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Trends of Unmanned Aerial Vehicles in Logistics Delivery

[1]Huu-Tho Nguyen, [2]Ihwan Ghazali*
Corresponding Author: * ihwan@utem.edu.my
[1] Nguyen Tat Thanh University, Vietnam
[2] Universiti Teknikal Malaysia Malaka, Malaysia

Abstract

The integration of unmanned aerial vehicles (UAVs) in logistics operations has attracted significant attention due to their potential to revolutionize delivery processes. This abstract provides an overview of the trends and advancements in utilizing UAVs for logistics. The study explores the current research landscape, identifies key challenges, and offers insights into the future applications of UAVs in logistics. By analyzing a range of scholarly articles, this abstract aims to illuminate the evolving role of UAVs in optimizing delivery efficiency, reducing costs, and addressing logistical complexities. Additionally, the abstract highlights the necessity for further research to address emerging issues and maximize the benefits of UAV technology in the logistics sector.

Keywords: *Logistics Delivery, Remote Area, Technolocy, Unmanned Aerial Vehicles*

Introduction

In contemporary discourse, the interchangeable use of the terms "unmanned aerial vehicle" (UAV) and "drone" reflects a complex interplay between technological advancements, societal perceptions, and evolving applications [1]-[3]. In essence, an "unmanned aerial vehicle" denotes any aircraft that operates without a human pilot onboard, relying instead on remote control systems or autonomous programming for navigation and operation. With its broader scope, this term acknowledges the diverse array of unmanned aircraft, ranging from miniature quadcopters to sophisticated surveillance drones with long-range capabilities.

Conversely, the term "drone" has emerged as a colloquial term often associated with the proliferation of consumer-grade unmanned aircraft [4]-[6]. Initially popularized through recreational hobbyists and enthusiasts, drones have become pervasive in various aspects of modern life. Filmmakers use them to capture breathtaking aerial footage and e-commerce giants to facilitate rapid deliveries. The term "drone" is associated with the image of sleek, compact aerial vehicles buzzing through the skies, which represents the democratization of aviation technology. However, within military contexts, the term "drone" assumes a more significant connotation, representing cutting-edge tools of warfare and reconnaissance. Military drones, which are equipped with advanced surveillance systems and, in some cases, lethal armaments, have revolutionized modern warfare by enabling precision strikes while minimizing risk to human personnel. In this context, the term "drone" is closely associated with strategic operations, intelligence gathering, and the unintended consequences of remote warfare. This study also noticed the current trend of unmanned Aerial Vehicles in Logistics Delivery publication in Scopus (Accessed on 25 May 2024) as served in Fig 1.

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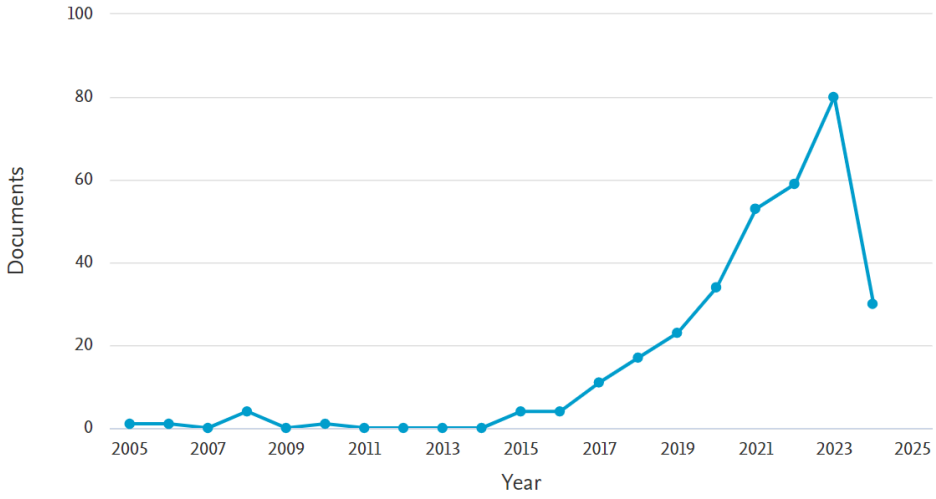

