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DRONES IN CIVIL AND AIR FORCE LOGISTICS

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Introduction

India is heading towards organising the "Drone Shaurya 2025", which is a specialised trade fair dedicated to innovations in drone technology and unmanned system. The first Drone Shaurya fair was organised from September 19 to 20, 2024, by the Pune-based Ajeenkya DY Patil University in collaboration with the Trade Promotion Council for Geospatial and Space Industry.[1] This time, Drone Shaurya 2025 is to be held from September 23 to 24, 2025 in New Delhi with focus on various aspects of drone technology, regulatory mechanisms, modalities of its application in the context of security and defence, environmental monitoring, agriculture, infrastructure inspection, and managing the contingencies arising in the emergency situations.[2]

This annual event serves as a platform for users ranging from the armed forces to the Central Armed Police forces, industry players, research scholars, policymakers as well as the enthusiasts coming on a single platform with an aim to exchange ideas besides conducting studies to explore the potential of unmanned systems across various domains.[3]

Having spoken about India's renewed focus on drone technology demonstrated through the conduct of "Drone Shaurya" first in 2024 and now in September 2025, we need to deliberate further on widening the arena of application of drones. In this regard, we must appreciate that drones or unmanned aerial vehicles (UAVs) have rapidly evolved from becoming integral components in various civilian and commercial applications to being the niche military tools. In India, the logistics sector appears to offer bright

prospects for the integration of drones, especially where infrastructure challenges, dense urban areas, and remote rural regions coexist, and the drones seem to offer the transformative potential to revolutionise logistics operations.

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We may recall the growing significance of drone logistics, which was amply demonstrated during the Covid-19 pandemic in India, wherein even the famous food delivery platform Swiggy attempted the adoption of drones in early 2022 to facilitate the delivery of groceries to its customers. To achieve this, Swiggy was approached by Garuda Aerospace, Marut Dronetech, and Skye Air Mobility to run the pilot projects. However, only Garuda Aerospace could successfully execute a pilot project, while the others are still awaiting permission. This speaks about the observed gaps between the stated logistics requirement and the ground-level progress.[4]

Drone-Driven Civil Logistics in India

India's logistics sector is geographically dispersed, range-wise diverse, transportability-wise multimodal, and instrumental in significantly contributing to the economic progress of the country. However, it is also plagued by inadequacies such as high costs, delays and constraints of accessibility in remote areas. The unique geographic diversity—from the congested metropolitan cities to the remote terrains especially in the Himalayas and deserts—renders conventional logistics operations arduous.

The Government of India's recently pronounced National Logistics Policy[5] or the *Gati Shakti* gives a direct push to initiatives like "Make in India", "Digital India", and "Atmanirbhar Bharat" that facilitate digital transformation, and has paved the way for creating an ecosystem conducive to adoption of drone technology. The liberalisation of drone regulations through the "Drone Rules 2021" and the creation of the Production-Linked Incentive (PLI) scheme for drone enthusiasts further underscores this shift. These efforts aim to make India a global hub for drone-driven logistics.

Broad Feasibility of Drone Operations to Energise the Indian Logistics Ecosystem

Retail and E-commerce: With advancements in the field of e-commerce in the country, speed and punctuality in delivery have become hallmarks of business adeptness. In this regard, drones offer viable options for timely, i.e. same-day deliveries especially relevant to the supplies of perishable goods and short-lifed items. Drone logistics also

helps in the timely replenishment of inventory shortfalls reducing dependency upon conventional transportation methods. Drones factually help combat the challenges of last-mile delivery especially faced in metro cities like Delhi. Companies like Swiggy and Zomato have already tested drone-based food delivery systems. Similarly, e-commerce giants such as Amazon and Flipkart can adopt drones to enhance the speed and efficiency of package deliveries. In rural regions, drones can bridge the gap between distribution hubs and remote villages, ensuring essential items like groceries, medicines, and small agricultural tools reach underserved communities, including farmers.

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Medical Supplies and Emergency Response: India's healthcare sector faces considerable challenges in supplying medical essentials to remote areas with difficult terrain. Drones offer a promising solution for transporting vaccines, blood samples, and medicines to regions with inadequate road infrastructure. During natural disasters, drones can play a pivotal role in delivering relief supplies, food, and medical kits to affected areas. The Covid-19 pandemic highlighted the importance of swift and efficient healthcare logistics. Notably, states like Telangana successfully conducted drone delivery trials for vaccines, demonstrating the significant potential of drones in revolutionising healthcare supply chains.

Agricultural Logistics: India's agricultural sector stands to gain significantly from the integration of drone logistics. Drones can be used to transport essential supplies such as seeds, fertilisers, pesticides, and lightweight agricultural tools directly to farmers in remote and hard-to-reach areas, reducing their dependence on traditional supply chains. Beyond logistics, drones offer advanced capabilities for precision agriculture, such as monitoring crop growth, assessing crop health, and identifying areas requiring intervention. This facilitates informed decision-making by the farmers, besides helping the optimal utilisation of the resources and enhancing the yield. The utilisation of drones is expected to facilitate rapid transportation, circumventing the challenges of terrain inhospitability especially in the areas having poor road connectivity, which is quite relevant to the Northeastern parts of India. Drones lead to the empowerment of farmers in these terrains by facilitating prompt and rapid logistics.

