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R&D AND INNOVATION STRATEGY: INDIA'S QUEST TO EMERGE AS GLOBAL DRONE HUB

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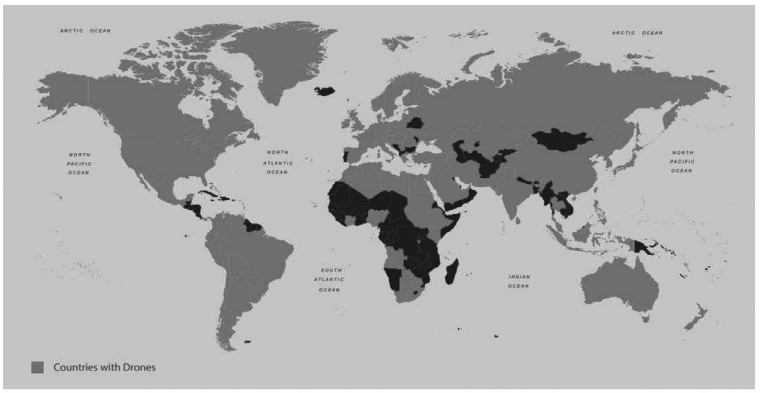
Abstract

The Indian armed forces released a proposal at the beginning of 2016 for the acquisition of over 5,000 drones over the next ten years, which is expected to cost three billion dollars. Due to several constraints and obstacles, India's R&D institutions were unable to build many effective drones for its military and commercial sectors, despite possessing a robust aviation R&D and production set-up. The recurring issue for India has been to transition from being an importer to an indigenous creator of aeronautical merchandise, particularly drones (UAVs). The paper investigates the scope of the Indian government's drone regulations and proposed mechanisms and strategies for implementing indigenous R&D. The study addresses major issues that must be addressed and suggests futuristic recommendations for drone R&D hubs.

BACKGROUND

Modern states are aiming to eliminate 'Boots on the ground' to minimise collateral damage and replace them with machines,[1] wherever they can be implemented. Keeping this in mind, the first-generation models of **Remotely Piloted Aircraft Systems (RPAS)** were developed for surveillance and assaults.[2] Initially viewed as a novelty, drones have evolved into regular military technology, producing an international system of facilities, bases, and test locations. Drones of varied sizes and capabilities have gradually

infiltrated into the conflict zones of Syria, Ukraine, Yemen, and other regional war zones of the Persian Gulf, the East China Sea, and Africa.



Source: Michael C. Horowitz and Matthew Fuhrmann, "Droning On: Explaining the Proliferation of Unmanned Aerial Vehicles," October 24, 2014.

The earliest UAV purchased for targeting systems is the **RUM 2MB** of Bulgarian origin, employed by the Army's Air Defence (AAD) for target practice. Later, Northrop Grumman's KD2R5 was bought and utilised as an AAD target.[3] The ***Defence Research and Development Organisation's*** (**DRDO)** initiative to create the '***Nishant Unmanned Aerial Vehicle'*** triggered India's indigenous hunt for UAVs in the 1990s.[4] However, drone applications in the Indian subcontinent came into existence with the Kargil conflict of 1999. The solutions were for visual surveillance across the ***Line of Control (LOC)***.[5] The Indian Air Force (IAF) initially attempted to utilise an English Canberra PR57 aircraft, but it proved futile and strategically unsound due to Kargil's difficult terrain.[6] This highlighted a severe issue and the necessity for developing UAVs that met India's diverse needs. Losing a Canberra PR57 to the Chinese built Anza infrared-homing missiles by Pakistan, Israel's timely help during ***Operation Safed Sagar*** by covertly supplying IAI Heron and Searcher drones, enabled ISR capabilities along the LOC.[7]

Considering that 4 Nishant UAVs were developed, the Indian Army expressed discontent with the overall outcome. The poor status of the government's defense-industrial complex is demonstrated by DRDO's Nishant UAV. Despite the mobile variant ***'Panchi'*** being developed out of Nishant, against the new set of requirements, it failed to get inducted for regular use.[8]

