Feasibility Study of Drone Delivery: Taking Meituan as an Example

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Abstract. With the development of technology and the growth of consumer demand, drone delivery has gradually become a research hotspot in the field of logistics. Utilizing the case of Meituan's drone delivery service as a exemplar, the present study delves into the utilization of drone delivery within the sphere of urban low-altitude logistics. It meticulously examines the technical merits, operational impediments, and the repercussions of this innovative mode of conveyance on the conventional distribution sector. Investigations indicate that the deployment of drone delivery systems is capable of effectively addressing the "last mile" distribution challenge within urban environments, enhancing the efficiency of logistics operations, diminishing associated costs, and affording consumers an enhanced level of convenience in their service experience.Nevertheless, the deployment of drone delivery continues to encounter a multitude of challenges encompassing technological constraints, regulatory hurdles, economic expenditures, and societal acceptance. The present article performs a comprehensive examination of various aspects within the domain of drone delivery, thereby offering valuable insights into the viability of this mode of delivery.

Keywords: Drone delivery; urban low altitude logistics; meituan; instant delivery; technical challenges.

1. Introduction

The rapid advancement of e-commerce and modern logistics has accentuated the dichotomy between the escalating demand for online shopping and the comparatively sluggish progress in traditional property management. Conventional delivery approaches have proven inadequate in satisfying consumers' increasing desire for swift and convenient service options. In this context, drone delivery, as an innovative mode of logistics, has garnered significant interest from both industry and researchers, owing to its distinct benefits. As a preeminent lifestyle service e-commerce platform within the Chinese market, Meituan has been proactively venturing into and experimenting with drone delivery technology in recent years. This research exemplifies Meituan's drone delivery service, with the objective of dissecting the present deployment of drone delivery within the urban low-altitude logistics sector. It seeks to investigate the potential of drone delivery to elevate delivery efficiency, curtail operational expenses, and augment the overall user experience. Concurrently, the study identifies and scrutinizes the primary challenges currently encountered, encompassing technological impediments, regulatory constraints, cost management, and societal endorsement. It subsequently formulates pertinent countermeasures and recommendations to serve as a reference for the prospective evolution of drone delivery services.

By examining Meituan's drone delivery initiatives, this article not only furnishes a case study for the tangible application of drone delivery technology but also introduces a novel perspective to the scholarly inquiry into urban low-altitude logistics. As technology advances continuously and the regulatory framework improves incrementally, it is anticipated that drone delivery will assume an increasingly pivotal role within the future urban logistics ecosystem.

2. The Development History and Current Status of Meituan's Unmanned Aerial Vehicle Delivery Technology

With the rapid development of drone technology, drone delivery, as an emerging logistics delivery method, has gradually entered our field of vision. Since 2016, Meituan has been developing unmanned delivery systems with the aim of quickly applying them to delivery services, mainly focusing on core businesses such as food delivery and flash sales; In 2017, Meituan began exploring drone delivery technology, with a focus on building a low altitude delivery network for fast and close range delivery; From 2018 to 2020, Meituan implemented unmanned aerial vehicle (UAV) delivery services internally and conducted large-scale testing. Despite the impact of the epidemic, Meituan still persisted in research and development, continuously optimizing its technology; In 2021, Meituan successfully released the FP400 series of new self-developed drones specifically designed for urban terminal scene delivery, thus building a comprehensive delivery ecosystem of "heaven, earth, and people" for drones, unmanned vehicles, and riders, turning the dream of "everything at home" from ideal to reality. As of June 2021, more than 200000 test flights have been conducted in Shenzhen, and over 2500 actual orders have been delivered [1], improving efficiency by nearly 40% compared to traditional models. Meituan's drone delivery technology has achieved initial scale operation. In August 2022, the China Civil Aviation Management Cadre College, Xunyi Technology, Civil Aviation University of China, Meituan, SF Express and other units jointly drafted the relevant drone route planning standards. This standard is the first drone route standard proposed by the Civil Aviation Administration of China for urban scenarios and also marks the entry of urban air logistics into the era of standardization [2]. In 2023, Meituan's research and development expenditure on drone technology reached 21.2 billion yuan, and the drone business has received continuous investment and support as part of the company's technological innovation. In February of the same year, Meituan acquired the opportunity to build a city-level cargo airline for commercial operations of urban low altitude logistics networks. As of October 2024, according to data from the official website of Meituan, there are over 400 patents related to Meituan drones and over 300000 completed orders for delivery. In an ideal scenario, drones can cover an area with a radius of 3 kilometers in just 400 seconds, which is faster than road speeds. When encountering bridge repair, road excavation, tunnel construction, as well as extreme weather and environment, it can better ensure the safety of riders and improve user experience, creating a 15-minute urban living circle [1]. Mao Yinian, Vice President and Head of Drone Business at Meituan, speculates that by around 2030, the platform will generate hundreds of drone delivery orders per week; Some industry insiders predict that by around 2030, orders delivered by drones will account for 10% to 20% of platform orders[2].