Fig. 1. Research trends unmanned aerial vehicles in logistic delivery

Despite the existence of these distinctions, the boundaries between "unmanned aerial vehicles" and "drones" are becoming increasingly indistinct as technology continues to evolve. The distinction between civilian and military applications has become increasingly blurred, with commercial drones adopting military-grade capabilities and military drones finding civilian applications in disaster response, environmental monitoring, and beyond. In navigating this semantic labyrinth, it is of the utmost importance to recognize the nuanced nuances inherent in these terms and their contextual implications. Whether discussing the recreational pastime of flying drones in a local park or deliberating the ethical implications of autonomous military drones, it is essential to have a clear understanding of the terminology involved. This is the first step towards engaging in meaningful discourse about the future of unmanned aviation and its impact on society.

Discussion

The use of drones in the field of logistics delivery is one area of application that continues to experience exponential growth. The technology offers several benefits, including increased efficiency, reduced operational costs, and the ability to reach areas that are difficult to access.

A. Logistics Efficiency

The deployment of UAVs has the potential to optimize logistics processes by reducing delivery times and costs. These drones can facilitate the expedited delivery of goods with consistent speeds, negating the need for rest periods, and thereby enabling logistics companies to transport goods more quickly. Ref. [7] researched to investigate the impact of drone delivery on logistics efficiency. The study demonstrated that UAVs could significantly reduce delivery times in comparison to traditional ground transportation methods. By employing drones for last-mile deliveries, logistics companies were able to accelerate the shipping process and enhance overall operational efficiency.

Moreover, a study by Ref. [8] examined the cost-effectiveness of utilizing drones for logistics operations. The research demonstrated how UAVs could streamline delivery routes, minimize fuel

consumption, and reduce operational expenses. By optimizing delivery routes and eliminating unnecessary stops, drones enabled logistics companies to achieve cost savings and enhance their competitive edge in the market. Furthermore, a report by the World Economic Forum (WEF) underscored the potential of drones to revolutionize the logistics industry. The World Economic Forum (WEF) posited that unmanned aerial vehicle (UAV) technology could revolutionize supply chain management by enabling faster and more efficient deliveries. The integration of drones into logistics operations allows companies to achieve faster order fulfillment, reduce shipping costs, and enhance customer satisfaction through timely deliveries.

The utilization of UAVs in logistics can optimize delivery processes by reducing transit times and lowering shipping costs. Drones offer a reliable and efficient means of transportation that can operate continuously without the need for breaks, thereby enabling logistics companies to expedite deliveries and meet customer demands more effectively. The integration of unmanned aerial vehicle (UAV) technology into logistics operations has the potential to enhance efficiency, reduce costs, and improve overall service quality in the logistics industry.

Fig. 2. Autonomous VTOL cargo systems (Source: https://www.aerospacetestinginternational.com/videos/cargo-drone-achieves-first-flight.html)

B. Accessibility

The advent of UAVs, or drones, has transformed how we access and navigate challenging terrains, including remote areas and regions with difficult topography. These technological advancements have significantly enhanced the efficiency and effectiveness of reaching locations that were previously inaccessible by ground vehicles. A study by Ref. [9] demonstrated the potential of drones in the delivery of medical supplies to remote areas. The research demonstrated how UAVs could overcome geographical barriers and deliver essential medical supplies to areas with limited access to healthcare facilities. The utilization of drones demonstrated a notable reduction in delivery times and costs when compared to traditional ground transportation methods [10]-[12].

Moreover, a research article by Ref. [13][14] examined the utilization of drones in disaster relief operations. The study demonstrated the deployment of UAVs to deliver aid to disaster-stricken areas with impassable roads or destroyed infrastructure. The deployment of drones proved to be an invaluable asset in providing timely assistance to affected populations, as they were able to access and navigate through challenging terrains with remarkable efficiency.

