

Analysis of the Development of Drones and their Application in the Logistics Field

Qi Zhao*

The Experimental High School Attached To Beijing Normal University, Beijing 100032, China

*Corresponding author: Qi Zhao, 3563246750@qq.com

Copyright: © 2024 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: This study discusses the evolution of drone technology and its application in the logistics field, analyzes its impact on the logistics industry, and predicts future development trends. Through case study and technology comparison, this article thoroughly researches the technological development, classification, characteristics of drones, and their application in the logistics field. The application of drones in the logistics field has gradually become widespread, and it shows significant advantages in the aspects of aerial transportation of cargo, inventory management of warehouses, and planning of distribution routes. The results show that drone not only improves logistics efficiency and reduce cost but also have a unique value in special environments and emergencies.

Keywords: Drone; Logistics; E-commerce

Online publication: June 11, 2024

1. Introduction

With the rapid development of the economy, China's logistics industry is also developing rapidly, and the express delivery industry has become an important force in promoting social development. However, factors like the nonoptimal structure of the logistics industry and the limitations of information technology have hampered the speed and increased the cost of distribution. To address this issue, many companies began to use drones for cargo transportation ^[1]. In recent years, drone technology has been developing rapidly and has been used worldwide, and governments have introduced relevant policies to support the development of the drone industry. In May 2016, the U.S. Federal Aviation Administration (FAA) approved the use of drone delivery by Amazon.com, which opened the prelude to the commercial application of drones. In January 2017, companies such as DHL and UPS also announced that they would be launching drone delivery services in the next few years. In March 2018, FedEx launched a drone package delivery system called SpeedScan. In September 2019, SF Airlines and China Post cooperated to open the first drone route, marking the official operation of drones in the logistics field. In October of the same year, Jingdong launched the first large drone that can carry passengers and the Cargo-X Series Drone with plans to realize normalized operation in 2020.

2. The concept and classification of drones

2.1. The concept of drones

A drone is a kind of unmanned aircraft that can be controlled remotely. Different types of Drones have different purposes. Types of Drones include fixed-wing aircraft, helicopters, multi-rotor vehicles, and so on ^[2-3].

2.2. Classification of drones

Drones can be divided into three categories according to their functions. First are military drones mainly used for military reconnaissance and attack. Second are civil drones mainly used for agricultural production, geographic surveying and mapping, and television filming. Third are commercial drones mainly used in courier transportation, logistics, and distribution.

Furthermore, drones can be categorized according to their applications. Military drones are mainly used for battlefield reconnaissance, precision strikes, and anti-terrorism operations. Civil drones are mainly used for agriculture and forestry, plant protection, environmental monitoring, aerial photography, and express delivery. Commercial drones are mainly used in express transportation, logistics, and distribution.

At present, the mainstream drones locally and abroad are quad-axis fixed-wing drones, six-axis multi-rotor drones, and eight-axis multi-rotor drones. Among them, the four-axis fixed drone is small, lightweight, and stable, but it has low endurance and is unable to carry out long flights. The eight-axis multi-rotor aircraft is widely used in express logistics due to its vertical take-off and landing, adjustable height, and high load capacity.

3. Development history and current status of drone technology

3.1. Development history of drone technology

Drone technology has matured since its introduction in the 1950s. Drones were initially used in military fields for reconnaissance and surveillance. With the advancement of science and technology and the increasing demand for civil use, civilian drones gradually came into the public eye and began to be widely used in agriculture, forestry, transportation, and other fields ^[4].

At present, the global drone industry is in the stage of rapid development, and the United States, Japan, South Korea, and other countries occupy a leading position in this field. Among them, the United States is the world's largest manufacturer and exporter of drones, and its production of drones accounts for more than half of the global market share ^[5]. China, on the other hand, is one of the largest producers of drones in the world, but there is still a big gap compared with foreign countries ^[6]. According to statistics, there are more than 300 drone production enterprises in China, with an annual output value of tens of billions of RMB and more than 100,000 employees. However, due to constraints like limited technology, capital, and talent, the scale of China's drone enterprises is generally small, and it is difficult to form a large-scale operation ^[7]. In addition, there are some quality issues with China's drone products, especially in terms of reliability, stability, and safety compared with other countries.

