

# INDIA'S DRONES ECOSYSTEM: ENHANCING CIVIL MILITARY FUSION

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*“The enthusiasm that is being seen in India regarding drone technology is amazing. This energy is visible, it is a reflection of the quantum jump in the drone service and drone based industry in India. It shows the possibilities of an emerging large sector of employment generation in India.”*

– Prime Minister Shri Narendra Modi,  
Bharat Drone Mahotsav, 2022

## **Abstract**

Drones being a dual use technology have not only changed the character of modern warfare but also transformed governance and commerce. Military drones can carry a variety of armaments, such as missiles, guided bombs and provide real time intelligence, whereas commercial drones serve several civilian purposes such as land digitizing, support climate resilient industry and logistics. India envisions becoming a Global Drone Hub by 2030, exploiting the Drone Revolution. However, the growth of drone industry is at a nascent stage in India and requires a deeper Civil Military Fusion, akin to countries like China and the US. The paper critically analyses the gaps that exist in the drones ecosystem and outlines several recommendations especially for the industry sector, research and policy framework to promote synergized relationship between the three stakeholders i.e., the Indian Armed Forces, Industry and Academia and how it can make India a hub of global drones by the next decade.

## INTRODUCTION

Since the end of the Cold War, the character of warfare has undergone significant changes. The present geo-political environment demands varied ways to deal with threats, which included cross border counter-insurgency operations, conducting targeted strikes and Intelligence, Surveillance, and Reconnaissance (ISR) Missions. *Leveraging new military technology to meet these challenges is of utmost salience.*

**Unmanned Aerial Vehicles (UAVs) or drones became a critical weapon as a part of ISR and punitive operations.** India, the world's largest democracy and one of the most rapidly growing economies, has a significant impact on international political and economic issues in this century. *However, there are a few external and internal security concerns for the rising power. India faces threats from its neighbouring countries, primarily Pakistan and China, as well as cross-border terrorist groups.* To address these challenges, **it is imperative to prioritise self-reliance in defence manufacturing especially by reducing foreign dependency while countering these threats.**

For India, *military modernisation is a priority, and UAVs can be at the forefront to deal with these security challenges.* The Indian Armed Forces have already inked several deals with domestic drone companies. According to the latest report from consulting firm 1Lattice, **the UAV market is currently estimated at \$43 million.**<sup>1</sup> *The next decade will witness a drone revolution, and this could be the finest opportunity for India to become a Global Drone Hub by 2030.* To achieve this, India must concentrate on a few fundamentals, including cost competitiveness, reliability, high quality, and indigenusness. Additionally, **India requires a strong Civil Military fusion where the best military minds collaborate with the brightest industry professionals and academia.** This will definitely *spur the growth of dual-purpose technology* like drones and *help to meet India's demands for both military and civilian use.*

## CIVIL MILITARY FUSION (CMF) IN DRONE TECHNOLOGY

India lacks an evolved CMF Strategy unlike the US and China. *The benefits of CMF are manifold, offering the unique advantage of leveraging civilian*

*technologies for military applications and vice versa.* This approach not only enhances economic viability but also significantly shortens development timelines.

Amidst the ongoing global crises, it is critical to note that they have severely disrupted the defence supply chains. **These disruptions underscore the need for a resilient and adaptive CMF strategy, thus, encouraging the two stakeholders i.e., industry and the armed forces, to reduce the reliance on imports.** There is an urgent need of *Atmanirbharta* (self-reliance) through cooperative relationships with friendly nations and partners. To achieve this *India needs to develop a strong CMF which would be based on a judicious resource management, swift and fair procurement procedures, supportive policies and innovative R&D and technologies.* India has already seen a spurt in defence export and industry participation in **Def Expo 2022** and **Aero India 2023** under **Make in India.**

However, *in an exclusive interaction, a drone professional* has opined that **India's CMF is still at a sub-optimal level.** *This is mostly due to the military not being able to provide clearly defined requirements to its civilian counterparts.* He further emphasized **the importance of a structured roadmap, particularly given the fragmented nature of the civilian sector.** Such a roadmap, spearheaded by the military, would establish essential guidelines. *This collaborative approach is crucial for fostering growth across all three sectors, providing a unified methodology for effective cooperation.*

