Drones can deliver emergency items such as medical supplies in any location. The World Economic Forum argues that last-mile delivery accounts for over 50% of the cost in good shipping. A study suggests that delivery drones can reduce greenhouse gas emissions and energy consumption in the shipping sector. It also points out that to realize maximum benefits by keeping warehousing minimum and drone size smaller (Stolaroff et al., 2018). Reports suggest that every drone delivery may eliminate a car off for delivery. A study by Deloitte in 2020 revealed that drone delivery cost less than half of the existing rate of an e-bike delivery. Since drone delivery is much faster than car or bike delivery, customers receive their meals quicker and fresher. Research shows that drone delivery saves energy and reduces the carbon footprint for the last-mile delivery (Chiang et al., 2019). Comparing truck and drone for parcel delivery, a study pointed out that drone delivery contributes to a 60% reduction in customer waiting time (Moshref-Javadi et al., 2021).

Drone Delivery Future

Drone deliveries are expected to be much more affordable and faster by human courier or ground transportations, such as cars and bikes. Like delivery robots are used in local delivery (Hossain. 2021) in many campuses and cities, delivery drones are more effective for the relatively longer distance. Ground transport takes time especially when for example traffic congestion is high; drones can be handy in such situations. Even though most companies promised to use drones but they failed to live up to their promise. While drone delivery practices may not be growing at an expected speed especially due to regulatory and other reasons, their use may increase in large factory premises, college campuses or other private businesses covering a large area like a small city. Drone delivery may get growing popularity to move goods within a warehouse. A study by the Association for

Unmanned Vehicle Systems International points out that in the USA alone, the drone industry can generate \$82 billion in economic activity and create up to 100,000 new jobs in 2015 -2025. City and rural skies crowded with drones may not be far away.

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Mokter Hossain

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Mokter Hossain is an Assistant Professor at the Center for Entrepreneurship, College of Business and Economics, Qatar University. Previously, he worked at Manchester University, Aalborg University, Aalto University, and Imperial College London. He has a PhD in strategy and venturing, an MBA in International Business, an MBA in Marketing, and a Postgraduate Diploma in Finance. His research interests lie at the intersection of entrepreneurship, innovation, and strategy on topics such as frugal innovation, open innovation, crowdsourcing, crowdfunding, sharing economy, etc.