3.2. Current situation of the drone technology industry

3.2.1. Status quo of military drones

The 2024–2029 China Drone Industry Market Research and Prospect Forecast Report released by China Business Industry Research Institute shows that the market size reached \$114.78 billion in 2022, a year-on-year growth of 2.85% (**Figure 1**).

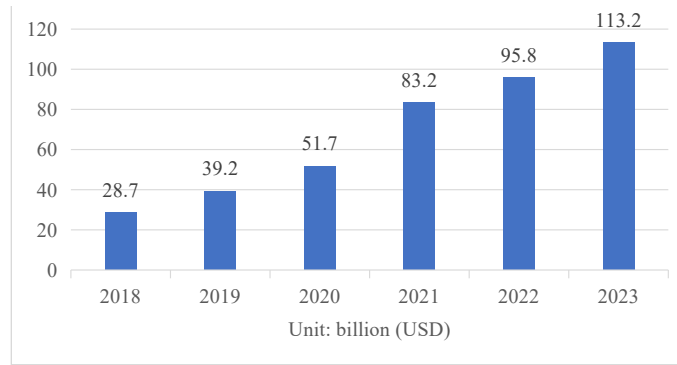


Figure 1. Global military drone market size and forecast, 2019–2021

3.2.2. Civilian drones

The 2024–2029 China Drone Industry Market Research and Prospect Forecast Report released by China Business Industry Research Institute shows that China’s civilian drone market size reached 119.6 billion yuan in 2022, which is a 37.63% annual increase (**Figure 2**).

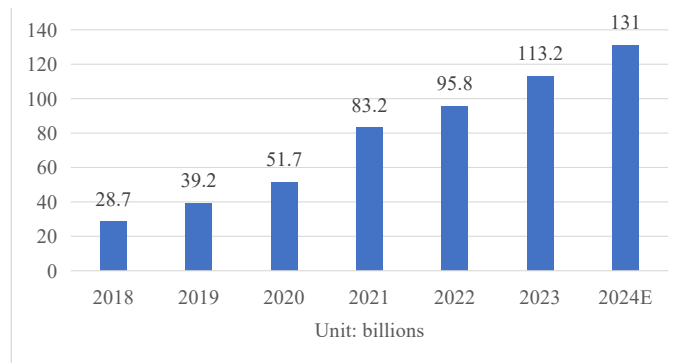


Figure 2. China civilian drone market size forecast, 2018–2024

3.2.3. Number of drone registrations

The 2023–2028 China Drone Industry Market Research and Prospect Forecast Report released by China Business Industry Research Institute shows that as of the end of 2022, a total of 958,000 drones were registered across the industry (**Figure 3**).

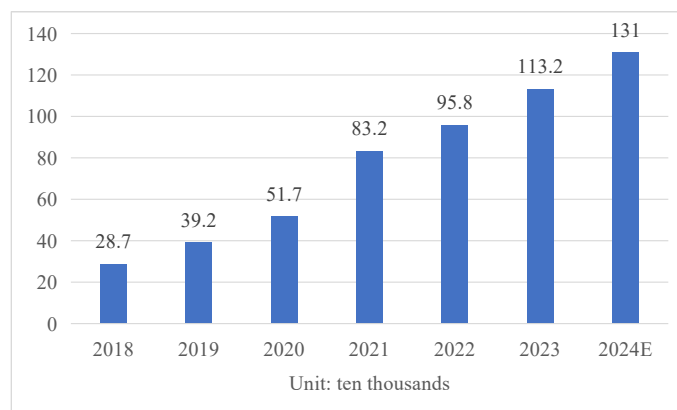


Figure 3. Forecast for the number of drones registered across the industry in China, 2018–2024

4. Application of drones in the field of logistics

The express delivery industry in China is currently marked by fierce competition among domestic e-commerce platforms, resulting in price wars and diminishing profit margins. Foreign logistics enterprises have been increasing their market share in the Chinese market ^[8]. Since 2016, drone delivery has gradually become a new trend, and large express delivery companies such as SF, Yuantong, and other large express delivery companies have launched their own drone delivery services to stand out amidst the fierce market competition.

