

Drones in Supply Chain

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ABSTRACT

Drones are typically remotely controlled aircraft used for various purposes including surveillance, photography, search and rescue, and military operations. They have become an essential component of the supply chain industry due to their ability to transport goods and conduct inspections quickly and efficiently. They can assist in multiple points of the supply chain, assisting with both the land and air portions of delivery. Implementing drones into supply chains has been great, and drones are becoming quite popular. Companies are planning to use drone technology to simplify their supply chains. This paper explores the various uses of drone in the supply chain industry.

KEYWORDS: *drones, unmanned aircrafts, unmanned aerial vehicles (UAVs), unmanned aircraft systems (UAS), supply chain, supply chain management (SCM).*

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INTRODUCTION

Drones have become a rapidly emerging technology in multiple industries, including the supply chain. We see drones often at sporting, concert, and community events. Drone manufacturer Airobotics describes drones as having a “limitless aerial perspective” with endless applications in mining, oil and gas, agriculture, and other industries. These unmanned aircraft systems can assist supply chains by transporting raw materials to the manufacturing floors and the finished products back to the shelves.

Drones could be the game changers in the supply chain. They have the potential to revolutionize the supply chain. Over the last few years, drones have been the topic of the experiment for use in expanding the potential of supply chain professionals.

WHAT IS A DRONE?

At least three terms are used to describe drones, depending on how they are operated. The terms include Unmanned Aerial Vehicles (UAVs), Unpiloted Aircraft System (UAS), and Remote Piloted Aircraft System (RPAS). The FAA defines drones, also known as unmanned aerial vehicles (UAVs), as any aircraft system without a flight crew

onboard. Drones include flying, floating, and other devices, including unmanned aerial vehicles (UAVs), that can fly independently along set routes using an onboard computer or follow commands transmitted remotely by a pilot on the ground. A typical drone is shown in Figure 1 [1]. A drone is usually controlled remotely by a human pilot on the ground, as typically shown in Figure 2 [1]. Drones can range in size from large military drones to smaller drones. Drones, previously used for military purposes, have started to be used for civilian purposes since the 2000s. Since then, drones have continued to be used in intelligence, aerial surveillance, search and rescue, reconnaissance, and offensive missions as part of the military Internet of things (IoT). Today, drones are used for different purposes such as aerial photography, surveillance, agriculture, entertainment, healthcare, transportation, law enforcement, etc.

Drones work much like other modes of air transportation, such as helicopters and airplanes. When the engine is turned on, it starts up, and the propellers rotate to enable flight. The motors spin the propellers and the propellers push against the air

molecules downward, which pulls the drone upwards. Once the drone is flying, it is able to move forward, back, left, and right by spinning each of the propellers at a different speed. Then, the pilot uses the remote control to direct its flight from the ground [2],

Drone laws exist to ensure a high level of safety in the skies, especially near sensitive areas like airports. They also aim to address privacy concerns that arise when camera drones fly in residential areas. These include the requirement to keep your drone within sight at all times when airborne. In the United States, drones weighing less than 250g are exempt from registration with civil aviation authorities. If your drone exceeds 250g in weight, you will also require a Flyer ID, which requires passing a test [3]. It is necessary to register as an operator, be trained as a pilot, and have civil liability insurance, in addition to complying with various flight regulations, and those of the places where their use is permitted.

Most drones have a limited payload, usually under 11 pounds. Drones are classified according to their size. Here are the different drone types:

- Nano Drone: 80-100 mm
- Micro Drone: 100-150 mm
- Small Drone: 150-250 mm
- Medium Drone: 250-400 mm
- Large Drone: 400+ mm

One of the emerging trends in drone use for factories is the utilization of LiDAR technology. LiDAR stands for Light Detection and Ranging. This technology provides accurate depth information essential for understanding the three-dimensional structure of the environment. LiDAR sensors emit laser beams to measure distances to objects, creating high-resolution 3D maps of the surrounding terrain and objects. The ability to capture detailed data through LiDAR technology has opened up opportunities for better predictive maintenance, reduction in inspection times, and overall cost savings [4].

