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TSAW Drones: Revolutionizing India's Drone Logistics with Digital Technologies

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Abstract:

Startups play a crucial role in driving a country's economic growth and transformation by fostering innovation and job creation and attracting investment. Startups such as Technology in Space and Aero Works (TSAW) can play a key role in transforming India's logistics sector through advancements in drone technologies. TSAW leveraged Internet of Things, big data, cloud computing, and artificial intelligence to become a key player in healthcare logistics, efficiently delivering essential medical supplies to remote and inaccessible locations. Having established its presence in healthcare logistics, the company is now considering expanding into the agricultural and infrastructure sectors. The critical question facing TSAW is whether to further advance its artificial intelligence-driven processes and technologies to enhance the safety and reliability of its existing logistics operations or expand its footprint into new sectors to seize emerging market opportunities. The case explores the evolution of drone technologies, their potential based on transformational digital technologies, the growing market and competition in this emerging field, and the fast-changing regulatory landscape in the country.

Keywords: Drone Logistics, Drone Technology, Artificial Intelligence, Cloud Computing, Smart Connected Products (SCPs).

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1 Introduction

> *Technology is growing… we try to use this technology and bridge the gap formed by the infrastructure challenges and build a fifth mode of transportation using drones.*[1]
> *Kishan Tiwari, CEO TSAW*

Technology in Space and Aero Works (TSAW) Drones was founded by two engineering graduates, Kishan Tiwari and Rimanshu Pandey, in 2019 and was playing a key role in transforming medical logistics in India. The medical logistics field in India is highly challenging due to the country's vast and diverse geography, which causes hurdles for efficient transportation networks to reach both urban and remote rural areas. Medical logistics require a robust cold chain system that ensures patient safety by preventing spoilage.[2] The challenges in delivering healthcare services further increase as we move towards the more challenging geographical terrains of the Northeast, Western Ghats, etc. (Aggarwal et al., 2024). In regions with highly diverse and challenging geographical terrains, drones emerge as a promising solution, offering new hope for overcoming logistical barriers and ensuring timely delivery of essential services. TSAW, identifying these challenges, aimed to utilize technological advancement in the drone industry to find solutions that could improve healthcare logistics in India.

In October 2023, TSAW partnered with the Indian Council of Medical Research (ICMR) for a six-month pilot program aimed at developing drone technology to deliver essential medical supplies to remote and previously inaccessible locations. The program aimed to utilize drones to transport tissue samples, diagnostic materials, and tuberculosis (TB) medications across various states in the country (Ahmed, 2024).[3] During this initiative, TSAW Drones achieved many significant records, such as setting a record for delivering medicines at an altitude of 12,000 feet in Himachal Pradesh, surpassing the previous record of 10,000 feet – delivering biopsy samples in Manipal, Karnataka, and transporting TB medications to Yaddari in Telangana while returning with test samples for analysis.[4]

> By harnessing the cutting-edge capabilities of drone technology, we are not merely opening doors but are tearing down barriers to healthcare access in the remotest regions of our country. This initiative with TSAW Drones stands as a testament to our resolve to leave no one behind and ensure that every citizen, regardless of their geographic location, receives the medical attention they deserve. Dr Sumit Aggarwal, Indian Council of Medical Research (ICMR) (Economic Times Health World, 2023, October)

As quoted by the official, these efforts and achievements signaled a significant transformation in the distribution of healthcare supplies to remote and inaccessible locations. By incorporating artificial intelligence (AI) into their drone technology, TSAW improved both the safety and precision of medical logistics, showcasing the potential scope of innovation and its impact on the healthcare sector.

> The potential of AI in autonomous drone delivery systems is boundless, and as technology continues to advance, even greater advancements in the field are anticipated. Rimanshu Pandey (Financial Express, 2023)

Leveraging their technical background, Kishan and Rimanshu founded TSAW with the goal of automating drones and reducing human dependency.[5] To achieve this objective, they developed in-house software to fully automate drone operations. Recognizing the infrastructure challenges in the logistics sector, TSAW aimed to establish drones as the fifth mode of transportation after road, rail, air, and water. TSAW built drones capable of carrying up to 20kg and planned to expand that capacity to 100kg for hub-to-hub delivery in remote locations, significantly reducing delivery times. In this journey, they identified the

[1] In an interview with *SME Futures*, Kishan Tiwari mentioned the objective of TSAW Drones, highlighting the company's mission to revolutionize logistics through innovative drone technology. (*Guild TV*, "TSAW Drones: Redefining Logistics," June 30, 2023) https://www.youtube.com/shorts/HHmLzupx5IE

[2] Bhattacharya, A. (2024, August 11). *Strengthening India's Healthcare Logistics Infrastructure*. ETHealthWorld. Retrieved from https://health.economictimes.indiatimes.com/news/industry/strengthening-indias-healthcare-logistics-infrastructure/112442962

[3] Mid Surgery Tissue Sample Delivery By TSAW Drones, In Collaboration with ICMR, Reported by Shoaib Ahmed, Available at https://www.tsaw.tech/blogs/mid-surgery-tissue-sample-delivery-by-tsaw-drones-in-collaboration-with-icmr

[4] Economic Times reported on Oct 24,2023, available at https://health.economictimes.indiatimes.com/news/industry/tsaw-drones-receives-service-order-from-icmr/104162438?utm_source=copy&utm_medium=pshare

[5] In the video *Drones in the Logistics Industry*, Kishan Tiwari discusses the aims, objectives, and journey of TSAW, outlining how the company is positioned to transform the logistics sector through drone technology. (*Dronefluence*, June 19, 2023). https://www.youtube.com/watch?v=wJyD1Imzmjs&t=82s

potential of artificial intelligence (AI) to advance autonomous drone delivery systems, envisioning a future where this technology could redefine logistics.[6] TSAW Drones applied IoT-driven technologies to address key challenges such as real-time battery and component monitoring, GPS failures, and landing feasibility. These innovations ensured the secure and efficient delivery of sensitive medical supplies, even in difficult terrains and high altitudes. However, as the industrial and regulatory landscape evolved, TSAW faced both opportunities and challenges that would shape its future. The drone sector was undergoing rapid transformation, with growing applications across various sectors, creating new possibilities for TSAW to expand its operations, offering many new growth opportunities. The changing industrial, technological, and regulatory landscape brought the company to a crucial juncture where it had to make critical decisions for its future growth. The company needed to decide whether to focus on advancing its digital technology capabilities and processes to enhance the safety and reliability of its existing operations to strengthen its presence in this segment or expand into new sectors where the applications of drone technology were rapidly growing. Both these choices had implications: continuing to focus on healthcare logistics would require the management to have a razor-sharp focus and direct its attention to mastering existing technologies at the cost of fast-emerging opportunities. In contrast, the decision to enter new growing segments might require additional funding and might divert and stretch the focus of the top management.

2 TSAW Drones

Kishan Tiwari and Rimanshu Pandey, engineering graduates from Motilal Nehru National Institute of Technology (MNNIT) Allahabad, began working on drone technology in 2013. Kishan, passionate about robotics and technology, had previously served as the Student President of the AeroClub and Robotics Club at MNNIT. His involvement in the aeromodelling club deepened his understanding of drone technology and its commercial applications. Kishan later joined the Indian Institute of Technology (IIT) Delhi for his MBA, which he eventually quit, but his time there allowed him to engage with the campus's entrepreneurial ecosystem. In 2019, he and Rimanshu co-founded TSAW Drones at the Research and Innovation Park of IIT Delhi, with the aim of transforming aerial mobility in India. Rimanshu, currently the Chief Technology Officer at TSAW Drones, aimed to fully automate drones and their operations (Bot & Drone News India, 2022). TSAW Drones operated under the motto "Less Human, More Machine",[7] emphasizing operational safety and efficiency. Initially, they focused on being a technology company developing software and support for drone companies, but after identifying the gap in the market, they expanded into the operational side of the business.