Take Amazon as an example, it launched its drone delivery business as early as 2013, and in May 2014, it was officially put into operation. Amazon's drone delivery has two main purposes, which are to provide delivery services for remote areas and to provide customers with a convenient shopping experience ^[9]. Amazon has carried out delivery services by drones in many places in the United States, including cities such as New York City, Los Angeles, Chicago, and Dallas. According to statistics, Amazon drones performed more than 650,000 deliveries in the United States as of July 2018, with a total of 75,000 flights.

4.1. Aerial transportation of goods

The most direct and significant application of drones in logistics is the aerial transportation of goods. By using drones for aerial transportation, logistics companies can bypass land traffic congestion and shorten transportation time, thus improving overall transportation efficiency ^[10]. Drones are especially suitable for scenarios such as cross-city deliveries, deliveries to mountainous or remote areas, or emergency material transportation, which substantially improves the flexibility and responsiveness of logistics services.

4.2. Warehouse inventory management

Drones also play an important role in warehouse management. Using the high-definition camera and image recognition technology carried by drones, inventory counting can be carried out automatically. This eliminates the inefficiencies and errors associated with manual counting. Drones navigate freely within warehouses, capturing images of goods on shelves. Through image processing software, they swiftly and accurately determine inventory quantities and distribution.

4.3. Distribution route planning

The drone distribution system can intelligently plan the optimal distribution routes according to real-time traffic information, weather conditions, and cargo demand. Through advanced algorithms and data analysis, the drone can choose the shortest, fastest, and safest flight path to improve distribution efficiency and reduce transportation costs.

4.4. Real-time monitoring and tracking

Drones are equipped with GPS positioning systems and real-time communication technology, which can realize real-time monitoring and tracking of goods ^[11]. Logistics companies and customers can view the location, speed, and transportation status of the goods in real-time through cell phones or computer terminals to ensure the safe delivery of goods and improve customer satisfaction.

4.5. Emergency handling

Drones can respond quickly in emergencies, reducing labor costs and safety risks. In natural disasters, rescues, and other emergency operations, drones can quickly fly to the scene and carry out tasks such as material placement and personnel search and rescue, providing strong support for rescue work.

4.6. Strong environmental adaptability

Drones exhibit exceptional adaptability to diverse environments. Whether it is facing challenging weather conditions like high temperatures, rain, snow, or haze, or navigating through complex terrains such as mountains, swamps, or water bodies, Drones maintain stability and reliability. This is achieved through the use of specialized equipment and advanced technical capabilities.

5. Laws and regulations related to the development of drone logistics

To promote the development of drone logistics, China has also issued a series of laws and regulations to regulate the development of the drone industry. On July 1, 2016, the Interim Provisions on the Administration of Civilian Unmanned Aerial Vehicle System Pilots issued by the Civil Aviation Administration of China (CAA) came into effect, which stipulates the real-name registration of drones, the operation area, as well as the altitude and speed of flight. In addition, the CAA issued two documents, the Administrative Measures for the Operation License of Civilian Unmanned Aircraft Systems (for Trial Implementation) and the Administrative Provisions for the Real-Name Registration of Civilian Unmanned Aircraft Systems, to further improve the drone operation license and authentication.

On March 27, 2018, the National Development and Reform Commission (NDRC) and the Ministry of Transportation (MOT) jointly issued the Opinions on Policies and Measures to Support the Development of Logistics and Distribution Enterprises. It was proposed to encourage the adoption of advanced technology and equipment to improve logistics and distribution efficiency. Subsequently, the General Office of the State Council issued the Opinions on Further Strengthening the Safety Management of Drones on February 28, 2019. This directive emphasized the importance of conducting pilot work while prioritizing safety and advocated for the gradual expansion of pilot programs. This marked the first instance of the Chinese government officially recognizing the application of drones in logistics, signifying the legitimization of drone usage in this field.