SUPPLY CHAIN DRONES

The use of drones in the supply chain is one of the most innovative and exciting technological advancements of the 21st century. The potential for drones as powerful business tools is huge. For supply chains, drones can be used in warehouses to increase the accuracy and efficiency of inventory management through to last-mile delivery. Drone technology is particularly useful to minimize the risk of working at height or dangerous locations, where an intervention beyond capturing data is required. Currently, there are two types of drones: those that capture information and those that can be used for delivery. Drones are designed to assist human workers indoors and benefit large organizations with stationary stock. The use of

drones in supply chain management can complete large inventory counts in a matter of hours rather than days if performed manually. It saves staff from walking around giant warehouses, which can be potentially hazardous environments. The use of drones in supply chain management reduces the number of potential shipping disruptions by improving information accuracy.

Recent announcements from Zipline, DroneUp, Wing, and Skyports Drone Services demonstrate drones' growing presence in supply chains. Big companies around the world have started to integrate drones into their supply chain over the past years to help manage their inventory. China's dominance of the dual-use drone presents an unacceptable national security risk to the United States and its allies. The United States and its allies must have a strategy to secure a trusted drone industry to compete against China.

EXAMPLES OF SUPPLY CHAIN DRONES

Drone has become a sought-after solution for many retailers who are considering using it as a viable tool to help with their supply chains. Leading companies such as Amazon, DHL, UPS, Dominos, Verizon, Maersk, and Google are already testing drone delivery systems, which may become more common in the near future. They are already using drones in their operations. There are many examples of drones making an impact on supply chain operations. Here are some notable developments in the drone delivery.

- **Amazon:** Amazon, the largest e-commerce store in the world, continues to lead the way in supply chain innovation and its ingenuity is to be applauded. It has been at the forefront of testing drone delivery systems. Amazon is consistently setting the bar high. It started to use delivery recently and its drone delivery is finally happening in California. Amazon's recent announcements about opening physical locations have some referring to these stores as their drone airports. Amazon has explored drones to automate warehouse tasks like picking and transporting items to fulfillment stations. The stores position Amazon product closer to residencies and will help them achieve their Prime Air 30 minutes or less delivery promise. An Amazon's drone delivery is shown in Figure 3 [5].
- **Walmart:** Walmart, who has been filing a lot of drone patents over the last few years, filed a patent for blockchain technology that will allow delivery drones to pass packages between each other. Walmart is testing drones for use in inventory tracking. Early indications are that their drones can conduct a full warehouse inventory

check in a single day - a task that usually takes an entire month. We have seen the success that drone companies like Zipline and DroneUp are enabling for clients like Walmart. Walmart says it has already made thousands of same-day drone deliveries to date. Walmart's drone delivery service with DroneUp is now available in Arizona, Florida, and Texas. Figure 4 shows a Walmart delivery drone [6].

- *UPS*: UPS was recently approved by the FAA and Department of Transportation to deliver packages via drone following a successful pilot program delivering medical supplies in remote areas in North Carolina. UPS Flight Forward became the first company to receive full certification from the FAA to operate a drone airline.
- *Zipline*: Zipline, a California-based company, uses drones to deliver medical supplies to remote areas in Rwanda and Ghana. Their drones, known as "Zips," can carry blood, vaccines, and life-saving medications to remote areas. The Federal Aviation Administration (FAA) just granted Zipline permission to fly its drones beyond the visual line of sight. Zipline's drones will deliver prescriptions to homes and transport samples and products between facilities in a new partnership with Pennsylvania-based health system WellSpan Health. The partnership leverages a drone-droid combo to precisely deliver a payload.
- *DoorDash*: DoorDash and Wing launched a drone delivery partnership in Christiansburg, Virginia. Customers with an eligible address can use DoorDash's app to have a qualifying order from the town's Wendy's restaurant be delivered via drone. Wing and DoorDash plan to expand their collaboration into other US cities later this year.
- *Ikea*: This is one of the world's largest furniture retailers, with over 400 stores in 52 countries. The company is renowned for its low-cost, flat-pack products that customers assemble themselves. However, managing its massive inventory of millions of items across its warehouses and stores is a complex challenge. To address this issue, Ikea has turned to drones. The company has partnered with Verity to deploy autonomous drones that can scan and count inventory in its warehouses during non-operational hours.