At the initial phase of development, TSAW faced numerous challenges related to the supply chain, data availability, route optimization, and personnel training. Since the drone ecosystem was still emerging, there were significant supply chain issues, particularly in the drone healthcare logistics vertical. Currently, TSAW's manufacturing is entrusted with a third-party vendor. Recognizing the market need in the healthcare logistics sector, TSAW focused primarily on building its network in remote areas and identifying the right stakeholders to partner with for end-to-end delivery. In this process, identifying optimal routes was another important challenge, as the routes needed to be both remote and commercially viable. The lack of comprehensive commercial data further exacerbated this challenge, requiring TSAW to spend considerable time identifying a replicable operational process, as it was handling high-value commodities that necessitate error-free operations. Additionally, the novelty of drone technology made it difficult to establish collaborations with stakeholders, many of whom were skeptical about its commercial viability and business potential. Moreover, recruiting drone pilots for healthcare logistics needed meticulous efforts as it required specialized training compared to the other sectors.[8]

Despite these challenges, TSAW successfully emerged as a key player in transportation, logistics, and supply chain solutions. Its primary goal was to establish a comprehensive drone network offering innovative end-to-end logistics services as an alternative mode of transportation. The company specializes in beyond visual line of sight (BVLOS) operations, and emergency and healthcare logistics, positioning itself as a pioneer of cutting-edge logistics technologies.[9] TSAW adopted a high-tech approach

[6] "TSAW Drones is Betting Big on Future Logistics," interview with Kishan Tiwari, *Guild TV*, YouTube video, January 2023, https://www.youtube.com/watch?v=u6cN9R_8PiQ.
[7] Drones in India: Revealing the Future with Start-up Journey of Kishan Tiwari Podcast. Available at AbhiTalk Youtube channel. https://youtu.be/i8oimvyCuvI?si=KxgX6WzfsVWJf1pN
[8] In the video *Drones in the Logistics Industry*, Kishan Tiwari discusses the challenges they faced TSAW during their initial phase of journery. (*Dronefluence*, June 19, 2023). https://www.youtube.com/watch?v=wJyD1Imzmjs&t=82s
[9] Information retrieved from TSAW's official website. https://www.tsaw.tech/about

to logistics, incorporating advanced drone technology, unmanned traffic management (UTM), and drone-specific software. It leveraged automated flight planning, real-time airspace monitoring, and collision avoidance systems to facilitate swift and economical deliveries. Its expansive network enabled rapid deliveries even in remote areas, enabling it to excel in specialized services such as on-demand medical supplies. TSAW's cutting-edge Drone Cloud Intelligence System (DCIS) further enhanced its fleet management and operational efficiency. By integrating a 5G network for low-latency communication, TSAW significantly reduced operational costs. It also explored new revenue streams, such as the installation of landing hubs, all supported by favorable Indian government policies promoting drone innovation (TSAW Tech, n.d.). Through continuous innovation and service expansion, TSAW was able to launch a subsidiary named Droneco, which focused on creating a robust aerial mobility ecosystem. Droneco is the logistic arm of TSAW, with a track record of 8400+ package deliveries covering a total distance of 6920+ km.[10] As TSAW moves forward, it must adapt to evolving industrial and technological advancements to remain the dominant player in the market.

3 Drone Industry in India

The drone industry in India has expanded beyond its roots in the defense sector into various commercial applications, opening up numerous opportunities. Globally, the drone market was valued at over US $3 billion in 2022 and was projected to grow at a compounded annual growth rate (CAGR) of approximately 39%, indicating significant expansion in the coming decades (Drone Industry Insights, n.d.). In India, the drone industry is evolving rapidly, with the market expected to reach around US $2.4 billion by 2030 (see Figure 1).[11]

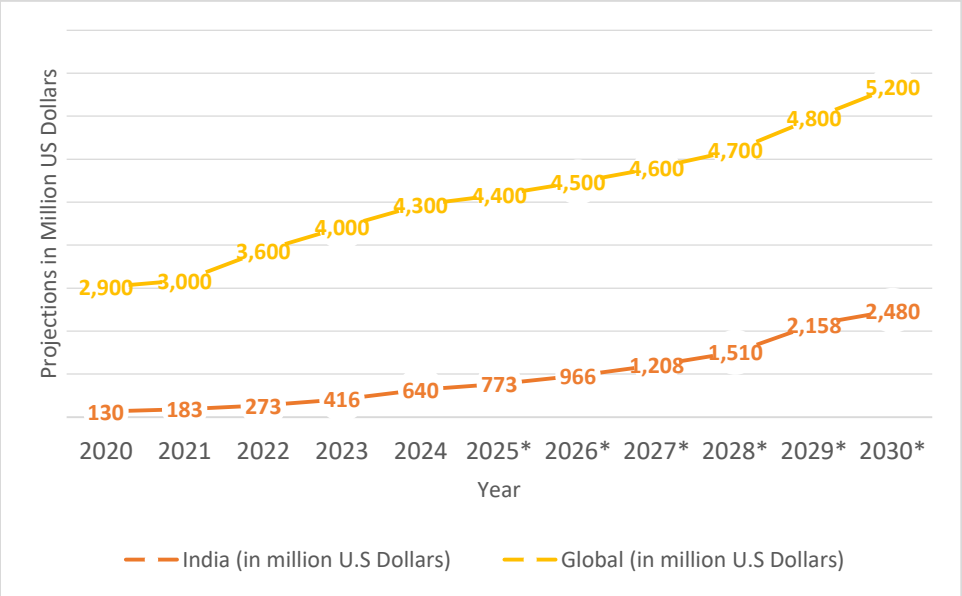


Figure 1. Market for Drone: India and Global (Source: Allied Market Research & KPMG India, 2022)

In 2023, the total number of registered drones crossed 10,000 and grew to more than 13,000 by mid-2024. Similarly, the number of registered drone pilots increased significantly, from 346 in 2022 to 16,000 in 2024 (see Figure 2).

[10] Report on DRONECO is available at Indian Transport & Logistics News. https://www.itln.in/cargo-drones/droneco-by-tsaw-drones-targets-10-lakh-deliveries-in-2023-1349159?infinitescroll=1

[11] EY, & FICCI. (September 6, 2022). Market size of drone in India in 2020 with forecasts till 2030 (in billion Indian rupees) [Graph]. In *Statista*. Retrieved October 25, 2024, from https://www.statista.com/statistics/1365217/india-market-size-of-drone/

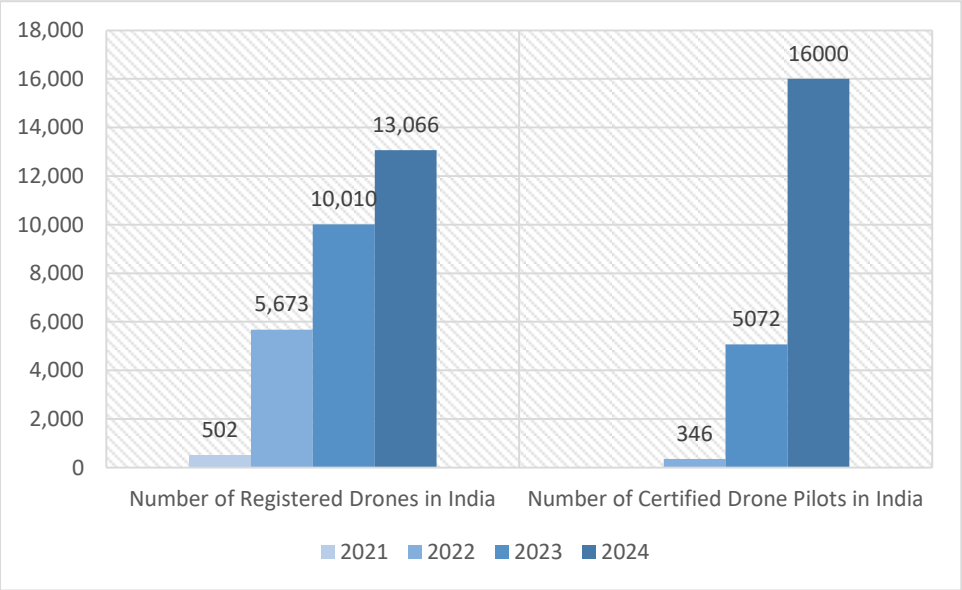


Figure 2. Drone and Drone Pilots in India (Source: Directorate General of Civil Aviation, Government of India, n.d.)