Supply Chain Management in the Production Activity: The factories and production floors often require swift internal transportation of small yet critically required components, wherein drones provide faster inter and intra-floor mobility

of stores. In a way, the usage of drones facilitates better and swifter availability of spares on the shop floor, which is an important hallmark of production activity in the industrial sector. The uninterrupted availability of critically required stores in real-time is critical to the economy of time required in an efficient production cycle in an industry of any magnitude. This is relevant especially in the industries thriving on Just-in-Time logistics, which are prevalent in every type of Fast Moving Consumer Goods (FMCG) sector. With the integration of drone into operations in the factories and warehouses, there is a possibility of not only enhancing productivity but also widening the scope of more agile production processes by reducing the dependency on the conventional methods of material handling.[6]

Using Drones in the Post and Telegraph (P&T) Sector: Drones offer significant scope for revolutionising Post & Telegraph logistics by bringing more agility to the distribution of parcels and letters, especially in the remote regions having difficult terrains and inadequate infrastructure. The usage of drones in this sector would cut through delays caused by the inadequately developed road and transportation infrastructure. The utilisation of drones would be tremendous especially in the distribution of critical documents, medicines and urgent government communications, besides facilitating the tackling of emergency situations in the face of natural calamities. The use of drones would also help the P&T Department in providing better services in the less privileged and underserved areas of rural India.

Facilitating Hazardous Goods Transportation: Drones provide safer and more efficient solutions to safely transport the hazardous materials such as chemicals, bio waste or other potentially dangerous materials thereby significantly reducing the human interface in the transportation of such substances. This would also ensure prompt compliances adhering to safety protocols inherent in the logistics of hazardous materials. This would go a long way in promoting the environment safety.

Utilisation of Drones in an Environmental Context: The usage of drones can also help in the reforestation drive and restoration of the ecosystem by facilitating the transportation of saplings in the remote terrains. This would in a way prevent deforestation besides transporting water, or soil samples for various research purposes to the labs thereby effective tracking of environmental health and quicker response to ecological threats.

Feasibility of Application of Drones in Indian Air Force (IAF) Logistics

The adaptation of drone technology in the Air Force logistics has not been conceptualised till date. But if adopted, it has a definite potential to bring about

transformative advancements, especially in the management of storehouses and distribution systems, by virtue of the drones offering highly efficient and streamlined supply chain operations, improving the accuracy and accelerating critical logistics processes, enhancing the logistics efficiency and ultimately the mission readiness.

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In the IAF, the logistics storehouses can use drones equipped with sophisticated sensors and cameras in significantly improving the inventory management. The drones can be programmed in close conjunction with the application of barcodes or Radio Frequency Identification (RFID) tags, facilitating real-time stock assessments and pinpointing misplaced or depleted items. Unlike conventional material handling technologies, the drones have the capability to swiftly navigate the warehouses and reach remote areas like the high or densely packed shelves, which may be difficult for normal humans to accesss in routine course. The drone capability tremendously reduces the timeframes required for inventory checks while the data collected through such stocktaking can be seamlessly integrated into the centralised Integrated Material Management Online System (IMMOLS) server, facilitating instant insight into the dynamic stocking levels and helping faster replenishments.

Drones can also facilitate efficient distribution logistics by enabling faster transportation of essential stores such as critical aircraft spares, tools & testers, besides other non-technical items like cleaning materials to the last man in the supply chain, i.e. the technician working on the aircraft on the tarmac. Apart from this, drones can facilitate faster transportation of tentage & barrack equipment to the inhospitable operational locations in the reduced timeframes that could potentially become the hallmark of operational efficiency in any mission. This capability is vital in the high-pressure environment of the air operations where the agility and reduced time frames are the inevitable imperatives.

The use of autonomous drones can enhance safety by reducing human exposure to hazardous tasks. For instance, drones can safely transport volatile materials such as fuels, explosives, or sensitive electronic components, mitigating risks for personnel.

Drones integrated with artificial intelligence can further bolster logistics operations

by anticipating supply needs based on consumption patterns commensurate with the desired duration and intensity of air operations. The utilisation of drones in logistics operations enables proactive resource planning, ultimately ensuring that the Air Force is always prepared to handle and address the dynamic demands in routine activities as well as emergencies.

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By incorporating drones into storehouse and distribution management, the air force logistics stands to achieve greater efficiency, precision and responsiveness, which would eventually be enhancing the agility and operational readiness of air force formations in a progressively complex defence environment.

Challenges Inherent in the Employment of Drones in Logistics

Adoption and execution of drone logistics can be easily achieved in the case of the IAF, being a government supported organisation. But in respect of the civil retail logistics, despite the liberalisation of drone regulations, it may be complex to navigate the approval processes. Besides this, ensuring compliance with air traffic rules, privacy concerns and security protocols can be another deterrent for Micro, Small and Medium Enterprises (MSMEs).