## **PRESENT GLOBAL DRONE SCENARIO & TRENDS IN CMF**

The trajectory of drone development has been promising, given its 'game changing' effect on conventional warfighting. *Proliferation of drones by state and non-state actors has also steadily increased.* UAVs used for surveillance date back to the 1980s.<sup>2</sup> Post 9/11 attacks, the US escalated the use of drones to target terrorists' groups, as hunter-killers. Drones were recently deployed for assassinating Iranian Major General Qasem Soleimani.<sup>3</sup> *Additionally, drones were also deployed to counter non-state actors like the Islamic State and Boko Haram, and lethal attacks using drones have steadily grown.* However,

the **Nagorno-Karabakh Conflict (2020)** induced a paradigm shift in the use of drones. The conflict *highlighted* that there are *entrenched vulnerabilities in conventional weapon systems without specific drone defences*.

The 44 days conflict between Armenia-Azerbaijan was a harbinger to what was to occur in Ukraine. *The ongoing Russia-Ukraine conflict has also highlighted the advantages of small and medium sized drones, calling for a revisit to CMF strategies in drone production*. Existing players like **China** and new entrants **Iran** and **Turkey** are revolutionizing the global drone market. **Iran's Shaheed 136** drones are being leveraged by Russians, filling a capability until it can boost indigenous UAV manufacturing.

China's civil and globally acclaimed drone company; **Da-Jing Innovations (DJI)** (大疆创新- meaning *Great Frontier Innovation*) has transformed the global drone industry. It is estimated that *China has sold \$ 12 million worth drones to Russia* to fill the gaps of combat drone, **especially DJI's Mavic 3**. Interestingly, *DJI commercial drones costing \$2000 or even less* have made inroads into the war. **These DJI drones are now being purchased on several legal and illegal platforms, and being re-configured for military purposes**. These commercial drones although not having sophisticated configurations, have high precision to target and destroy.

In April 2023, *Pakistan imported the first batch of Bayraktar Akinci* combat drones from **Turkey**,<sup>4</sup> in spite of Pakistan's growing economic challenges. Additionally, Pakistan has been importing the *Chinese Cai Hong-4 (CH-4)* and the *Wing Loong-II* since 2018, in order to increase its military infrastructure. During the Galwan Standoff, *both India and China employed drones for monitoring the frontiers*. *MQ-9 SeaGuardian* drones, on lease to Indian Navy, *were employed by the Indian Navy to monitor Chinese activity in the Indian Ocean Region (IOR) post the Galwan Valley clash in June 2020*.<sup>5</sup>

India's border disputes and the evolving nature of modern warfare in the ongoing Russia-Ukraine War highlights *the need to integrate a coherent CMF strategy for the drones ecosystem and fill the gaps between policy and technology development in the country*.

## GLOBAL CMF MODELS IN DRONES

India is a largely new entrant to leveraging drone technology but has made great strides in incentivizing and promoting drone industries while also nurturing talents to have drones manufactured indigenously. Nevertheless, it is essential to draw key lessons from leading drone exporting countries.

**US.** The American drone market is expanding and by 2024 it is predicted to increase threefold. The *market for drones is divided into catering the drone supply based on two factors-application and geography*. A **collaborative drone community** and **technology adoption** remain the *key characteristics for the development of drones in the US*.



Source: The Drones World, 2022 URL: <https://thedronesworld.net/drone-industry-in-the-us/>

**Drone policies** in the US are monitored by the *Federal Aviation Administration (FAA)* that *issues regulations, expands opportunities for R&D and also integrates industrial policies to create an interactive drone ecosystem in the country.* Drones have expanded in the US to an extent where leading *companies like Amazon* have introduced *drone delivery services* known as '**Prime Air**', enabling same day delivery.