APPLICATIONS OF SUPPLY CHAIN DRONES

In recent times, drones have become increasingly popular and have been successfully used in aerial photography, construction, search and rescue mission, mining activities, security, scientific research,

military activities, supply chains, and logistics companies. Drones can be used in supply chains to improve inventory management, delivery, and tracking. Increasingly they are being used for inventory management, monitoring, surveillance, inspection, and last-mile delivery. Common applications of drones in supply chain include the following [7,8]:

- *Drones in Warehouses*: In warehouses, drones are used for accelerating inventory counting, optimizing paths around a warehouse when pulling inventory, and for improving worker safety. Scanning inventory, particularly on high shelves, is much faster with a drone scanning RFIDs/barcodes. Warehouse drones can improve how long it takes to count inventory and provide better accuracy by eliminating human error. Figure 5 shows some warehouse drones [9].
- *Drones in Surveillance*: Drones have the potential to provide monitoring and surveillance services in the supply chain industry. Drones are being used in surveillance to perform facility and warehouse safety inspections. They are also used to inspect cargo ships as they are easier and faster to maneuver than workers. Drones are also being used to inspect railways, which cuts down on operational interruptions and increases safety. Drones also enable railroad workers to quickly and safely assess areas during emergencies. With cameras and sensors attached to them, drones can watch over warehouse activities and pinpoint any safety hazards that might arise.
- *Drones for Delivery*: Drones are becoming a popular way to deliver goods in the supply chain industry, especially for companies like Amazon and UPS. Drones can help companies deliver packages faster and more efficiently. Drones seem a natural fit for getting packages to customers in that last mile. When it comes to the use of drones in supply chain management, one might think that last-mile delivery would be the killer app. Drones can also be used for inventory management, facility inspections, and supply chain monitoring, improving accuracy and speed while reducing operational costs. Several companies are trialing using drones in tandem with delivery trucks to reduce gas costs and speed up deliveries. Figure 6 shows some delivery drones [10].
- *Drones for Inventory*: Using drones to scan and check inventory anywhere in the warehouse using RFID and barcode readers can offer better inventory management. Drone technology can collect videos and images, which is crucial during

inventory audits. It can be incredibly time-consuming and labor-intensive to manually count and monitor your inventory, especially during peak seasons like the holidays. Drone operations can prioritize efficiency and manage inventory better. They can scan and check inventory using barcodes, OCR, QR, and RFID readers, while seamlessly moving from warehouses in moments. Drones can easily access warehouse areas that are otherwise very difficult to access and get an inventory read on.

- *Drones for Inspection:* Drones can be used to inspect facilities. In the supply chain industry, particularly in the energy and construction sectors, drones have emerged as beneficial instruments for carrying out inspections. They can examine hard-to-reach infrastructure such as power lines, pipelines, and wind turbines, which generally demand specialized equipment. Drones equipped with cameras and sensors can capture high-quality images and data.
- *Drones for Food Supply:* Drones can be used to deliver food to underserved communities. One will not have to wait much longer to have pizza and more delivered by drone. For example, Uber Eats is testing drone food delivery in high-density urban areas. Figure 7 shows a drone for delivering food [7].
- *Drones for Medical Supply:* 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. Many companies are working with the NHS to build drones into the medical supply chain. This has value for time-critical deliveries to remote areas, because certain drugs have a short effective lifespan. Drones can carry various health commodities (vaccines, medicines, diagnostic samples, blood products, medical products, etc.) and help extend the reach of the supply chain to communities and health centers that are in access-constrained areas. For example, the Red Cross in Austria is working with aerospace company Thales to deliver life-saving blood samples to hospitals if required within minutes. Figure 8 shows a drone for medical delivery [11].
- *Drones for Pharma Supply:* Drug product delivery by drone technology in pharma supply chain is changing the pharma industry. The drone technology in pharma supply chain is paving the road for success in the industry. The technology is here to stay. Drones are changing the

pharmaceutical supply chain transportation model and enabling the safe delivery of life-saving vaccines and medical supplies to areas. Drones are swiftly increasing as a crucial tool for logistics companies in regions where conventional methods of transport cannot reach. Drone technology in pharma supply chain is revolutionizing the delivery of essential drugs to remote areas.