The Directorate General of Civil Aviation (DGCA) authorized the setting up of 70 drone pilot training facilities in the country.[12] This rapid growth was driven by over 200 startups, which have collectively raised more than $140 million dollars in funding since 2014. Identifying the opportunities present in this growing market, investors showed interest in funding upcoming startups in this sector. Notably, 76.4% of this funding was directed toward early-growth-stage startups, underscoring investor confidence in their scalability and market potential (Inc42, 2024). Meanwhile, around 70% of the deals occurred at the seed stage, highlighting a strong interest in nurturing early-stage innovation within the sector (Agarwal, 2024). The Indian drone industry has experienced substantial growth, witnessing an approximately 35% increase in drone startups between 2020 and 2022, reflecting the rising adoption of drones across sectors. As mentioned, the past decade has witnessed significant growth in the establishment and growth of startups leveraging India's evolving drone technology market. Of the 200-plus newly founded startups, a few of them were significant contributors, and their contributions are summarized in Table 1.

Table 1. Key Drone Players (Source: Inc42, 2024)

Company	Founders	Founding Year	Key Focus Areas	Key Achievements	Current Status (2023)
Asteria Aerospace	Nihar Vartak, Neel Mehta	2012	Full-stack drone technology, surveying and mapping, agricultural monitoring	Has approximately 320 employees; Reliance Industries invested ₹120 crore in 2019; introduced the first micro-category surveillance drone (A200-XT)	The company is performing well with an operational revenue of ₹1-100 crore, EBITDA increased by 12.17% in 2023, holds 42 patents related to drone design and capabilities
DUMs	Srinivasan S, Vishnu Vardhan Reddy	2016	Drone development, R&D, training, and services	Introduced UAVs for various applications, including surveillance, agriculture, and logistics	Expanding into various industries and focusing on innovation; collaborated with government projects aimed at surveillance and security measures

[12] DGCA (India). (November 2, 2023). Number of registered drones in India from 2021 to 2023 [Graph]. In *Statista*. Retrieved October 25, 2024, from https://www.statista.com/statistics/1421661/india-number-of-registered-drones/

Idea Forge	Ankit Mehta, Ashish Bhat, Rahul Singh	2007	Drone technology, VTOL drones	Introduced Netra UAV, won Best Autonomous Hovering Vehicle (2010) in the US-Asian Demonstration and Assessment of Micro Aerial and Unmanned Ground Vehicle Technology contest and MIT's Innovators under 35, played a critical role during the Uttarakhand floods (2021)	Filed over 30 patents; deployed 1,500+ systems; trained 3,200+ pilots; IPO raised ₹300 crore; valued at $430 million; revenue of $23 million
Garuda Aerospace	Agnishwar Jayaprakash, Ritika	2015	Low-cost drone solutions, agricultural drones	Developed 38+ drone types; employed MS Dhoni as a brand ambassador; Elon Musk is an investor, 55% market share in agricultural drones	Its founder shared plans of raising US $100 Million-US $150 Million in Series B funding in 2023 at a valuation of US $500 Million- US $600 Million. In October 2023, the startup raised about US $ 3 Million in a bridge funding round led by Venture Catalysts and WeFounderCircle. It also partners with Lockheed Martin, HAL, and BEML.
Drone Acharya	Prateek Srivastava	2017	Enterprise solutions, drone training	IPO oversubscribed 23 times (2022), secured order from Adani Group, acquired 76% stake in Aerophile Academy	Employee base of ~100; revenue $2.3 million; valuation $60 million; 65% revenue from training
Redwing	Anshul Sharma, Rishabh Gupta, Arunabha Bhattacharya	2018	Medical deliveries in remote areas	Selected for Techstars US; partnered with We Robotics; inbuilt temperature loggers for safe transport	Operates on a hub-and-spoke model, where each drone is capable of 180 deliveries a day

Asteria Aerospace, based in Bangalore, secured over $2.9 million dollars, and focused on drone-as-a-service (DaaS), catering to industries such as defense, agriculture, oil and gas, and telecommunications.[13] Dhaksha Unmanned Systems (DUMs) in Chennai, with $4.9 million dollars in funding, offered seven drone-based solutions for agriculture, mining, defense, and surveillance (Inc42, 2024). Pune's Drone-Acharya, backed by $4.6 million dollars, provided solutions for various industries and offers comprehensive drone piloting and data processing training.[14] Garuda Aerospace in Chennai, with over $30 million dollars in funding, and ideaForge in Mumbai, with over $38.5 million dollars, operated in multiple sectors, including event photography, agricultural surveys, and surveillance (Jose, 2024). Their extensive product range and sector diversification underscored their significant market traction and growth potential, with the last two companies having achieved the milestone of getting listed on the stock market. Startups like Redwing focused particularly on healthcare logistics, presenting domain-specific competition for TSAW. Redwing followed a hub-and-spoke model and developed a technology wherein each drone was capable of completing 180 deliveries a day.[15] However, a notable trend was that companies receiving substantial investments operated across multiple domains and sectors. This diversification mitigated risks and maximized commercial opportunities, making these startups particularly attractive to investors. The

[13] Inc42 had provided a comprehensive report on Indian drone tech landscape in their report *India's drone tech startup landscape report 2024*. Inc42.com. Retrieved from https://inc42.com/reports/indian-drone-tech-startup-landscape-market-opportunity-report-2024/

[14] Geospatial World. (2022, May). DroneAcharya Aerial Innovations secures USD 4.6 Million investment. GW Prime. Retrieved from https://www.geospatialworld.net/news/droneacharya-aerial-innovations-secures-usd-4-6-million-investment/

[15] Saxena, R. (n.d.). *Redwing Aerospace Lab: India's Very Own Medical Drones Service.* India Flying Labs. Retrieved from https://flyinglabs.org/blog/redwing-aerospace-lab-indias-very-own-medical-drones-service

significant funding allocated to these multi-domain companies reflected the recognition of drone technology's wide applications and expansive market reach.

4 Drone Technology and Its Applications in India

Initially, drones in India were primarily used for defense purposes, but over time, their applications expanded significantly. Beyond military and security applications, drones were employed by the public for a variety of purposes, including delivery, disaster management, agriculture, waste management, energy, media, GIS mapping, mining, public safety, and logistics.