6. Prospects of drones in the field of logistics

With advancements in science, technology, and societal advancements, drones will play an increasingly important role in the logistics field in the future. First of all, drones can effectively improve the efficiency of logistics. Their ability to operate at varying altitudes and speeds, and carry diverse loads enables them to mitigate challenges posed by urban traffic congestion and facilitate the transportation of goods in remote regions ^[12]. Secondly, drones can provide more choices for logistics enterprises. There are already many types of drone products on the market, such as fixed-wing drones, vertical take-off and landing drones, and so on. These products can be customized according to different needs. In addition, drones can also be equipped with high-tech technologies such as intelligent navigation systems and automatic obstacle avoidance systems, thus further improving the quality of logistics services. Finally, drone logistics can also realize the innovation of traditional logistics. Due to the relative advancement and low cost of drone technology, it can effectively reduce logistics costs. Furthermore, drones do not cause any pollution during their operation, making them environmentally friendly. In short, with the development of e-commerce and people's desire for a better life, the future of drone logistics will usher in broader development prospects.

7. Conclusion

As drone technology continues to evolve, its applications, especially in logistics, are expanding. Drones offer

solutions to challenges like traffic congestion and environmental pollution in the logistics industry. However, drone development in logistics is still in its infancy, with many unresolved issues. To maximize the potential of drones, efforts should focus on the following aspects: enhancing the legal and regulatory framework for drones; expediting the establishment of drone infrastructure; strengthening the training of drone professionals; and facilitating the growth of the drone-related industrial chain. Addressing these tasks effectively will enable wider drone adoption in logistics, revitalizing the logistics sector.

The future of the drone industry confronts various challenges, such as technological advancements and cost management. Continuous exploration and innovation are imperative for achieving the sustainable growth of the drone sector. Additionally, governmental and regulatory bodies should actively implement policies and foster a conducive environment for drone industry development. This concerted effort is essential for the orderly progression of the drone industry.

Disclosure statement

The author declares no conflict of interest.

References

- [1] Meng F, Zhang H, Zhu Y, 2022, Development Trend of Maritime Reconnaissance and Surveillance Drones. *National Defense Science and Technology*, 43(2): 33–38.
- [2] Huang Z, 2021, Development of Unmanned Aircraft and Drone Technology. *Automation Today*, 2021(7): 23–24.
- [3] Zhao Z, 2016, Prospect and Practicality of Drone Development. *Science and Technology Innovation and Application*, 2016(25): 95.
- [4] Lan Y, Chen S, Deng J, et al., 2019, Analysis of the Development Situation and Problems of Plant Protection Drones in China. *Journal of South China Agricultural University*, 40(5): 217–225.
- [5] Yang H, 2020, 5G Communication Technology to Promote the Development of Military Drones. *Network Security Technology and Application*, 2020(12): 92–93.
- [6] Huang K, Jin J, Zhang Y, et al., 2023, Current Situation and Trend Outlook of Drone Development in China. *Xiamen Science and Technology*, 2023(1): 59–62.
- [7] Ma F, Zhang Z, Xu J, 2023, Design of Automatic Unloading Device for Unmanned Aircraft Logistics System. *Packaging and Food Machinery*, 41(1): 102–106.
- [8] Jin B, Liu Z, Liu A, 2024, A Review of Drone Logistics Research and CiteSpace Visualization Analysis. *Journal of Chengdu Institute of Technology*, 27(1): 69–74 + 81.
- [9] Sun B, Guo Y, 2023, Analysis of Hotspots and Trends of Domestic Drone Logistics Research. *Journal of Shijiazhuang Railway Vocational and Technical College*, 22(3): 101–106.
- [10] Tong G, Chen Z, Wang F, et al., 2022, Design and Optimization of Unmanned Aircraft Logistics System. *Mechanical Design and Manufacturing*, 374(4): 279–283.
- [11] He M, Yang W, 2023, Research on Drone Logistics and Distribution Path Control Based on GPS/INS. *Information Recording Material*, 24(3): 230–232.
- [12] Chen M, 2020, Trends in Drone Logistics and Distribution Services. *Logistics Engineering and Management*, 42(10): 90–92.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.