In order to *encourage the use of drones in the commercial sector*, drone manufacturers are *working with service providers to offer cutting-edge technology-integrated drone solutions.* Additionally, the FAA also **identifies Center of Excellences (CoE) designated to conduct quality R&D** by leading *Universities* across the country that look into critical areas for the successful integration of drones in the US's airspace. The **FAA is presently collaborating** with the **National Aeronautical Space Agency (NASA)** to resolve *issues related to Unmanned Traffic Management (UTM).* The FAA works closely with other agencies including business, academia, and government in order to frame rules, guidelines, and standards for drone operations.

**China.** The *Civil Aviation Administration of China (CAAC)* is the nodal agency that monitors drone development in the country. The CAAC *has established test areas known as drone sandboxes across the nation for the testing of drone systems and operating procedures.* The CAAC devises **comprehensive regulatory programs to compliment the drone industry** in China.<sup>6</sup> A significant state-funded initiative to upgrade the nation's armed forces to "world class standards" is partially responsible for China's dominance of the combat drone market worldwide.

Chinese drones are characterized by *their cost effectiveness and delivery precision.* **China's unmanned programs are inherently technological showcases made to encourage homegrown inventiveness.** Local businesses work on these initiatives to improve their capacity for prototyping, developing, and manufacturing.

China already operates a variety of UAVs, including different **short-range systems**, tactical UAVS, such the *ASN-209 tactical UAV system*, and **Beihang University-developed BZK-005 MALE reconnaissance UAV.** It is apparent

that the PLA wants to enhance these capabilities.<sup>7</sup> Further, **China is said to have invested \$322.6 million in the construction of a civilian R&D drone station in Taiyuan**, reflecting the significance of nonmilitary applications for unmanned systems. *SF Express, the largest delivery service in China, is testing drones to carry packages with the CCP's approval.*<sup>8</sup>

**Turkey.** Turkey has emerged as one of the top users and producers of armed drones globally. A *Do It Yourself (DIY) strategy can be attributed to this rapid growth*. The US Congress sanctioned sale of combat drones to Turkey in 2010 and 2012, because of concerns that the technology might be used against Israel. Therefore, *Turkey decided to make its drones with two agencies; Turkish Aerospace Industries (TAI) and Baykar Makina.*

Today's Bayraktar TB2 drone that are being employed in Russia-Ukraine conflict, was the **brainchild of Selcuk Bayraktar** who briefly pursued education in America's MIT only to return to Turkey to develop armed drones. *Baykar imported high tech parts that Turkey was unable to develop indigenously and since many of these parts could be used in either civilian or military applications, and were therefore not subjective to export restrictions.*

The shift began in the early 2000s, when Ankara set forward a plan to develop a contemporary, *self-sufficient defence industry and promote local investment. The sheer volume of international deals that Turkey's defence companies have closed over the past few years indicates fast increasing demand, significant R&D investment, and an expanding source of diplomatic clout for Turkey.*<sup>9</sup> *Techno-nationalism and the guided intervention has completely transformed the drone's market in Turkey. Further, drones have given the Turkish government a new tool for projecting its foreign policy as a growing regional power.* Turkey is already exporting its HALE Bayraktar Akinci drones to the Middle East and Pakistan.

## **DRONE STARTUPS IN INDIA: AN OVERVIEW**

The startups today are working on "*Next generation Missions and Technologies (NGMT)*". Although the growth of drones started in 2018, the shaping of this technology to command the skies in 2030 is projected.



Although there exists objectives and plans, the main focus should be on what is doable.

So far, India has seen the rise of several key players that are *making significant contributions to both the domestic and international markets*. **Idea Forge**,<sup>10</sup> **State-owned Hindustan Aeronautics Ltd.**,<sup>11</sup> **Zen Technologies**,<sup>12</sup> **Bharat Forge**,<sup>13</sup> Lastly, **TSAW Drones**, a startup originating from IIT Delhi, is working on enabling logistics through drones.<sup>14</sup> There are a *few problems, which retard the growth of these startups*. **Competition from government programs and involvement from agencies like DRDO**,<sup>15</sup> **lack of alignment between civilian technology and military requirements**, **limited growth-phase funding**, **the complex certification process**, and **a lack of effective collaboration and interaction between the industry, armed forces, and academia**, has hindered the growth of these startups.