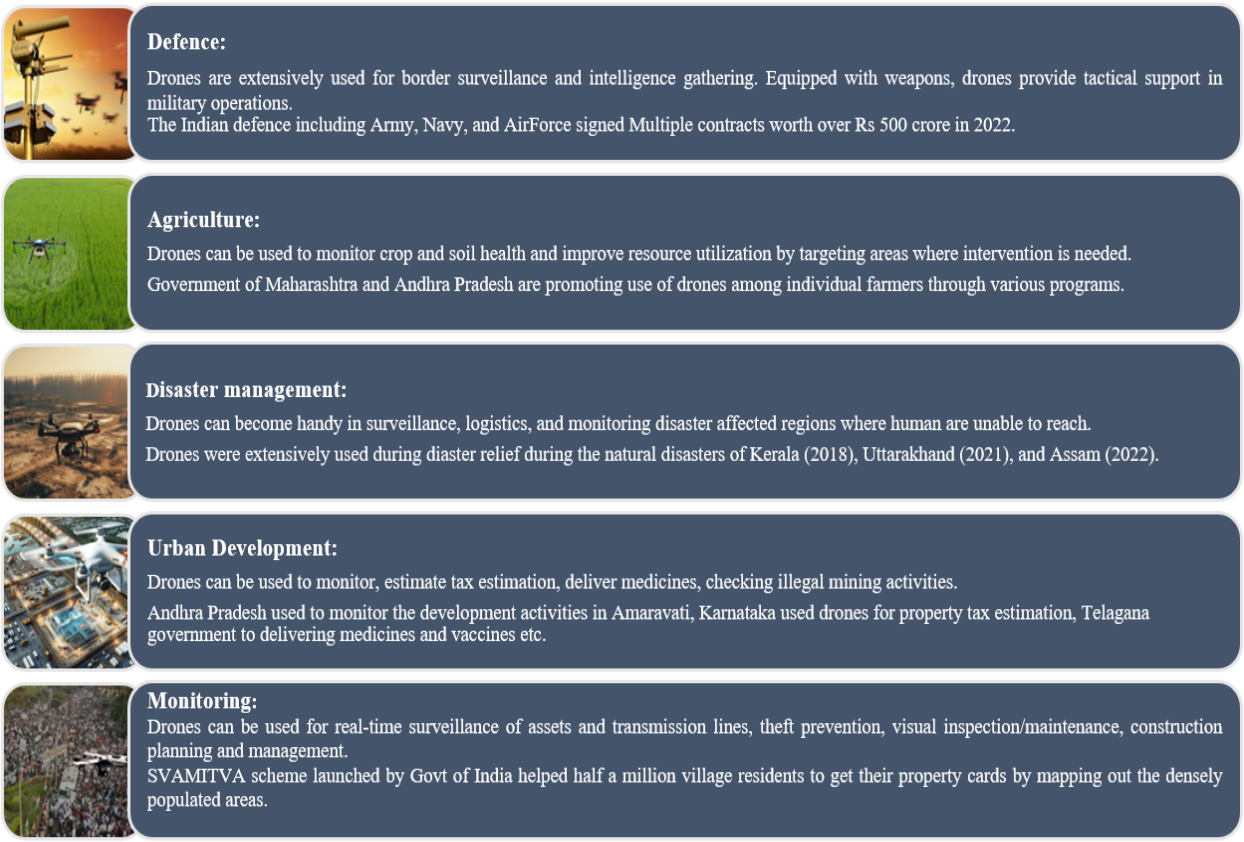


Figure 3. Drone Application in India (Source: Compiled by Authors)

Drone technology underwent significant advancements, making it a versatile tool deployed across various sectors. These applications ranged from optimizing electrical panel inspections, revolutionizing crop monitoring, and enhancing last-mile delivery efficiency. The rapid evolution of drone technology was driven by advancements in radio communication, smartphones, AI, and cloud computing. AI enabled drones make autonomous decisions, monitor flight parameters, assess terrain conditions, and avoid obstacles, ensuring safe and efficient operations. This integration with AI, machine learning, and computer vision significantly enhanced the capabilities of autonomous drone systems, positioning them as pivotal tools for tasks such as monitoring, controlling, optimizing, and providing autonomy across industries (IdeaForge, 2023).

Based on these integrations, drone technology was having a transformative impact across various sectors. For instance, urban air mobility (UAM) aimed to revolutionize urban transportation by leveraging passenger drones, or urban air vehicles (UAVs), which can help mitigate congestion and offer efficient point-to-point travel. For UAM to succeed, real-time traffic management systems, seamless air traffic control integration, and robust communication networks managed through cloud computing were essential. Internationally, over the years, governments experimented with different applications of drone technology. For example, Dubai conducted successful drone-based autonomous air taxi trials in 2020 (Tripathi et al., 2022). Simultaneously, drone delivery services could reshape logistics by employing route optimization algorithms, real-time tracking systems, and secure payment gateways, all supported by

scalable cloud infrastructure. This dynamic approach enabled drones to adjust delivery routes in response to real-time traffic and weather data, ensuring efficient and timely deliveries. Companies such as DHL, TSAW, Truxcargo, and Zipline invested in drone logistics in India. Additionally, drones equipped with sophisticated sensors and cloud data analysis could revolutionize precision agriculture methods. Utilizing high-resolution imaging and multispectral sensor technology, farmers could gain essential insights into crop health, soil conditions, and water management requirements, thus improving overall yield and sustainable practices in agriculture (IdeaForge, 2023).

Drones with advanced features such as night vision, thermal imaging, and cloud computing could enhance public safety and security by enabling instant data relay to various agencies. This integration could substantially enhance emergency response and operational efficiency by enhancing situational awareness. Cloud computing supports beyond visual line of sight (BVLOS) operations, which are crucial for extensive inspections and surveillance across sectors like oil and gas, agriculture, and infrastructure. In 2021, the Indian government conducted experimental drone flights utilizing BVLOS technology. The safety of these advanced operations was ensured through secure communication channels and cutting-edge obstacle detection technologies (Van et al., 2023). Over the years, the government has actively formulated regulations, which have focused on standardizing drone operations and their applications in various domains to ensure safety and higher efficiency.

5 Government Policy Framework

India's drone policy has radically transformed from a restrictive framework to a supportive one (see Table 2).

Table 2. Evolution of Drone Regulations in India (Source: IdeaForgetech, 2023)

The initial application of drones in the defense sector started with the Kargil War of 1999. During the War, the need for advanced drone technology for border security was highlighted (Manish, 2022). However, civilian drone use remained limited. In 2014, the first civilian drone regulation was introduced, requiring permission for operation. Although draft rules were introduced in 2016, finalization was delayed. The launch of the Digital Sky platform in 2018 marked a move towards regulated civilian drone use. However, the 2020 Unmanned Aircraft System (UAS) Rules were criticized for being overly stringent. In response, the government introduced the Drone Rules 2021 in August 2021, also known as the Drone Regulations 3.0 (Hussain, 2022). These rules aimed to simplify the regulatory process, reduce permission categories, cut bureaucracy, establish the Digital Sky platform for online processing, and lower fees. The framework waived pilot licenses for specific categories, relaxed approval processes, and created drone corridors. It also streamlined processes by reducing the required permissions from 25 to 5,[16] significantly lowering entry barriers for startups. Subsequently, regulations restricting the import of drones have bolstered

[16] Sabu, C. reported about the latest regulatory changes in drone industry published by Impact and Policy Research Institute on May 5, 2024. *Production Linked Incentive: Drone Scheme 2021 – Insights, Policy Update, IMPRI.*

domestic manufacturing, benefiting startups focused on drone production and services. The Insurance Regulatory and Development Authority of India (IRDAI) introduced innovative insurance products tailored to various drone applications, laying the foundation for risk management in drone operations.[17] The government proposed the establishment of a Drone Promotion Council, which included stakeholders from academia and startups with the aim of facilitating a collaborative environment for developing security standards and promoting growth in the industry. It provided a platform for startups to voice their concerns and contribute to regulatory frameworks. The government envisions positioning India as a global drone hub by 2030. Policy initiatives like the "Drone Shakti" scheme, "Kisan Drones", and the facilitation of "Drone-as-a-Service" were designed to accelerate industry growth.[18] The timeline of these developments showcased a clear shift from initial restrictions to a more liberalized and supportive regulatory framework (Sirsikar, 2022). Subsequent amendments further eased regulations, promoted domestic manufacturing through import restrictions, and introduced a Production-linked Incentive (PLI) scheme to drive growth in the sector. The PLI Scheme for drones, notified on 30 September 2021, offered Rs. 120 crore incentive to Indian drone and drone component manufacturers based on value addition in India, with a 20% incentive rate spread over three years. Eligible MSMEs and startups must meet minimum sales revenue thresholds, and manufacturers can recover lost incentives in subsequent years if value addition shortfalls are made up.

In India, all drones except those in the ultra-lightweight "nano" category (less than 250 grams) require registration with the Directorate General of Civil Aviation (DGCA) and must be issued a Unique Identification Number (UIN). Drones are classified by weight into five categories: nano, micro (250 grams to 2 kg), small (2 kg to 25 kg), medium (25 kg to 150 kg), and large (above 150 kg) (see Figure 4).