Since Kargil, India has acquired Israeli combat drones on a large scale to address tactical shortcomings. In 2009 IAF and Israel Aerospace Industries signed a $100 million contract for the procurement of 10 ***Harops.*** In February 2013, the IAF procured a new generation of Heron medium-altitude, long-endurance drones for $280 million. Presently, Israel Aerospace Industries' ***Harpy, Harop, IAI Searcher*** and ***Heron UAVs***, constitute the heart of India's drone arsenal.[9]

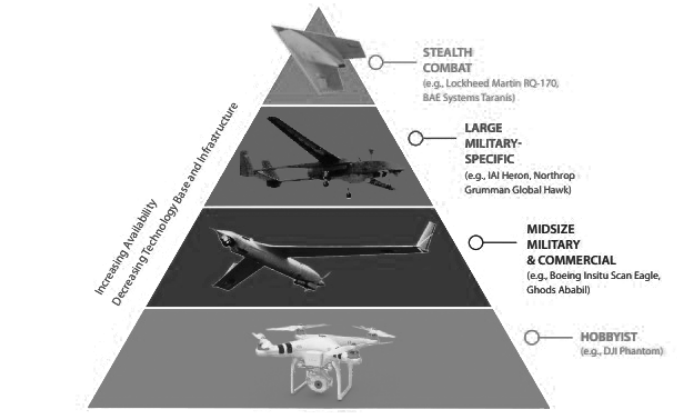
In 2013, India deployed Heron drones in a limited capacity to combat **Naxalism** in the ***Red Corridor*** insurgent areas in the East (Andhra Pradesh, Odisha, and Chhattisgarh).[10] The UAVs performed poorly in ISR capabilities due to thickly forested areas. This called for installing thermal imagers and infrared cameras for tracking insurgents despite dense forest cover. National Disaster Response Force, or NDRF, opted for utilising UAVs to aid Nepal in documenting the degree of devastation caused by the deadly earthquake of 2015, highlighting how Delhi has enthusiastically welcomed such pilotless planes, or ***"eyes in the sky."***[11] The ***Searcher UAV*** of Israeli origin was obtained by the ***Artillery's Surveillance and Target Acquisition (SATA)*** troops. It was employed to find targets in extensive detail and provide post-firing battle damage evaluations.[12] The Indian Armed Force at present heavily relies on the revised variant, Searcher Mark II. ***Operation Jhajjar Kotli***[13] in recent years, employed drones[14] to track down terrorists rather than choppers hovering above to locate the hiding grounds.[15] During the 2020-21 Galway Standoff with China, India acquired Israel's advanced Heron for reconnaissance missions in the eastern Ladakh area.[16]

In June 2023, the ***Indian Navy*** announced procuring ***30 Predator UAV***s from America. The Navy will additionally acquire four TAPAS-BH-201s.[17] Under the **iDEX**, the Indian Navy had highlighted the requirement for mini, micro and swarm drones.[18] In 2021, the Indian navy had signed a contract with BEL to acquire anti drone naval systems. The NADS detects and jams micro drones using radar systems electro-optical/infrared (EO/IR) devices, and radio frequency (RF) sensors. The DRDO's RF/Global Navigation Satellite System (GNSS) recognises the range utilised by the operating system and jams the transmissions. This stipulates the Indian military with both 'soft kill' and 'hard kill' capabilities for dealing with rapidly evolving airborne challenges.[19] ***ALS-50 Tata Advanced Systems Limited (TASL)***

recently handed over the initial set of indigenous ***ALS-50 Vertical Take-off and Landing (VTOL)*** Loitering Munitions to IAF.[20] Throughout the tests, the ALS-50 effectively demonstrated its ability to strike targets. It additionally showed its capacity to work in high-altitude settings amid testing in Ladakh.

GLOBAL PLAYERS IN THE DRONE ECOSYSTEM

With the emergence of Grey-zone warfare, prototypes are constantly being refined. Almost all nations having a more significant international presence are in pursuit of drones having enhanced agility and cutting-edge technology. As the global drone industry continues to expand, acquisition and authority over operating UAVs with diverse capabilities have become accessible to multiple stakeholders, which can be segmented into four categories distinctly supported by the chart below:[21]



HOBBYIST	MIDSIZE MILITARY & COMMERCIAL	LARGE MILITARY-SPECIFIC	STEALTH COMBAT
Limited payload capacity	Moderate payload capacity	Larger payload capacity	Low observable features
Limited range/persistence	Moderate range/persistence	Long range/persistence	Low-probability-of-intercept/ low-probability-of-detection data links
High-definition imagery/ video transmission	Advanced radar	Low-probability-of-intercept radar	Higher resistance to adversary jamming
Autonomous GPS and waypoint navigation	Encrypted, high-bandwidth data links	Enhanced jamming/ electronic warfare	
	Limited jamming/electronic warfare	Beyond line-of-sight communications	
	Target identification and designation	Releasable missiles/bombs	
	Communications relay function		

Source: A World of Proliferated Drones: A Technology Primer

Governments throughout the globe have been developing drone R&D and regulations to enable drones for optimal efficiency.