*Air Marshal GS Bedi* opines that *India's drone startup should focus on domestic manufacturing as 70% of components are still imported and then assembled in the country*. There's also the *practice of rampant white-labelling which must cease for substantial sectoral advancement*.<sup>16</sup> Therefore, *perseverance as well as patience in terms of the industrial involvement and support in terms of schemes from the government and integration through civil military fusion are the key elements*.<sup>17</sup>

## USAGE OF DRONES: AN INDIAN PERSPECTIVE

Drones are a *dual use platform* that can be used for either purpose with innovations and modifications. The different usage of drone technology *by military, civil and non-state actors* have been discussed in the table below:

Table 1

Capabilities	Military Use	Civilian Use	Use by Non-State Actors Against India's National Security
<b>Endurance &amp; Power</b>	Persistent UAVs for long sky stay crucial for making critical battlefield decisions.		



	Solar & Air Launched UAVs. <sup>18</sup>		
<b>Teamwork &amp; Coordination</b>	Manned Unmanned Teaming (MUMT) with Indian Air Force. <sup>19</sup>		
<b>Data &amp; Intelligence</b>	Intelligence for unmanned combat air vehicle.	Digital land records	
	Leveraging Cyber-Physical Systems that encompass various layers, including sensing and perception.	Under the SVAMITVA initiative, drones have successfully mapped around 42,000 villages across several states, providing high-quality data quickly and cost-effectively. <sup>20</sup>	
<b>Survivability &amp; Security</b>	Survival in contested airspace		Pakistan delivering drugs in Punjab, India.
	Drones that can operate in communication-denied or GNSS-denied environments		In June 2021, the terrorist attacks on the Jammu Indian Air Force facility verified fears that non-state organizations are using drones in terrorist activities. <sup>21</sup>
	Indian Army has acquired drones which remain impervious to current jammers in India, with kinetic counter drone strikes being the only effective means of neutralization		Chinese civilian drones easily available which could be used by non-state actors against India
<b>Applications &amp; Contracts</b>		Drones in mining & forest preservation.	
		Climate resilient agriculture. <sup>22</sup>	

Source: Authors.

While the table above highlights the capabilities of drones in India, it also underscores significant shortcomings. **Currently, India does not possess the adequate capacity or the essential sensors to detect, track, monitor, and neutralize drones should they become rogue.**

### GOVERNMENT POLICIES TO SUPPORT INDIAN DRONE INDUSTRY

India is presently undergoing a technological revolution that will bolster existing industries for 'Atmanirbhar Bharat'. After the liberalization of **Drone Policy 2021**,<sup>23</sup> the government additionally introduced *a series of policies to incentivise existing drone industries* and further provide a platform for indigenization.

**Table 2: Policy Measures Enhancing CMF**

Name of Policy	Key Features
1. <b>Innovation for Defence Excellence (iDEX)</b>	<ul style="list-style-type: none"> <li>Engaging MSMEs, research and academia directly linked to the user at the R&amp;D stage;</li> <li>Aims to provide grants, funding and other potential forms of support;</li> <li>iDEX Prime funding enhanced to Rs 10 cr.</li> </ul>
2. <b>Defence India Startup Challenge (DISC)</b>	<ul style="list-style-type: none"> <li>Launched in 2018 and aimed at supporting Startups/MSMEs/Innovators to create prototypes and/or commercialize products/solutions;</li> <li>Awards Rs. 1.5 crores in the form of grant/equity/debt;</li> <li>Successfully establishes synergy between R&amp;D, Academia, Armed Forces and Industry.<sup>24</sup></li> </ul>
3. <b>Development Cum Production Partner (DcPP)</b>	<ul style="list-style-type: none"> <li>DRDO led DcPP engages industry as Development Partner (DP) during execution of drone projects;</li> <li>Indian Industries get free access to DRDO patents.</li> </ul>
4. <b>Technology Development Fund (TDF)</b>	<ul style="list-style-type: none"> <li>Provides financial support to MSMEs &amp; Startups for design &amp; development of innovative defence products;</li> <li>Funding through the means of grants-in-aid.</li> </ul>