Figure 4. Size-based Classification of Drones (Source: Digitalsky (Directorate General of Civil Aviation, Government of India, n.d.))

Permissions for flying a drone depended on the category and location. Nano and micro drones could be flown up to specific heights in uncontrolled airspace without permission. Permission was granted automatically through the online Digital Sky portal for other categories unless the flight zone is sensitive (Digital Sky, DCGA).

Operating a drone required a "Remote Pilot Certificate" (RPC) for all categories except nano drones. To obtain an RPC, drone pilots must have undergone training at DGCA-authorized Remote Pilot Training Organization (RPTO). Safety regulations applied to all drone operations, including the requirement for pilots to maintain a visual line of sight (VLOS) with their drones and adhere to a maximum flight height of 400 feet above ground level (AGL). No-fly zones, such as those around airports, security installations, and government buildings, could be checked via the Digital Sky portal. Night flights were generally prohibited unless special permission was granted. The Digital Sky Platform served as the central hub for drone registration, permission requests, pilot certification, and airspace information. The digital infrastructure

[17] Antara Vats, in her article "Fast-Tracking the Flight of India's Drone Industry", discusses the evolving drone regulations in India and their impact on the market, emphasizing how regulatory advancements are shaping the growth of the industry. (*Observer Research Foundation*, August 16, 2023) retrieved from https://www.orfonline.org/research/fast-tracking-the-flight-of-india-s-drone-industry.

[18] Adarsh, in his article "Things to Know Before Flying a Drone in India", discusses various drone regulatory changes in India, highlighting important schemes and policies aimed at ensuring safe and lawful drone operations. (*Sify*, September 10, 2023) retrieved from https://www.sify.com/science-tech/things-to-know-before-flying-a-drone-in-india.

streamlined the regulatory process, allowing startups to focus on innovation rather than bureaucratic hurdles (Ministry of Civil Aviation, 2021).[19] Following these regulations was mandatory, and violations resulted in penalties. Import restrictions were in place for most drones and drone components, with exceptions for defense, security, research, and development purposes.

Starting from a nascent sector with restrictive regulations, India has now actively nurtured a drone ecosystem with the potential to become a global leader. This transformation rested on five key pillars (i.e., ease of doing business, financial incentives, government as a market maker, export liberalization, and domestic industry promotion) (Sharma, 2024) (see Figure 5).

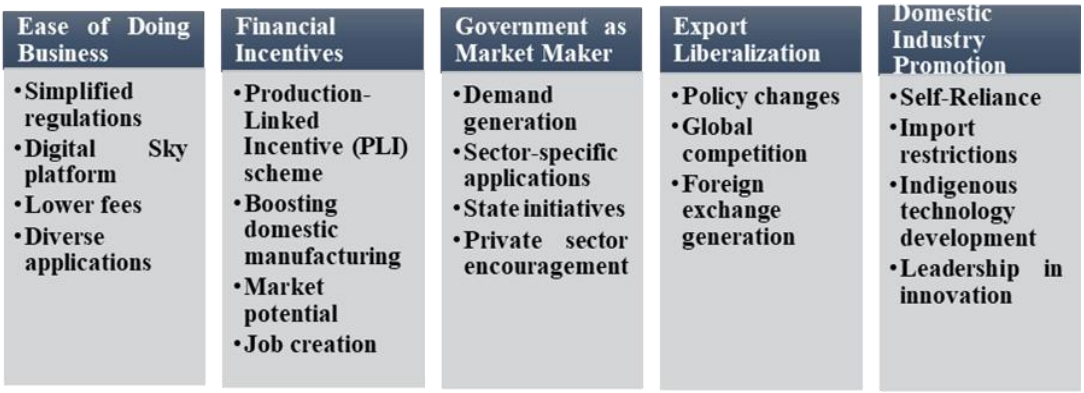


Figure 5. Key Pillars of Drone Regulation in India (Source: Sharma, 2024)

These five pillars worked in tandem to create a supportive environment for the Indian drone industry. By simplifying regulations, providing financial support, promoting exports, and fostering indigenous production and the local market, the Indian government positioned itself to become a significant player in the global drone market. Increasingly favorable government policies and rising demand for monitoring, surveying, and cost-effective data collection were significant industry growth drivers (Agarwal, 2024).

6 Transformative Impact of Smart-Connected Products on Drone Technology

In the era of smart-connected products (SCPs), the drone industry experienced substantial growth, driven by advancements in information technology. SCPs are advanced devices that integrate hardware, software, and connectivity to enhance functionality and user interactions. These products primarily consisted of three core elements: physical components, smart components, and connectivity components (Porter & Heppelmann, 2014). The physical components included mechanical and electrical parts; the smart components encompassed sensors, microprocessors, data storage, controls, software, operating systems, and user interfaces; and the connectivity components included ports, antennae, protocols, and networks. Innovations in IoT, big data, cloud computing, and AI fueled the creation of numerous advanced SCPs. IoT connected the physical and digital worlds, generating large volumes of data. This data was then processed, analyzed, and utilized to inform intelligent decision-making, supporting the development of machine learning and AI models in cloud computing environments (Chen, 2020). The origins of AI can be traced back to the 1950s when first-generation electronic computers were invented. Since then, AI has progressed through several phases, including cybernetics, brain simulation, cognitive simulation, and computational intelligence, evolving into contemporary AI technology that leverages big data and machine learning (McCarthy, 2000).

During the 1960s and 1970s, the first wave of IT focused on automating individual activities within the value chain, resulting in increased productivity and the availability of vast amounts of data. This advancement allowed the IT sector to streamline individual value chain processes and facilitated the integration of global supply chains. In the 1980s, the rise of an inexpensive and ubiquitous internet

[19] The Drone Rules, 2021, released by the Ministry of Civil Aviation on January 28, 2022, through the Press Information Bureau, introduced the No Permission No Takeoff (NPNT) policy, ensuring that drones adhere to safety standards before flights. (Press Information Bureau, *Ministry of Civil Aviation*, January 28, 2022) retrieved from https://static.pib.gov.in/writereaddata/specificdocs/A/2022/jan/doc202212810701.pdf.

resulted in the second wave of IT-driven transformation. Following the success of the first and second waves, the third wave emerged with characteristics such as integrated embedded sensors, processors, software, and connectivity. One major advancement in this third wave was the Internet of Drones (IoD), which was an infrastructure that allowed users to control and access drones over the internet (Abdelmaboud, 2021). The IoD integrated vehicle mobility with cloud-based functions, enabling remote access and control of drones while offering scalable offloading and remote cloud storage capabilities (Gharibi et al., 2016). AI and IoT significantly advanced drone technology by enhancing its operational capabilities and enabling autonomous functions. AI empowered drones to analyze real-time data, make informed decisions, and adapt to changing environments, thereby improving safety and efficiency in complex tasks such as surveillance and logistics (Obiuto et al., 2020). Meanwhile, IoT facilitated seamless connectivity between drones and other devices, enabling improved data collection, real-time communication, and enhanced drone operations, accuracy, and effectiveness across various sectors (Cheng et al., 2020). These advancements had a major impact on the development of present-day drone technology as these features significantly enhanced drone functionality and performance.

The capabilities of SCPs in the drone industry could be broadly classified into four categories: monitoring, control, optimization, and autonomy (see Table 3).