Furthermore, a report published by the World Food Programme (WFP) has identified the advantages of utilizing drones for the delivery of humanitarian aid in conflict zones. The WFP employed UAVs to deliver food and supplies to areas with security risks and limited accessibility. The report underscored the capacity of drones to facilitate the delivery of aid to vulnerable populations in conflict-affected regions, thereby exemplifying the pivotal role of UAVs in surmounting logistical obstacles in humanitarian operations. In general, the deployment of drones in the delivery of healthcare, disaster relief, and humanitarian aid has proven to be a transformative development in various fields [15]. These technological innovations have significantly enhanced the accessibility of critical services and supplies in areas that were previously inaccessible by traditional means. The continued advancement and integration of UAV technology hold great promise in further enhancing accessibility to remote regions and overcoming logistical barriers in the delivery of essential resources.

C. Monitoring and Security

The advent of UAVs has transformed the landscape of logistics operations, offering a novel approach to real-time monitoring of shipments. This capability plays a pivotal role in reducing the likelihood of incidents such as theft or damage to goods during transportation. A study conducted by Ref. [16] examined the potential of drones for real-time monitoring of logistics operations. The study demonstrated how UAVs equipped with advanced tracking systems could provide continuous surveillance of shipments throughout the delivery process. By employing drone technology, logistics companies have been able to monitor cargo in transit, identify any anomalies, and take prompt action to mitigate potential risks, such as theft or damage.

Moreover, a case study by Ref. [4] demonstrated the advantages of utilizing drones for the monitoring of perishable goods during transportation. The research demonstrated the potential of UAVs equipped with temperature sensors and cameras to monitor the condition of sensitive cargo in real-time. By continuously monitoring temperature fluctuations and potential damage, logistics companies were able to guarantee the integrity of perishable goods and take proactive measures to prevent spoilage or losses. Furthermore, a report by the International Air Transport Association (IATA) underscored the significance of drones in bolstering supply chain security and risk management. The IATA emphasized that UAVs could provide real-time visibility into logistics operations, enabling companies to identify and address potential risks promptly. By integrating drones into their monitoring systems, logistics companies can enhance the security of shipments and minimize the impact of unforeseen events during transportation.

D. Air Regulation and Safety

The deployment of UAVs necessitates the implementation of rigorous regulations to guarantee the security of flight operations and the protection of individual privacy. The establishment of transparent guidelines and rigorous regulations is of paramount importance to prevent incidents and the unsafe usage of drones. In their research, Ref. [17] explored the significance of regulatory frameworks for UAV operations.

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Fig. 3. An airborne Detect and Avoid (DAA) radar on a small Unmanned Aerial Vehicle (sUAV) (Source: https://www.dpaonthenet.net/article/126133/Enabling-cars-and-drones-to-sense-the-world.aspx)

The study underscored the necessity for comprehensive guidelines to govern drone flights, emphasizing the significance of regulations in ensuring airspace safety and mitigating potential risks associated with unmanned aircraft. By establishing clear rules and standards, regulatory bodies can effectively manage drone operations and safeguard against accidents or unauthorized drone activities.

Moreover, a report published by the Federal Aviation Administration (FAA) delineates the regulatory stipulations about drone operations within the United States. The FAA's guidelines encompass registration procedures, airspace restrictions, and operational limitations, which collectively promote safe and responsible drone usage. The objective of these regulations is to safeguard the integrity of the airspace, to prevent collisions with manned aircraft, and to guarantee the safety of the public and the protection of their privacy.

Fig. 4. MQ-4C Triton Maritime Surveillance Unmanned Aircraft System (Source: https://globalmilitaryreview.blogspot.com/2013/05/mq-4c-triton-broad-area-maritime.html)

Moreover, a study by Ref. [18] examined the implications of drone technology on privacy and the necessity for robust privacy regulations. The research highlighted the potential privacy risks posed by

drones, including unauthorized surveillance and data collection. To address these concerns, the study recommended the implementation of comprehensive privacy regulations to govern drone operations and protect individuals' privacy rights.