<p>5. <b>Defence Acquisition Programme (DAP) 2022</b></p>	<ul style="list-style-type: none"> <li>• Promotes “indigenization” for capital purchases;</li> <li>• The ‘Buy and Make’ category was replaced with ‘Buy Global-Manufacture in India’;</li> <li>• Amendments to Buy (Indian-Indigenously Designed, Developed and Manufactured)/ Buy (Indian-IDDM);</li> <li>• ‘Make’ category was divided into three subcategories;</li> <li>• Categories for ‘Innovation’ and ‘Leasing’ were added.</li> </ul>
<p>6. <b>Production Linked Scheme (PLI)</b></p>	<ul style="list-style-type: none"> <li>• PLI programme designed for drones and its parts;</li> <li>• Aimed at increasing India’s drone manufacturing capacity by earmarking norms for both MSME and Non-MSME.</li> </ul>
<p>7. <b>Open Challenge Programme (OCP)</b></p>	<ul style="list-style-type: none"> <li>• Aims to “identity, recognize &amp; reward” to the aspiring and early-stage tech innovators and entrepreneurs;</li> <li>• Assist entrepreneurs and innovators in strategic networking, seed funding, state-of-the-art incubation.</li> </ul>

Source: Authors.

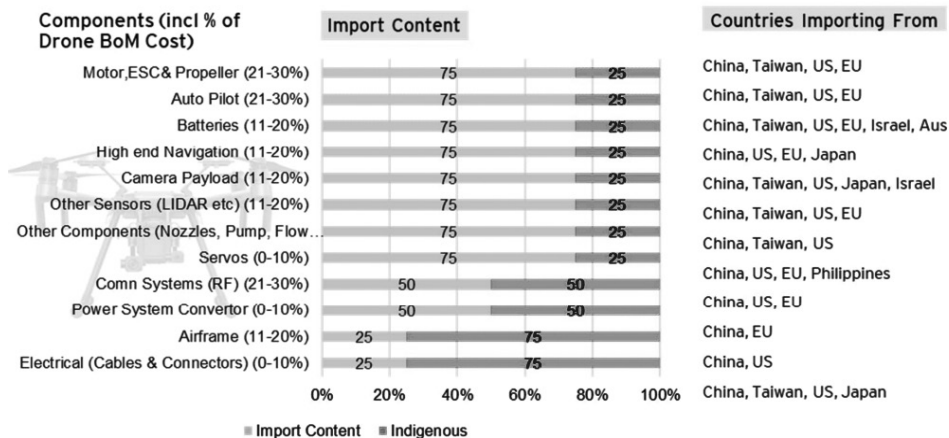
## CHALLENGES TO THE INDIAN DRONE INDUSTRY

### *Policy Gaps*

- **Absence of UTM.** Drone registrations in India have increased significantly, with 29,500 drones registered in 2021 and adoption is predicted to rise in the next two years. The *turnover of the Indian drone industry will increase from 60-80 crore to 900 crore by FY 2024.*<sup>25</sup> Despite the skyrocketing numbers for drone registrations, the *question of integrating the UTM ecosystem with the Air Traffic Management remains unresolved, though UTM Policy Framework was released on 24<sup>th</sup> October 2021.* The UTM ecosystem is envisioned as a cooperative extension of the existing Air Traffic Management (ATM) services, but for unmanned aircraft in airspaces where such ATM services are either not currently available or are unable to handle the anticipated volume of unmanned aircraft traffic.

The UTM is how the airspace can be managed 'Beyond Visual Line of Sight' (BVLOS) for multiple drone operations that can be conducted at low altitudes. Restrictions on private entities by **India's Drone Rules 2021**, identifies and **classifies fly zones into red, green and yellow**.<sup>26</sup> The **US, Netherlands, Israel** have resolved issues relating to UTM calling for a greater integration into the air defence system. Notably, the Israel Innovation Authority, Ayalon Highways Ltd, and the Israel Civil Aviation Authority developed new procedures and technologies to allow 150 kg drones to fly up to 150 km in and between urban centres.<sup>27</sup> Additionally, *the lack of military UTM and accompanying technologies could become a source of attrition both during peacetime and conflict*. As a result, there is **an urgent need** for the development of *remote identification systems and UAS UTM*, as well as their *integration* with the air defence system.<sup>28</sup>

- **Self-Reliance in UAV Manufacturing.** In February 2022, the **Directorate General of Foreign Trade (DGFT)** banned the import of foreign drones to promote an indigenous drone ecosystem in India. Nevertheless, this move *did not limit imports of drone components* for which India remains largely dependent on global players.