Table 3. Capabilities of SCPs in the Drone Industry (Source: Porter & Heppelmann, 2014; Quamar et al., 2023)

Capability	Description	Examples in the Drone Industry
Monitoring	The sensors and external data sources present in the SCPs help comprehensively monitor product condition, external environment, product operation, and usage. It enables alerts and notifications of changes.	Real-Time Fleet Tracking: Drones equipped with GPS, LiDAR, and cameras monitor delivery routes, weather conditions, and obstacles, sending real-time alerts about environmental changes. Precision Agriculture: Sensors collect data on soil health, crop conditions, and moisture levels for farmers.
Control	The software embedded in the SCPs or the product cloud helps in controlling product functions and personalizing user experience.	Geofencing and Remote Control: Users set virtual boundaries (geofencing) or remotely control drone operations for specific tasks like aerial photography or surveillance through mobile applications or cloud platforms. Drone Inspection: Operators use software to adjust flight paths for inspection tasks, ensuring coverage of desired areas.
Optimization	Monitoring and control capabilities allow algorithms that can be used to optimize product operation and use in order to enhance product performance and allow predictive diagnostics, service, and repair.	Battery Management Systems: Algorithms analyze battery health and optimize flight patterns for energy efficiency. Logistics Drones: Route optimization algorithms reduce delivery times and save costs by selecting the best paths based on real-time traffic and weather data.
Autonomy	The monitoring, control, and optimization capabilities of SCPs will lead to the fourth capability of autonomy. This helps to allow autonomous product operations, product enhancement and personalization, self-coordination of operation with other products and systems, self-diagnosis, and service.	Autonomous Drone Deliveries: Drones autonomously navigate to destinations, adjusting routes based on real-time conditions. Swarm Drones: A network of drones coordinates independently for large-scale tasks like search-and-rescue operations or agricultural spraying, with minimal human intervention. Self-Diagnostics: Drones perform regular self-checks and report potential maintenance needs.

While the application of these capabilities varied across different sectors, it played a crucial role in driving innovation and advancing the use of drones in fields such as logistics, agriculture, and disaster response. Additionally, these capabilities improved the overall utilization and effectiveness of drones in addressing real-world challenges across various other applications. Recognizing the potential of drone technology, policymakers, investors, and entrepreneurs have shown keen interest in these sectors over the last decade. The advancements have reshaped market dynamics, attracted investment, and expanded the scope of drone applications. Companies such as TSAW led this evolution by leveraging AI and cloud technologies to enhance drone capabilities. As SCP technology advances, drones are set to become increasingly vital in driving technological progress and addressing global challenges. This integration highlighted the profound influence of SCPs in defining the future of drone technology and its varied applications across multiple industries.

6.1 Logistics Efficiency

In the logistics sector, the monitoring and control capabilities of drones have significantly enhanced operational efficiency. Drones equipped with SCPs could efficiently navigate urban environments and optimize delivery routes by integrating real-time data. The integration of Geographic Information Systems (GIS) with drone technology has further improved operational efficiency by reducing delivery times and costs. GPS- and GIS-enabled drones could expedite delivery processes and allow drones to navigate difficult terrains and access otherwise inaccessible areas. This could also enhance the efficiency of geographic data collection, analysis, and visualization efficiency for future developments. Studies suggest that using drones for delivery services could lower costs by 22.13%, cut carbon emissions by 24.90%, and shorten delivery times by 20.65%, compared to traditional methods (Bauer et al., 2021).

6.2 Agricultural Innovation

According to studies by Radoglou-Grammatikis et al. (2020), SCP-equipped drones could play a major role in crop management through AI-driven precision monitoring in the agricultural sector. Utilizing GIS technology in precision agriculture, drones can be used to capture high-resolution imagery and detailed maps of crop health. This could assist farmers in monitoring crop growth, rapidly identifying issues, and efficiently allocating resources. To minimize wastage of fertilizers and pesticides, GIS-enabled drones could support spatial data analysis, optimizing the targeted application of these inputs on crops. This could reduce the environmental impact by lowering chemical usage, optimizing irrigation practices, and ultimately leading to better crop yields.

6.3 Disaster Response

During natural disasters such as hurricanes, earthquakes, and floods, it can be nearly impossible for humans to reach affected areas. In such scenarios, drones equipped with SCPs could play a critical role by providing essential data for prompt evaluation and coordination of response efforts. Drones fitted with sophisticated sensors and cameras provide real-time information by monitoring and gathering data, which could be used to refine rapid response strategies. GIS technology can be used to enable spatial analysis of the impacted area, helping to assess damage, and swiftly determine necessary relief measures. In particularly difficult disaster zones, where human responders might face significant challenges, drones equipped with GIS technology could enhance decision-making accuracy, reduce response times, and improve overall operational safety (Daud et al., 2022).

7 Products and Innovations of TSAW Drones

TSAW's products were advanced and diverse, adapted to the changing requirements of the drone industry. One notable application of TSAW's technology was the use of drones to transport oncological tissues during surgeries, highlighting its capabilities in healthcare logistics. However, this sector faces strict safety and efficiency challenges due to the precise requirements of healthcare logistics. To address these issues, TSAW launched its Unmanned Traffic Management (UTM) system, which aimed to enhance the healthcare system by ensuring safer drone operations. This system featured automated flight planning, real-time airspace monitoring, digital air traffic control, sophisticated collision avoidance,

streamlined incident reporting, and reliable drone tracking.[20] In early 2024, TSAW introduced LogHat, an innovative tool that has transformed the analysis and simulation of drone log files. LogHat provided extensive analytics, advanced simulation capabilities, an intuitive interface with detailed visualizations, and quick diagnostic and predictive tools, all designed to help drone professionals and businesses enhance their operations, ensuring improved safety, efficiency, and performance (TSAW Drones, 2023).

At Aero India 2023, TSAW made a significant impact with the launch of its hybrid fixed-wing Vertical Take-Off and Landing (VTOL) drone, the Adarna V2. This in-house-designed drone merged the best attributes of fixed-wing and rotary-wing drones, offering versatility for applications in logistics, surveillance, environmental monitoring, and infrastructure inspection. The Adarna V2 is equipped for vertical takeoff and landing, agile maneuvering in confined spaces, and navigation across challenging terrains. TSAW's innovative QR-based landing technology further boosted its performance, enhancing operational accuracy and safety. Renowned for delivering advanced and cost-effective solutions, TSAW positioned itself as a major player in the drone sector. With a specialized division focused on drone logistics and drone software, TSAW offered a range of products poised to revolutionize industries such as e-commerce, healthcare, agriculture, infrastructure, and industrial applications.

7.1 Drone Logistics Division

In response to a 50% increase in demand driven by e-commerce, food delivery services, and the extensive uptake of 4G technology across India, TSAW Drones aimed to address a major logistical hurdle. Its drones could travel 50 km in just 15 minutes, enabling them to deliver to all 20,000 postal codes throughout India, including the most inaccessible ones.[21] The company achieved an impressive milestone, delivering over 43,000 packages, logging nearly 300 flight hours, and covering 25,045 km. TSAW Drones has established itself as a trusted partner for e-commerce platforms, handling drone deliveries for online stores. By strategically situating drone hubs, it facilitated efficient hub-to-hub delivery. It also collaborated with eco-friendly electric vehicle (EV) providers to ensure a seamless and sustainable final delivery experience for customers.

In healthcare logistics, TSAW Drones offered easy-to-set-up services, flexible scheduling, live order tracking, and safe delivery to medical facilities and pharmacies. Its drones were specifically designed to carry insulated containers, maintaining the integrity of temperature-sensitive packages, and adhering to the rigorous requirements of organizations such as UNICEF.[22] TSAW Drones has proven its intent to transform healthcare logistics by pioneering the first-ever drone delivery of oncological tissues during surgery in India, highlighting its dependability and capabilities in critical areas.

Beyond healthcare, TSAW Drones has provided cutting-edge solutions for educational institutions, business offices, residential areas, and manufacturing sites. Its drones have enabled quick, secure, and on-demand transportation of textbooks, office and school supplies, groceries, parcels, and food orders, enabling students, faculty, and workers to receive immediate deliveries efficiently.

7.2 Software Division

The software division of TSAW provided services related to drone technology. The main services included automated flight planning, real-time airspace surveillance, advanced collision avoidance, digital air traffic control, and efficient incident reporting. These features, provided by their UTM system, were designed to enhance safety and operational efficiency, providing significant value. Additionally, TSAW Drones offered the Drone Cloud Intelligence System (DCIS), a sophisticated software suite that supports fleet management, real-time data processing, automated flight management, and 5G-based ground control station (GCS) operations. This system optimized flight path development, obstacle avoidance, rerouting, and fleet health monitoring, thereby increasing the safety and efficiency of drone operations.