3. The Advantages of Drone Delivery

After receiving the user's order, the rider goes to the merchant to pick up the goods and deliver them to the departure airport. After loading the cargo box, the drone delivers the goods to the destination community delivery station according to the route planned by the UTM backend system. The user can scan the code on their mobile phone to open the community delivery station grid to pick up the goods. In the future, it will also support various pickup methods such as robot pickup and indoor cargo hold.

3.1. Fast Speed

Drone delivery can significantly shorten delivery time, fly over terrain obstacles and traffic congestion, achieve point-to-point linear delivery, and is not affected by traffic conditions, greatly improving delivery speed and efficiency. For example, the environment of scenic spots is complex, and it takes a long time for delivery drivers to find the specific location of users in the park, which makes it difficult to guarantee the user experience. After using drones for delivery, users only need to walk to the airdrop cabinet in the park to pick up their meals, which not only saves a lot of communication time, but also reduces delivery time by nearly half compared to the past.

3.2. High Flexibility

Drones ignore terrain limitations and can deliver in small or difficult to reach areas, such as mountainous regions, remote areas, or high-rise buildings in cities where delivery is inconvenient; Replacing manual delivery with drones in extreme weather and harsh environments reduces the risk of personnel on the road and improves the safety of manual delivery; Drones can avoid ground traffic congestion, have no impact on ground traffic, reduce the occurrence of traffic accidents, directly deliver to destinations, break through geographical limitations, and improve the flexibility of delivery. For example, during the outbreak of the COVID-19 in 2022, Meituan UAV began to carry out regular nucleic acid sample transportation in Hangzhou from May 20. As of August 16, 4.33 million nucleic acid samples had been delivered accumulatively [2].

3.3. Low Cost

Although the initial investment cost of drone delivery is relatively high, in the long run, drone delivery can reduce overall operating costs, reduce reliance on delivery personnel, and thus lower labor costs, especially during peak hours and special environments; Drones use batteries as a power source and do not produce exhaust emissions during operation, which is not only more environmentally friendly but also reduces fuel consumption and dependence. Professional data shows that the terminal delivery process of logistics and distribution occupies 20% -40% of the delivery time of a single delivery by delivery personnel. And drones precisely connect the last 100 meters of logistics and distribution, reducing the cost of manual delivery.

3.4. Technological Innovation

Drone delivery integrates multiple advanced technologies such as artificial intelligence, machine learning, sensor technology, etc., driving technological progress in the logistics industry. Drones can collect geographic information and traffic data during the delivery process, providing valuable data support for logistics companies to optimize delivery routes and strategies.

Meituan drones have always been committed to providing users with low altitude and timely delivery services in urban scenarios and promoting the transformation of fulfillment tools through technological innovation. The fourth-generation drone of Meituan can operate autonomously in moderate rain and snow conditions, regardless of cold or hot weather, as well as wind and rain hazards. It has low noise, a maximum load capacity of 2.5 kilograms, a maximum return radius of five kilometers, and a maximum speed of 83 kilometers per hour. The fourth generation unmanned aerial vehicle supports IP45 protection, with an independent computing platform that can reach up to 30 tops. It is equipped with an external recording camera and two 4D millimeter-wave radars and supports redundant backup of perception navigation planning. Based on 3IMU redundancy and dual redundancy flight control architecture, even with a single flight control time, it can continue to fly without sensing. Human machine collaboration can be achieved in various scenarios such as communities, shopping malls, scenic spots, and office buildings to complete delivery and bring everything home.

4. Comparison between UAV Distribution and Traditional Distribution

4.1. Service Model Transformation

Traditional delivery companies need to consider how to integrate drone technology, improve their service efficiency and quality, upgrade technology and innovate services, and promote the transformation of some manpower towards technology.

Throughout the entire drone delivery process, delivery personnel remain a crucial link, and it is expected that a collaborative delivery system between drones will emerge in the future. Mao Yinian, the head of Meituan's drone department, once mentioned that delivery personnel will undergo a career transformation. Previously, the tools used by delivery personnel were electric vehicles, with one

delivery personnel corresponding to one electric vehicle. In the future, the delivery personnel's tool will be drones, and one person can command multiple drones for delivery. The delivery personnel will also be technicians. Delivery personnel may also be mall pickups or community delivery personnel, greatly shortening the delivery chain. The delivery personnel undertake the delivery of '100 meters in sequence' and actively interact with machines, such as delivery robots inside the building, to form a complete delivery system. True intelligence is about freeing up people's hands and allowing them to further exert more initiative. The future blue-collar workers may not be the workers we understand now, but rather those who can check the operation of intelligent front-end and terminal and solve related service problems. In the non-contact economic situation, it is not that manpower is not needed, but rather that blue-collar workers need to become a group of workers who can master new technologies. From the perspective of the industrial chain, the non-contact economy has a strong and diversified demand for both software and hardware scenarios. Each field will form a vertically deep development chain, which will give rise to more new industries and fields, and also require new blue-collar workers in the era of intelligence [3].