Source: EY Knowledge Report on Drones 2022<sup>i</sup>

<sup>i</sup> Ernest & Young and FICCI (2022), "Making India The Drone Hub Of The World" [online: web] Accessed 03 September 2023, URL: [https://assets.ey.com/content/dam/ey-sites/ey-com/en\\_in/news/2022/09/ey-ficci-drones-report.pdf](https://assets.ey.com/content/dam/ey-sites/ey-com/en_in/news/2022/09/ey-ficci-drones-report.pdf)

- Although the government has formally adopted the import ban, *there continues to be grey areas between the ban on imports and the schemes like PLI. Domestic manufactures are not at par to develop and meet the quality threshold of leading drone exporting countries due to lack of funding and no dedicated R&D in this field. Critical components such as electronic chips, batteries, software are still being imported and therefore true 'Atmanirbharta' has been not achieved in manufacturing 'Made-In-India' drones.* A robust and self-reliant drone ecosystem that matches global standards, plagues the promising drone industry in India.
- **Undefined Trajectories for Drone Development.** India has many centres of excellence for drones and other emerging technologies. However, it *lacks defined trajectories of development* when compared to global players, particularly the US, Europe and China.<sup>29</sup> *The trajectories of development generally followed by these countries are compartmentalized into Funding, Timeline and Objectives, whereas such tailored and defined trajectories are missing in the Indian scenario.* The defence sector projects are said to follow certain defined and structured timeline, much contrasting to the civilian scenario. *Additionally, there are no designated policies for the development of Civil UAVs in India.*
- **Proliferation of Drones.** Proliferation of drones is similar to gun proliferation and no substantive policies exist to counter it. **Non-State actors and anti-national elements continue to proliferate drones using illegal and unlicensed means.**

### *Industry Gaps*

- **Matching Civil Tech to Military Needs.** The main emphasis of India's drone startups must be to enable the Armed Forces with better equipment. However, *the challenge is to map their engineering capability with the need of the Armed Forces.* Therefore, *the challenge for the startups to map its technology to the need of the user continues to be a significant and an unresolved issue.*<sup>30</sup>

- **Ideating.** Ideating and then incorporating that technology to create any infrastructure is a daunting task. Looking at the historical records, *there are not many products that most startups have been able to develop and deliver.*<sup>31</sup>
- **Seed Funding.**<sup>32</sup> Seed funding is often the *first hurdle; even after securing it, many companies struggle to obtain the crucial growth-phase funding.* This is particularly problematic for big-ticket startups aiming for large-scale projects, such as developing a substantial UAV program. *While they might secure an initial seed funding of Rs 10 crore, the overall program cost could be as high as Rs 100 crore, leaving the startup to grapple with sourcing the remaining Rs 90 crore.* Although there is a policy assurance of procurement, the challenge of raising that additional capital remains a significant barrier. **It's crucial to understand that the journey from initial prototyping to a market-ready product involves multiple iterations, rigorous testing, and certification processes, making the funding aspect even more critical.**<sup>33</sup>
- **Certification.** Certification is a challenge for the startups. Currently, **Directorate General of Quality Assurance (DGQA)** handles military induction checks. However, it only assesses certain sensors and not the entire air vehicle. *Startups lack exposure to certification processes, which currently lack a mechanism for resolution.* For, the development of manned aircraft, five years are dedicated to technology development, and an additional three to four years are required for testing and certification. The challenge arises as to **who would bear the funding for drone certification.**

### *Gaps in Academia*

- **Lack of Interaction Between Industry, Academia and The Armed Forces.** While initial steps have been taken India still needs to bridge the gap between the three fraternities.
- **Academia's Contribution.** *Academia enjoys a less competitive landscape when it comes to government funding, compared to industry.* For instance,

institutions like *IITs often receive swift financial approval from the Department of Science and Technologies* for product development. *Despite this advantage, academia tends to focus more on the theoretical aspects of a product rather than its practical applications.*<sup>34</sup>