[20] TSAW's website have mentioned about their products and solution both in terms of hardware and software. Retrieved from https://tsaw.tech/#dls

[21] Information retrieved from the logistics section of TSAW's official webstie. https://tsaw.tech/#dls

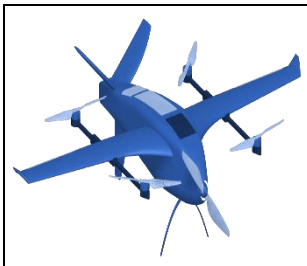
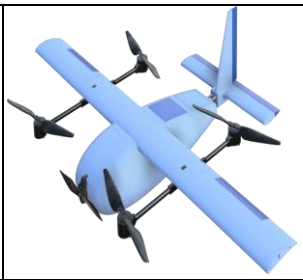
[22] Singh, B. (2024, October). *Case Study: Transforming Rural Healthcare Logistics with TSAW Drones*. Retrieved from https://tsaw.tech/blogs/case-study-transforming-rural-healthcare-logistics-with-tsaw-drones

7.3 TSAW Drone Fleet and Features

A notable innovation of TSAW Drones was a drone with a four-meter wingspan, capable of ascending to altitudes of up to 10,000 feet and transporting an 8 kg payload across a distance of 100 km, all for under ₹7 lakh. This price point was considerably lower than the typical market price of ₹15–18 lakh for a comparable model. Its drones were equipped with payload compartments designed to carry temperature-sensitive deliveries in cold boxes, meeting the stringent standards set by organizations like UNICEF.[23]

By prioritizing efficiency and cost-effectiveness, TSAW Drones were well-positioned to significantly reduce operational costs and enhance the reliability of logistics operations. The company's advanced fleet exemplified its ability to innovate across various segments and applications. TSAW Drones' flagship products demonstrated their versatile and cutting-edge capabilities, from hybrid VTOL drones to heavy-duty industrial models (see Table 4).

Table 4. TSAW Drone Fleet (Source: TSAW, n.d.)

			
Adarna V2	Adarna Mini	Maruthi 3.1	Airawat
120 km	80 km	40 km	Long range

The Adarna V2, Adarna Mini, Maruti 3.1, and Airawat drones varied in range, payload capacity, and endurance. The Adarna V2 had a range of 120 km and could carry up to 8 kg, while the smaller Adarna Mini offered a range of 80 km with a 2 kg payload. The Maruti 3.1 could handle up to 20 kg over a distance of 40 km, and the long-range Airawat supported a significant 500 kg payload designed for heavy-duty operations. All drones have an endurance of 60–90 minutes and can operate at maximum heights of 3,500–4,000 meters.[24] All these fleets can be used for different industrial applications, especially in the logistics sector. In healthcare applications, where precision and accuracy are critical, the margin for error is minimal, and the value of items transported is significantly high in terms of human value. The Maruthi drone, engineered specifically for delivering temperature-sensitive pharmaceutical products and vaccines, demonstrated the significant advantages of drone technology in healthcare logistics by facilitating rapid and reliable deliveries in remote areas.

TSAW Drones' innovative products and solutions positioned them at the forefront of the drone industry. The company was set to redefine the future of drone operations by focusing on efficiency, cost-effectiveness, and advanced technology. Its commitment to innovation and excellence ensured that it continued leading the way in transforming industries through cutting-edge drone technology.

8 Collaborations and Strategic Partnerships

TSAW Drones engaged in several strategic collaborations to expand its reach and services. It signed an MoU with DE Drone World Solutions at Asia's largest air show, Aero India 2023. This partnership was aimed at developing and promoting innovative drone solutions for various industries (India Strategic, 2023*)*. Satish Kumar, MD of DE Drone World Solutions, expressed his enthusiasm, stating,

> The collaboration with TSAW Drones comes at the right time as we are gearing up to combine our extensive industry knowledge to advance drone-based solutions in India. I highly regard the business they have set up, and I am eager to develop the best possible solution for our corporate clients. Satish Kumar

[23] Times of India, report prepared by Arpit Sharma, reports about the launch of medicine delivery of TSAW, in Feb, 2023. https://timesofindia.indiatimes.com/videos/news/startup-launches-drone-delivery-of-medicines-in-kolkata/videoshow/97939585.cms
[24] TSAW's website have mentioned about their products and solution both in terms of hardware and software. Retrieved from https://tsaw.tech/#dls

In the field of medical logistics, TSAW partnered with several prestigious institutions to enhance healthcare delivery. For instance, AIIMS Gorakhpur successfully conducted a drone trial under high-wind conditions, demonstrating the reliability of TSAW's technology. Similarly, RSDKS Government Medical College in Ambikapur pioneered aerial medical logistics, while AIIMS Raebareli initiated futuristic drone delivery services, showcasing TSAW's capability to improve healthcare delivery through innovative drone solutions.[25] TSAW formed two major collaborations to address crucial logistics needs in the healthcare system. First, they joined forces with Zypp Electric to improve last-mile delivery.[26] Second, TSAW partnered with Simply Blood to enhance blood transportation services.[27] Additionally, TSAW introduced a B2C drone delivery service for medication in Kolkata in collaboration with Kanhaiya Life Care Medicine, further showcasing their capacity to improve healthcare logistics.[28] The scope of TSAW's medical logistics services was also expanded through its collaboration with GIMS Noida to deliver medical supplies.

In a strategic move, TSAW Drones partnered with the Open Network for Digital Commerce (ONDC), a private non-profit entity formed under the Department for Promotion of Industry and Internal Trade of the Government of India, to advance open e-commerce and facilitate deliveries to remote areas (Srinivasan, 2023). This collaboration allowed TSAW to tap into the rapidly growing e-commerce market, particularly in the post-COVID era. By implementing a per-flight charge model and reducing both capital and operational costs for clients, TSAW made drone logistics more accessible and cost-effective. TSAW's continuous focus on research and development (R&D), along with strategic partnerships, solidified its position as a leader in the emerging logistics category, capable of integrating AI, machine learning (ML), and other advanced technologies to create a robust supply chain ecosystem. In January 2024, TSAW Drones achieved a significant milestone by partnering with Accelerated Money for U (AMU), marking the first official entry of a non-banking financial company (NBFC) into drone debt financing. This partnership is expected to fuel growth in the UAV sector (Economic Times Auto, 2024). Nehal Gupta, Managing Director of AMU, highlighted the importance of this collaboration, stating,

> AMU's partnership with TSAW Drones is a huge milestone for us as we step into the advanced air mobility space. I am thrilled to witness how our powerful collaboration unfolds and its potential impact on the nascent UAV industry. Nehal Gupta

In the defense sector, TSAW Drones partnered with SpaceFields to develop solid propellant drones for defense use, including kamikaze drones, loitering munitions, and surveillance.[29] This collaboration was aimed at creating more affordable, reliable, and powerful drones, propelling India's defense industry to new heights. Through these partnerships, TSAW Drones demonstrated its commitment to driving innovation and advancements in drone technology.

9 Business Expansion Opportunities

India's drone sector encompassed a broad spectrum of firms catering to various industry segments, each with its own distinct expertise and market presence. Notable established players include ideaForge and Asteria Aerospace, alongside new entrants like DUMS and Raphe (see Table 5).