In addition, the lack of adequate drone infrastructure, in terms of landing pads, charging stations, and maintenance facilities, poses a challenge. Additionally, there is also need for advancements in the battery technology to enhance drone endurance and payload capacity.

India's diverse and unpredictable weather conditions, such as heavy rains, strong winds and extreme temperatures, may also affect drone operations.

While there are enormous possibilities of achieving a reasonable degree of functional ease by utilising drones, there is also a need to build the public trust in drone technology alongside the concerns over safety, noise pollution and privacy that need to be addressed simultaneously to ensure widespread acceptance.

Besides, while the procurement of drones is economically viable for big organisations like IAF, the high upfront cost of adopting drone technology can be a deterrent for small and medium-sized enterprises. However, with increasing drone manufacturers now coming up and with the incentives and subsidies from the government, the initial high costs can be

effectively addressed.

Another major constraint in the adoption of drone technology in the Indian context is that India is presently facing significant challenges in strengthening its domestic drone industry and securing its technological future. There are key vulnerabilities in India's drone ecosystem and in the broader technological landscape that urge immediate action to build resilience and self-reliance. A major concern is cryptography, where India has relied upon the classical and conventional cryptography standards set by the National Institute of Standards and Technology (NIST) USA and remains unprepared for the transition to post-quantum cryptography (PQC).

Similarly, while the global drone industry is shifting towards post-quantum technologies, India lags behind in both awareness and preparedness. Another critical gap lies in drone operating systems, which are currently dominated by foreign-developed platforms. India's dependence on imported Global Navigation Satellite System (GNSS) and atomic clocks further exposes its vulnerability to disruptions, as shown during the Kargil conflict. The chip industry in India remains a weak spot, with India lagging behind in producing advanced 7-15 nanometres (nm) chips, besides a lack of focus on next-generation technologies like quantum computing and spintronics. Furthermore, the absence of indigenous infrastructure, such as servers, storage, and navigation algorithms create security risks, including data leaks and potential hardware trojans embedded in imported components. India's reliance on foreign rare earth elements for motors, batteries, and electronics further compounds supply chain vulnerabilities. In this scenario, the failure to establish a unified national blockchain infrastructure has led to transparency and security issues. Apart from this, AI and data security are also at risk from the biased training data and malicious prompts. There is no denying the fact that India's vision for technological independence by 2047 merits urgent and sustained effort in research & development, and deserves to be considered as a driver of strategic and economic growth. In the absence of a plausible immediate remedial action, India becomes prone to the risk of remaining technologically dependent and strategically vulnerable while staring into the future[7].

As a final word of caution, the drones are susceptible to hacking and cyberattacks, which can compromise sensitive data and logistics operations. Therefore, robust cybersecurity measures are imperative to safeguard the operation of drone systems.

Deductions

To facilitate the adoption of drone technology, the Indian government has introduced several policy initiatives to promote the usage of drones. The "Drone Rules 2021" provide a

simplified framework for drone operations, while enterprises like the "Digital Sky Platform" facilitate online registration and approval processes. However, further refinements in policy are positively required to address the unique needs of drone logistics in the civil as well as the military logistics.

There is no denying the fact that the drones possess enormous potential to transform India's logistics sector, addressing longstanding challenges while alongside creating new opportunities. Their adoption can lead to faster, more efficient and sustainable logistics solutions. However, realising this vision requires concerted efforts from the government, private sector as well as the technology providers to overcome regulatory, technological and social barriers. With the right strategies and a positive will, India possesses a definite potential to emerge as a global leader in drone logistics, setting an example for other nations to follow.

Notes:

[1] "ADYPU Hosts Drone Shaurya 2024: Pioneering the Future of Aviation and Unmanned Systems," Ajeenkya DY Patil University, September 2024, https://adypu.edu.in/event/adypu-hosts-drone-shaurya-2024. Accessed on March 12, 2025.

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[3] "About 2nd Drone Shaurya 2025," *Drone Shaurya*, https://droneshaurya.com/marine-systems-bharat/. Accessed on March 12, 2025.

[4] Lavpreet Kaur, "Home delivery with drones in India still a long way to go," *Deccan Herald,* February 06, 2023, https://www.deccanherald.com/business/home-delivery-with-drones-in-india-still-a-long-way-to-go-1188157.html. Accessed on January 15, 2025.

[5] Bhakti Jain and Ishita Dhar, "National Logistics Policy in India," Invest India, September 20, 2022, https://www.investindia.gov.in/blogs/national-logistics-policy-india#:~:text=To%20boost%20the%20ease%20of,in%20Vigyan%20Bhawan%2C%20New%20Delhi. Accessed on January 16, 2025.

[6] Akshat Sharma, "Car manufacturers leveraging drone technology for delivering parts," Jungleworks, July 30, 2019, https://jungleworks.com/car-manufacturers-delivering-parts-via-drones/. Accessed on January 16 2025.

[7] Dalip Singh, "India way behind global standards in fixing drone security norms: MoD cyber advisor," *BusinessLine,* March 12, 2025, https://www.thehindubusinessline.com/info-tech/india-way-behind-global-standards-in-fixing-drone-security-norms-mod-cyber-advisor/article69320549.ece. Accessed on March 18, 2025.

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