- **Big Industries Lack Research And Development (R&D).** Expectations of R&D from startups are pressing, but *these startups lack the true capacity of fulfilling quality R&D.* Even a giant R&D organisation like DRDO, with the central theme of R&D has not been able to roll out a UAV as of yet. Big business houses must get involved and spare some funds for that. *The Government has created a National Research Fund, but how much of it will fall in this sector, cannot be ascertained.*<sup>35</sup> The big industries in India like the *big five, Tata, Mahindra, Kalyani, Reliance and Adani, undertake limited R&D and are mostly focused on Transfer of Technology (TOT).*

## RECOMMENDATIONS

### *Policy Recommendations*

- **Integration of a Comprehensive UTM System.** The approach towards *UTM and the integration of drones with the Air Defence System and Digital Sky*<sup>36</sup> *seeks civil-military actions.* The results of such approaches have started to surface especially after **the launch of Skye Air,**<sup>37</sup> *UTM that allows drone operators across India to plan routes and avoid risks before any drone-related operation.* Skye Air UTM is a first of its kind and therefore sets a benchmark for more private players to address the issue of UTM integration. Additionally, *registered third party users may be allowed to extract data safely and securely from Government led applications like Digital Sky to facilitate in developing more user friendly UTM applications that can accommodate special features pertaining to terrain, disaster, weather etc.* More research and technological developments are needed to create both civil and military UTM ecosystems. *Civil-Military IDDM projects can also focus on creation of capabilities that provide safe integration of the UAVs in both UTM and military air space management.*



The development and implementation of UTM systems will be essential in enabling the safe and efficient integration of drones into the existing air defence system as the drone market continues to grow.

- **Develop Medium Term Objectives.** In the light of recent geopolitical developments, *the need to reconfigure civilian drones for military purposes have arisen, thereby calling the drone industry to boost production.* Nonetheless, *the key drone manufactures are often hamstrung due to lack of concrete mid-term objectives.* **Medium Term target specifications must be conveyed and monitored on a Medium Term policy level to monitor the development of drone prototypes.** Medium Term objectives must be outlined by the user prior to tendering to the industry.<sup>38</sup>
- **Need Of A Central Body.** Aeronautical Development Establishment (ADE) under DRDO has initiated projects with various agencies, including VRDE Indigenous Engine development, CVRDE Landing Gear, DRDO HQ, SME (68), NSTL RCS Studies, CAIR Uplink Security, along with payload development such as LRDE and IRDE.<sup>39</sup> However, there **lacks a central oversight project management approach.** Thus, there is a need to partner with industry for various future platforms, using models such as MUM-T platforms, IDDM, and other suitable models.

### *Industry Recommendations*

- **Upgrade The Technology Markets.** One of the biggest challenges is that the Indian markets for drone technologies are still lagging behind when compared to China and the US. This is *mostly due to the fact that drone proliferation and industrialisation has started very recently i.e., in the last three to four years in India.* Therefore, upgrading these technology markets is of great salience.<sup>40</sup>
- **Involvement of End User at The Research And Development Stage.** It is very essential to know and get the end user involved right at the R&D stage. This is critical because it supports the startups in developing the requirements and at the same time find a ready buyer once it crosses the desired technological milestone.<sup>41</sup>

- **Private Industry led R&D Funding.** A considerable share of fundings for the startups and companies are expected from government and government led agencies. For example, the **Indian Air Force's Mehr Baba Drone Competition** delivered the platform for the entry of Swarm drones led by Startups. Such tailored *competitions or funding programmes can be encouraged and anticipated from key private industry and investors to promote quality and excellent R&D for drones in India.*