The deployment of UAVs necessitates the establishment of a robust regulatory framework to ensure the safety of flights and the protection of privacy. Clear rules and stringent regulations must be established to prevent incidents, promote responsible drone usage, and safeguard privacy rights. By establishing comprehensive guidelines for drone operations, regulatory authorities can effectively manage the risks associated with UAVs and foster a safe and secure environment for drone activities. The trend compilation of unmanned aerial vehicles in logistic delivery is served in Table 1.

Table 1. The trend of Unmanned Aerial Vehicles in Logistics Delivery

Trend	Description	Impact
Logistics Efficiency		
Route Optimization	Use of AI and machine learning to optimize delivery routes.	Reduces delivery times and operational costs.
Autonomous Operation	Development of fully autonomous UAVs for delivery tasks.	Minimizes human intervention, increasing efficiency.
Faster Deliveries	UAVs enable rapid delivery, especially for short distances.	Meets customer expectations for quick service.
Accessibility		
Remote Areas	UAVs can access remote or hard-to-reach areas.	Provides delivery services to underserved regions.
Urban Environments	Development of UAV systems tailored for dense urban environments.	Solves last-mile delivery challenges in cities.
Cost Reduction	Decreasing costs of UAV technology and operations.	Makes UAVs accessible to smaller businesses, expanding market reach.
Monitoring and Security		
Real-time Tracking	Integration with IoT for real-time tracking and monitoring.	Enhances transparency and allows for precise delivery tracking.
Data Encryption	Implementation of advanced data encryption methods for secure communication.	Protects sensitive delivery information and increases trust.
Geofencing	Use of geofencing technology to restrict UAV operations to specific areas.	Prevents UAVs from entering unauthorized or unsafe zones.
Air Regulation and Safety		
Evolving Regulations	Governments are updating regulations to accommodate UAV operations.	Facilitates broader deployment while ensuring safety and compliance.
Safety Protocols	Development of safety protocols and standards for UAV operations.	Enhances safety and reliability of UAV deliveries.
Pilot Programs	Collaboration between companies and governments to test UAV delivery systems.	Accelerates innovation and helps shape regulatory frameworks.

Conclusion

This study addressed the identified research gap by providing valuable insights into the utilization of UAVs in optimizing logistics operations. The findings of the study have demonstrated the considerable impact of drones in reducing delivery times and costs, thereby enhancing operational efficiency in the logistics industry. While the research has illuminated the advantages of UAV technology, it is essential to recognize the constraints of the study, including the necessity for further investigation into specific operational facets of drone logistics. The anticipated outcomes regarding the enhanced efficiency and reduced costs associated with drone deliveries were validated, while unanticipated outcomes may include unforeseen challenges in regulatory compliance or technological integration. For

future studies, it is recommended that the regulatory frameworks governing drone operations be delved deeper into, that the scalability of drone logistics be explored on a larger scale, and that the potential environmental impacts of increased drone usage in logistics operations be investigated.

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Authors

Huu-Tho Nguyen received his PhD degree at the University of Malaya (UM) in 2016 under a JICA AUN/SEED-Net PhD sandwich scholarship between UM and Keio University. He was a lecturer at Ho Chi Minh City University of Technology (HCMUT), Vietnam during the period of 2009-2017 and a lecturer at Ho Chi Minh City University of Food Industry (HUFI) from 2018-2021. Currently, he is a lecturer at Nguyen Tat Thanh University (NTTU), Ho Chi Minh City, Vietnam. His research interests include manufacturing systems and logistics engineering technology, material handling systems, MCDA, DOE, and intelligent manufacturing. (email: nhtho@ntt.edu.vn).

Dr. Ihwan Ghazali is a senior lecturer at Universiti Teknikal Malaysia Malaka (UTeM), Malaysia. He has a history of working as a business and project manager for an environmental consulting services company in Indonesia. He received his Ph.D. in Industrial Engineering from the University of Malaya, Malaysia, and is mainly concerned with green product design, industrial engineering, product design and development, and cultural study. (email: ihwan@utem.edu.my).