- *Drone-as-a-Service (DaaS):* Companies that do not want to invest in their own drones can use Drone-as-a-Service (DaaS) providers, which offer drones for specific logistics tasks on-demand. Instead of purchasing and maintaining drones, companies can lease them as needed. DaaS allows businesses to scale their drone use up or down depending on seasonal needs or specific projects. There are two predominant DaaS models that are offered by private companies: the third party logistics (3PL) model and the carrier model. 3PL service providers offer integrated supply-chain services that include order management, inventory storage and management, picking and packing, and contract management. In the carrier model, a service provider is responsible for only one function: transportation.

BENEFITS

Drones in the supply chain industry can offer significant benefits, including increased efficiency, cost-effectiveness, safety, and improved visibility. The benefits of using drones in the supply chain industry make them an attractive option for companies looking to gain a competitive advantage. Drone technology can bypass the traditional road network and deliver packages, saving companies fortunes in fuel costs and delighting the customer with instant deliveries. Businesses can also leverage drone deliveries in rural areas. Drones can take direct routes over difficult terrain, significantly reducing delivery times in areas where road infrastructure is poor. Other benefits include the following [8]:

- *Asset Management:* Manually monitoring inventory can require workers to spend extraordinary amounts of time and resources to count products on shelves. Keeping track and monitoring inventory levels can be an exhaustive process when done periodically. The use of drones to scan and check inventory anywhere in the warehouse using RFID and barcode readers can offer better inventory management.
- *Speeds Up Deliveries:* Drone delivery offers speedier delivery. Drones speed up and reduce costs associated with traditional supply chains. Drones could reduce costs and improve the

efficiency of the supply chain by allowing for faster delivery. While retailers have tried to sell the notion of drones performing home deliveries when offering same-day services, your company may benefit from product delivery inside the supply chain. Although drones have primarily been used to leverage last-mile delivery services, they can also be utilized for supply chain management. Companies can seek the help of drones to move raw materials from warehouses to the manufacturing floor and the finished products back to the warehouse shelves.

- *Increased Efficiency:* Drones can significantly improve the efficiency of operations in the supply chain industry. As illustrated in Figure 9, drones can increase efficiency in SCM by streamlining the delivery process, reducing the cost of transportation [12]. They can complete tasks like inspections, delivery, and monitoring in less time than traditional methods. This reduces downtime and increases productivity, allowing companies to focus on other aspects of their operations.
- *Cost-Effectiveness:* Drones are relatively inexpensive compared to traditional transportation and inspection methods. By using drones, companies can save on costs associated with equipment, maintenance, and labor. This cost-effectiveness is particularly beneficial for small businesses that operate on tight budgets. Drones could become as cost-effective for package delivery as traditional transport modes.
- *Increased Safety:* Safety is paramount when conducting drone delivery flights and requires intensive preparation. Drones can improve safety in supply chain management in a number of ways. They are of great help for tasks that are dangerous for humans, such as inspecting power lines or monitoring hazardous materials. This reduces the risk of accidents and injuries, making operations safer for workers. In addition, drones can help identify potential safety hazards in warehouses or on job sites, improving overall safety.
- *Sustainability:* Traditional delivery trucks, especially those running on diesel, are significant contributors to carbon emissions. Drones are a greener alternative for many businesses whose focus is just developing on environmental sustainability. They can reduce fuel consumption compared to traditional delivery vehicles, contributing to a greener supply chain. Drones are a greener alternative for many businesses whose focus is just developing on environmental sustainability. These battery-operated, drones are more environmentally friendly as compared to

other vehicles. Electric drones offer a greener alternative to gas-powered delivery vans. For local deliveries with short lead times, drones are producing fewer emissions than road transport while being more efficient.