4.2. Employment Direction

Traditional logistics delivery is purely manual, but its efficiency is greatly reduced in extreme conditions and emergency situations. Drone delivery is aimed at achieving high timeliness and complex terrain delivery, including delivery difficulties in extreme weather, epidemics, and other situations, and more importantly, to make up for the work that delivery drivers cannot complete. Drone delivery may reduce reliance on traditional delivery personnel, which has a certain impact on the job market. New techniques may reduce traditional delivery positions, but at the same time, it will also create new employment opportunities, such as drone operators, maintenance personnel, etc.

4.3. Security

The traffic violations such as running red lights, going in the wrong direction, and speeding committed by delivery personnel under the requirement of "on-time delivery" are becoming increasingly prominent. The traffic accidents caused by food delivery are also increasing year by year and are becoming a major hidden danger that causes and endangers urban traffic safety. Drone delivery can reduce the risk of personnel on the road. From December 1st to 15th, 2021, the number of traffic violations committed by food delivery drivers reached 8311, making it one of the industries with high traffic violations. In Shanghai, on average, one delivery rider is injured or killed in a traffic accident every 2.5 days [4]. In severe weather or dangerous areas, the safety of riders cannot be guaranteed, and drones can replace manual delivery to ensure the safety of riders during the delivery process.

5. Challenges Faced by Drone Delivery

5.1. User Privacy and Security

Drone delivery not only improves delivery efficiency but also faces issues of user privacy and security. Drones may use devices such as GPS and cameras during the delivery process, which may violate consumers' privacy rights. In addition, once a drone crashes, it may cause safety issues such as fires. Therefore, how to effectively protect user privacy and security while ensuring delivery efficiency is an important issue that needs to be addressed in drone delivery[5].

5.2. Technical Challenges

At present, the cost of drone delivery is still higher than that of human labor, with technology research and development and the supply chain of accessories such as batteries being the main costs. Technical issues such as drone load capacity, endurance, and safety still need to be further addressed. Despite the many advantages of drone delivery, its technological bottleneck cannot be ignored. Firstly,

air traffic management is a complex issue that requires the establishment of a comprehensive flight management system to ensure the safety of drones in the air. Secondly, the precision of autonomous driving and flight safety are also urgent technical challenges that need to be addressed[6].

5.3. Social Background Support

Consumers' acceptance and trust in drone delivery need to be gradually established. Drone delivery is not an independent thing, it often relies on new things produced by the entire digital and intelligent society. Drone delivery requires good infrastructure support, complete and efficient route planning, and a smooth operating environment.

6. Future Prospects of Drone Delivery

With the advancement of technology, the technological bottleneck of drone delivery will gradually be resolved. As the production scale of drones expands, manufacturing costs will decrease. In the future, drones will become more intelligent, safe, and reliable, providing strong support for the widespread application of drone delivery[7].

With the widespread application of drone technology and the gradual improvement of regulations, the commercial application of drone delivery will become more convenient. Governments of various countries will gradually establish and improve relevant regulations and standards for drone flight, providing guarantees for the legal and compliant operation of drone delivery.

The market prospects for drone delivery are broad. With the maturity of technology and the improvement of regulations, drone delivery will gradually expand from the food delivery field to the delivery of special scenarios such as drugs and emergency supplies. This will open up a broader market space for drone delivery and enrich its application areas[8].

7. Conclusion

As an emerging logistics delivery method, drone delivery is gradually changing the face of the traditional logistics industry with its unique advantages. Taking Meituan as an example, through its active exploration and practice in the field of drone delivery, we can see the enormous potential of drone delivery in terms of speed efficiency, cost-effectiveness, technological innovation, and market expansion. Looking ahead, with the advancement of technology and the reduction of costs, drone delivery is expected to become an important component of logistics distribution in the future. With the continuous maturity of technology and the gradual improvement of regulations, drone delivery will gradually expand from the food delivery field to more fields, such as the delivery of drugs, emergency supplies and other special scenarios. This will open up a broader market space for drone delivery, enrich its application areas, and provide strong support for the long-term development of e-commerce platforms. The active exploration and practice of enterprises such as Meituan in the field of drone delivery not only bring competitive advantages to themselves, but also provide useful reference and inspiration for the future development of the entire industry.

The utilization of drone delivery, an innovative mode of logistics distribution, has demonstrated its capacity to enhance distributional efficiency, curtail operational expenses, and broaden the serviceable range. As technological advancements persist and regulatory frameworks are refined, it is anticipated that drone delivery will garner a broader application in the future, emerging as a pivotal catalyst for transformation within the logistics distribution sector. The proactive development of drone delivery is instrumental in fostering the construction of a symbiotic relationship between humanity and technology.

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