[25] TSAW Drones. (2024, May). *Drone delivery in rural healthcare.* LinkedIn. Retrieved from https://www.linkedin.com/posts/tsawdrones-india_dronedelivery-dronetech-ruralhealthcare-activity-7185856945512185865-hDy9/

[26] TSAW Drones. (2022, August). *TSAW Drone Delivery, with last mile via Zypp electric Scooters* [Video]. YouTube. https://www.youtube.com/watch?v=pahbyp6Gm6Y

[27] Hindustan times report prepared by Sandeep Kumar in Dec, 2021,reports about TSAW's partnership with SimplyBlood. https://www.hindustantimes.com/cities/others/maruthi-2-0-to-deliver-drugs-blood-to-remote-sites-101638298355461.html

[28] *Healthcare Radius.* (2023, April). *Kanhaiya Life Care starts B2C medicine drone delivery in Kolkata.* Retrieved from https://www.healthcareradius.in/features/technology/kanhaiya-life-care-starts-b2c-medicine-drone-delivery-in-kolkata

[29] Bots and Drones News India, Reported about the strategic collaboration between TSAW and SpaceFields in July, 2023 https://botsanddrones.in/news/f/solid-propellant-drones-for-defense-by-spacefields-tsaw-drones?blogcategory=Bot+%26+Drone+News+India

Table 5. Drone Players & Sectors (Source: IdeaForge, 2023)

Companies	IdeaForge	Asteria Aerospace	SDE intelligence	AUS	Adani	TATA	DUMS	Raphe	DCM Shriram
Year of establishment	2007	2011	2015	2013	2017	2012	2019	2017	2021
Defense	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Agriculture	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Energy and utilities	Yes	Yes	No	No	No	No	Yes	No	No
GIS, construction & real estate	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes
Mining	Yes	Yes	No	Yes	No	No	Yes	No	No
Oil and gas	Yes	Yes	Yes	No	No	No	No	No	No
Public safety	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Logistics	No	No	No	No	No	No	Yes	Yes	Yes
Passenger	No	No	No	No	No	No	No	No	No
Profit after tax margin (%)	33.7%	-23.8%	8.6%	4.9%	0.7%	13.4%	0.5%	600.0%	8.0%

The sector in which TSAW is majorly concentrated is the logistics sector. Advancements in drone technology present a potential future for the logistics sector, offering solutions that can reduce operational costs, enhance delivery effectiveness, and reach inaccessible areas. TSAW has capitalized on market opportunities within this sector, bolstered by several key elements. First, the surge in online shopping and food delivery demand, coupled with the widespread adoption of 4G technology across India, has created significant market potential. Second, the conventional logistics model has its shortcomings; for instance, a typical driver may end up wasting hundreds of hours annually due to delivery delays. Finally, the logistics sector faced a huge annual expense of US $22 billion due to high operational costs, highlighting the need for more economical alternatives. Identifying this potential market, TSAW developed fast, efficient, and cost-effective delivery solutions through drones. Open access to knowledge and incubator support enabled TSAW to establish itself within the drone industry. A community of passionate developers, along with funding from investors, allowed the founders to transform their initial idea into a comprehensive business model. The company secured ₹2.9 crore in funding from notable investors such as Log9 Materials, Zypp Electric, Chandigarh Angel Network, and We Founder Circle, with backing from IIT Delhi. Despite having achieved a strong position in the logistics sector, the temptation to expand into other sectors was equally strong as they present attractive opportunities. Most drone startups focused on expanding across different segments to seize new opportunities and leverage the changing liberal regulatory environment.

On the other hand, the reasons to focus on the existing sector were equally strong as this would result in a sharp focus on the logistics sector, the competition was growing in this category, and the present funding environment was tough. TSAW faced several challenges as it sought to establish itself, which included reduced entry barriers, which has intensified competition, pushing it to innovate continuously. One key area of innovation was digital technologies and AI integration. While AI and cloud computing significantly enhanced drone efficiency, these digital technologies were accessible to all competitors, making TSAW's innovations easily replicable. Therefore, the chances of competitors adopting similar digital technologies could impact the existing strong position of TSAW. In this context, TSAW's efforts to advance through AI integration and digital technology would determine its unique positioning in the logistics market. Otherwise, to ensure stable financial flow and broader market positions, TSAW, like other competitors,

could focus on multiple applications (see Table 5). However, this required significant resources and focus, presenting a constraint for most growing startups.

10 Decision Time

The founders of TSAW, Kishan and Rimanshu, stood at a crossroads, facing a rapidly evolving drone technology landscape compounded by a tough funding environment and growing investor concerns. The company has established a strong base in the healthcare logistics sector, leveraging its competencies over IoT, Drone Cloud Intelligence System (DCIS), Beyond Visual Line of Sight (BVLOS) operations, automated flight planning, real-time airspace monitoring, and collision avoidance systems among others. However, the advances in Artificial Intelligence (AI) and Machine Learning are reshaping the dynamics of the drone industry. Many companies are trying to improve their competencies around the technological changes that would determine their future. Each technology is directed toward different capabilities of autonomous drone systems, and companies need to decide, which technology to specialize in that would enhance their market position. Companies that build these specializations require resources to support their research and development, deployment, and market testing, among others, making these decisions financially demanding. For start-ups like TSAW with limited resources, deciding their future growth trajectory and aligning it with the need for specific technological advancement would be crucial.

For TSAW to remain competitive, they have two options: one is to innovate deeply within their existing vertical and enhance their healthcare logistics operations, and the other is to expand horizontally into other sectors like agriculture and infrastructure. In the first option, TSAW could focus on enhancing its healthcare logistics operations, leveraging emerging technologies such as IoT, big data, cloud computing, and AI to streamline processes and create a unique competitive edge. Concentrating on healthcare logistics would allow it to deepen its expertise in a critical and growing domain while mitigating over-diversification risks. It would help them to build their expertise around emerging technologies utilizing their current networks and specialization. However, this approach required substantial financial resources for testing and deploying advanced solutions, which might constrain TSAW's ability to expand into other high-potential sectors. To evaluate this option, the founders need to analyze both the industry and firm capabilities of TSAW (i.e., how the regulations around emerging technologies are evolving)? Who are the important stakeholders if TSAW tries to expand healthcare logistics? What verticals should TSAW concentrate on in healthcare logistics? How do they leverage their existing technological expertise in building their expansion in healthcare logistics? While doing this, they could use industry analysis frameworks like Porter's Five Force and SWOT analysis.

On the other hand, expanding into agriculture and infrastructure presented a promising opportunity to capitalize on the increasing demand for drones in these sectors. In the agriculture sector, drones are utilized for precision farming, crop monitoring, and resource optimization, while in infrastructure, they play a key role in surveying, construction monitoring, and maintenance. Entry into these sectors could diversify TSAW's revenue streams and open new growth avenues. Additionally, TSAW would need to build its expertise in technology around sector-specific demands; for example, high-resolution imaging and multispectral sensor technology are highly useful in the agricultural sector. However, this shift could dilute TSAW's commitment to the logistics sector, stretch its resources thin, and increase the risks of technological misalignment and operational inefficiencies. For the second option, the founders need to understand the industry landscape and the competitive dynamics to make strategies, make decisions, and execute their plans. Identifying the right competitors and planning competition strategies are the primary tasks for TSAW. Other concerns include understanding one's technological capabilities to expand into other sectoral verticals. Does their current position give them a competitive advantage to proceed with the second option? How could they leverage their existing funding options? In what directions should they step in first if they secure funds? They need to evaluate in detail the difference between horizontal and vertical growth strategy and its implications and the technological competence required for this.

The key strategic question that the TSAW management faces is: Should they concentrate on deepening their presence in healthcare logistics, or should they venture into agriculture and infrastructure to capitalize on emerging opportunities? What would be the potential trade-offs between focus and diversification on resource allocation? These dilemmas highlight critical points for deliberation as TSAW charts its future course. Furthermore, TSAW must consider strengthening its competitive edge against well-funded rivals targeting emerging sectors, ensuring its offerings remain relevant and differentiated. Finally, the company faces a key conundrum: would diversification dilute TSAW's identity as a specialized healthcare logistics provider or enhance its market appeal as a multi-domain drone solutions leader?

These questions are pivotal as TSAW navigates the trade-offs between focus and expansion in a fast-changing industry. They need to assess their capabilities using a resource-based view and the need to build a competitive advantage.

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