### *Recommendations For Academial Services*

- **Role of Mandated Agencies.** *Strengthening interaction between the industries and armed forces is of utmost salience.* There exists mandated agencies to connect the two fraternities such as the Directorate of Aerospace Design for Air Force, Technology Development Acceleration Cell (TDAC) for Navy and Army Design Bureau for the Army. An *enhanced role of these agencies will be able to provide enough information related to the requirements for the developers.*
- **Bridge The Gap Between Industry, Academia And The Armed Forces.** To bridge the gap between the three stakeholders, a major effort has to be driven by the armed forces. This is because *now the government is very clear about buying indigenous products and approximately 75% of the capital budget is reserved only for indigenous products.* Therefore, the biggest responsibility is on the armed forces to align academia as well as startups to work together.<sup>42</sup> Air Marshal Bedi opined that *academia and industry should collaborate more closely, and this partnership should also include key officers from the armed forces.* He pointed out that while officers are often deputed to organizations like **DRDO or HAL**, which have traditionally been involved in defence manufacturing, *a similar model could be extended to the private sector, which is now being encouraged to participate in defence production.*<sup>43</sup>
- **Academia's Shift From Theoretical Concepts To Practical Application.** The fusion of academia, the military, and industry is a relatively new development, driven by initiatives like 'Atmanirbharta' and the 'Make in

India' campaign. Therefore, it's unrealistic to expect immediate, sweeping changes in the active involvement of academia in practical applications. Nonetheless, *within the next ten years, India is likely to witness increased collaboration among these three sectors in the development of homegrown drones.*<sup>44</sup>

To illustrate this recent shift, the MoU inked between *Idea Forge, and MIT World Peace University (MIT-WPU) can be highlighted.*<sup>45</sup> Similarly, the *Indian Institute of Technology Guwahati (IITG) has also entered in an MoU with Assam Electronics Development Corporation (AMTRON) and RC Hobbytech Solutions. Centre For Excellences (CoEs) on drones at IITs are being established.* This collaboration focuses on *drone-based training, research, and development across sectors like agriculture, disaster management, wildlife conservation, and healthcare.*<sup>46</sup>

- **Drone Oriented Academic Courses.** Although the discourse on drones in India is remarkable, it is far from penetrating into educational curricula. The essentiality of *introducing MTech and PhD courses in UAS Technology have been flagged* earlier, but *academic courses right from the elementary school levels can be nurtured in country.* The US has rolled out school programmes notably known as '**Drones in School**' which *provides platform for young students to further foster their talents and develop entrepreneurial skills related to drones. Similar programmes can be rolled out in India.*
- **Role of Think Tanks.** A greater CMF integration can be displayed by the *existing think tanks that supplements and streamlines the connect between academia, industry and user by providing platforms to discuss and deliberate future trajectories for drones in India. Annual, bi-annual or quarterly seminars, workshops and webinars should be organized to provide a tangible direction to all stakeholders engaged in making India the next drone hub.* Notably the **Annual Seminar by the Centre for Joint Warfare Studies (CENJOWS) and the Indian Military Review (IMR) on 'Unmanned Aerial Systems'** remains an exemplary case. The Think

Tanks can *leverage National Potential* by combining **capital and creativity from the Industry, Science and Technology from Academia and experience from Government agencies/users.**

## CONCLUSION

The drone ecosystem in India is promising. The dual nature of drones provides the scope and platform for several civil stakeholders to engage in the development of military UAVs. *The drone sector in India faces challenges in-one, becoming self-reliant in critical emerging and disruptive technology and two, emerge as a leading drone hub by 2030.* Nonetheless, **India needs to embrace a strong integration of CMF strategy to overcome the existing fallacies.** A closer integration between all stakeholders will promote transparency and credibility among Civil and Military UAS capability development programmes.

*The industry, academia, and the armed forces cannot rely solely on the government which mostly provides with guidelines and protocols.* A close partnership, with the armed forces guiding academia and industry is essential. The product's quality and utility must attract foreign investment, a vital factor for the drone industry.

The aggression of Russia in Ukraine altered the landscape of conventional warfighting and certainly **leveraging disruptive and dual use technologies have emerged equivalent to any country's national asset.** Countries across the globe have been leveraging and re-configuring civilian drones for military purposes. In India's '*Kartoya Kal*', **CMF in Drones** should be the way forward by **harnessing the spirit of Atmanirbhar Bharat** and creating a **cohesive and resilient drone ecosystem** that *streamlines a connect* between Academia, Industry and its Users.

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