- *Scalability:* Drones offer scalability that traditional vehicles cannot match. As demand increases, a fleet of drones can be expanded more rapidly and at a lower incremental cost than hiring additional drivers and purchasing more vans. As operations expand, the drone fleet and supporting systems should be able to grow accordingly.

CHALLENGES

There are drawbacks to using drone technology. Despite all the benefits that drones can bring, there are many problems and challenges that drone operators face before they can fully implement drones in the supply chain. These challenges must be addressed in order to fully operate the drones in supply chains. Fully autonomous drones are prohibited, a remote pilot should always be present. The human workforce is worried about their future as robots start to replace them. Other challenges include the following [13]:

- *Regulations:* There are regulatory and security concerns surrounding the use of drones, particularly with regard to privacy and air traffic control. Governments around the world are still establishing drone regulations. The current regulations regarding drone operations in the United States are very complicated. Although regulatory issues, safety concerns, limited range, and payload capacity of current drone models have slowed drone adoption in the logistics industry, advances in technology and changes in regulatory policies are making it easier for companies to use drones. By investing in the right technology, training employees, and staying up-to-date with regulatory changes, companies can harness the potential of drones to improve their operations and better serve their customers.
- *Safety:* Companies must address safety concerns such as collisions, hacking, and privacy violations and invest in training employees to operate drones safely and effectively. Although, numerous problems could be identified with drone technology, companies are working to implement this technology by considering safety and reliability. As drones often come equipped with cameras and sensors, there is a heightened risk of infringing on individuals' privacy.
- *Public Perception:* As drone deliveries become more common, public perception is shifting

positively, which is crucial for widespread adoption. The future might worry workers as they feel targeted and soon stand the risk of being replaced by more efficient and accurate drones. Populating the skies with drones can be risky in urban areas as they have to consider multiple obstacles.

- **High Cost:** Drones can be expensive to purchase and maintain, and the cost of training staff to operate them can be prohibitive. Since drone technology is in its introductory phase, the cost of drones is very high. Even if the availability of affordable drones is increasing, the initial investment remains high, at least for most companies. Not to mention the regular maintenance check cost, repairs, and the training of the workers who do not especially know how to use specific drones.
- **Insurance:** The idea that an unmanned vehicle would be flying hundreds of feet above the ground, carrying valuable goods to be delivered does not sit well with insurance companies. Also, the fact that such an idea is largely untested makes it harder for the insurance company to consider insurance of drones. Additionally, if drones cause personal injury, then the compensation can be in millions of dollars.
- **Weather:** How will small drones fare against harsh weather conditions? Harsh weather can damage not only the drone but also the package it is carrying. Every country and every state has seasonal weather patterns with adverse weather condition occurring every now and then. The challenge for the drone technology would be to tackle this adverse weather condition.
- **Lack of Flexibility:** Traditional delivery systems use delivery personnel to deliver the parcel to concerned person in hand or drop it in a mailbox which will be secure. This is not possible using drone technology, as it can only drop a parcel in a relatively open area. Drone delivery does not provide the flexibility that is available with conventional methods.
- **Workforce:** The supply chain sector is pivotal to the global economy, yet it faces significant workforce challenges. According to the American Trucking Association (ATA), the truck driver shortage is expected to reach 160,000 job openings by 2030 if current trends continue. The aging workforce in logistics is another critical issue, with over 60% of truck drivers aged 45 or older. These trends highlight the urgent need for younger talent and to attract today's dynamic,

tech-savvy, school-age generation. One promising approach is integrating drone technology into K12 education, sparking early interest and providing students with hands-on experience in a tech-enabled industry. Drones, as autonomous vehicles, require students to understand the principles of automation, coding, and robotics.

- **Government Engagement:** Uncle Sam is taking a keen interest in securing the drone supply chain. The Federal Aviation Administration (FAA) has created rules around what drone owners can and cannot do. Commercial drones are still waiting for the approval of the FAA to be permitted to fly around delivering products. The FAA (website: www.faa.gov) is streamlining the process to allow the commercial use of drones, provided that they will not hinder or endanger the public or aircraft in urban areas.
- **Cybersecurity:** Drones have become a headache for cybersecurity professionals and law enforcement officials.

CONCLUSION

Drone is not just a tool of the future, but it is going to change the rules in supply chain management. Globally, drone production is interestingly strong. But when you look at it country by country, it is very different. Domestic drone production and supply chain capabilities are currently limited in the US. The supply chain sector for drones is not going to be competitive if they are not allowed to fly. It is like making cars without roads.

In recent years, there has been no shortage of media attention on both the positive and negative aspects of drone deployments. Drone has become a sought-after solution for many companies who are looking at these unmanned aircraft systems (UAS) as a viable tool to help with their supply chains. Drone delivery will also revolutionize customer expectations around what can be delivered. It will also impact how warehouses and distribution centers are designed and laid out. As drones continue to play a vital role in industries ranging from agriculture to public safety, ensuring the integrity of their supply chains is more critical than ever. Forward-thinking companies will plan today for a drone-enabled future. More information about drones in the supply chain industry can be found in the books in [14-16].

REFERENCES

- [1] "Drone in construction & infrastructure," <https://www.jouav.com/industry/drone-in-construction>
- [2] "How drones work and how to fly them," May 2024,

- <https://dronelaunchacademy.com/resources/how-do-drones-work/>
- [3] “What are the main applications of drones?” June 2024, <https://www.jouav.com/blog/applications-of-drones.html>
- [4] “Drones in manufacturing: A game-changer for industry,” <https://viper-drones.com/industries/infrastructure-drone-use/manufacturing/#:~:text=The%20integration%20of%20drones%20into,on%20manufacturing%20is%20no%20exception.>
- [5] “Amazon’s plans for delivery drones,” Unknown Source.
- [6] “Walmart seeks amazon-like drones for delivery,” https://www.robotics247.com/article/walmart_seeks_amazon_like_drones_for_delivery
- [7] “Drones in supply chain management - Warehouse, tracking, and delivery,” October 2019, <https://blog.freightpop.com/drones-in-supply-chain-management-warehouse-tracking-surveying-delivery>
- [8] “The drone revolution: How it may impact the supply chain,” July 2023, <https://softlinkglobal.com/the-drone-revolution-how-it-may-impact-the-supply-chain/>
- [9] “Securing the drone supply chain,” January 2025, <https://www.supplychainconnect.com/supply-chain-technology/article/55260234/securing-the-drone-supply-chain>
- [10] “Drones in supply chain,” <https://www.moduslink.com/blog/drones-in-supply-chain/>
- [11] “Drones in healthcare – Aiding medical supply chain,” November 14, 2021, https://roboticsbiz.com/drones-in-healthcare-aiding-medical-supply-chain/#google_vignette
- [12] “How drones can improve supply chain management efficiency,” Unknown Source.
- [13] “The pros and cons of drone technology in the supply chain,” November 2024, Unknown Source.
- [14] M. N. O. Sadiku, *Drones and Their Applications*. Xlibris, 2025.
- [15] P. R. Bates, S. Y. Lee, and T. Kille (eds.), *Unmanned Aerial Vehicles in Civilian Logistics and Supply Chain Management*. IGI Global, 2019.
- [16] A. Stokenberga and M. C. Ochoa, *Unlocking the Lower Skies: The Costs and Benefits of Deploying Drones Across Use Cases in East Africa*. World Bank Publications, 2021.



Figure 1 A typical drone [1].



Figure 2 A drone is usually controlled by operators on the ground [1].



Figure 3 An Amazon's drone delivery [5].



Figure 4 A Walmart delivery drone [6].



Figure 5 Some warehouse drones [9].



Figure 6 Some delivery drones [10].



Figure 7 A drone for delivering food [7].



Figure 8 A drone for medical delivery [11].



Figure 9 Drones can increase efficiency in SCM [12].