- The examination of drone R&D projects performed by the United States, Israel, the EU, and Chinese reveals an emphasis on the establishment of a drone infrastructure comprised of testing locations, guidelines, standardisation, accreditation, and R&D projects. The number of research operations and demonstrations performed to create varied drone capabilities has served a significant part in promoting regional production and making drones operating within their airspace more feasible. Drone identification and tracking framework, guidelines, and procedures for approving big drones, solutions for increasing drone security, BVLOS operation, UTM, cyber defence, UAM, and Advanced Air Mobility (AAM) systems are among the significant developments that are currently being created. The ecosystem-building and research initiatives done by the United States, Europe, and China show significant commonalities.
- In case of Iran, IRGC has mastered the art of drone reverse engineering. The several navigation methods used by Iranian-designed drones make jamming and spoofing harder.[22] Iranian drones are cheaper, low-tech and are controlled via a jammable civilian GPS. To combat GPS jamming, Iran has removed the satellite connections from several UAV models. In contrast, its UAVs are often piloted using line-of-sight radio controls or are capable of employing GPS systems like those used in commercial sat-nav systems for self-guiding.[23]
- Turkish drones are economically viable, precise, durable, and efficient, with technical manufacturing and piloting plan capabilities that increase effectiveness. By restricting the degree of advanced technology used in production designs to only what is essential, such as HDR cameras, simple engines, low radar signature body designs, and—most importantly—AI software code technology for identifying visuals for aiming Turks

recently installed an autonomous digital warfare component to their ships to increase their lethality at a very minimal cost.

India lacks the supporting environment and key pillars, such as R&D evaluation centers, standardization between civil/combat/dual-use drones, needed to construct a high-value drone business, which inhibits big MNCs and independent entrepreneurs from developing new drone technology. As a result, India must construct essential foundations and an environment to foster R&D of a world-class, high-technology, important drone sector within India.

INDIA'S ATTEMPTS

Drones have been considered a ***'crucial force multiplier'*** by the Indian forces. This provides India with a platform to expand its defence drone infrastructure.[24] While the MSMEs can equip the troops, achieving the full capabilities of the military drone sector would necessitate careful nurturing and prompt resolution of some critical challenges. Between 1985 and 2014, India topped the list, accounting for 22.5 percent of worldwide acquisitions of unmanned aerial vehicles, next to Britain and France.[25]

Observing all these developments India has been making efforts to step up its game in drone research and development. Even the spearheads of India's defence sector: DRDO and ***Hindustan Aeronautical Limited (HAL)***, a premier institution for the development of fighters, helicopters and now drones have been making significant contributions to achieve these futuristic goals that have been set by the Government and deliver the Indian Armed Forces, world-class tech UAVs. In attempts to militarise the drones developed under the ***"Make in India"***[26] initiative, the following is an inventory of drones that the nation has been working on:[27]

DRDO Abhyas	Aeronautical Development Establishment (ADE) laboratory by Defence Research and Development Organisation (DRDO)
DRDO Ghatak	DRDO's ADE laboratory
HAL CATS	HAL and a private Indian firm (Newspace R&D)
Rustom- 1	DRDO
TAPAS-BH-201	DRDO's ADE laboratory
DRDO Imperial Eagle	DRDO's ADE and CSIR's National Aerospace Laboratory
DRDO Kapothaka	DRDO
DRDO Lakshya	DRDO's ADE laboratory
DRDO Netra	The Research and Development Establishment (R&DE) and IdeaForge, a Mumbai-based private enterprise
DRDO Nishant	DRDO's ADE laboratory
NAL/ADE Golden Hawk	DRDO's ADE and the CSIR's NAL
NAL/ADE Pushpak	DRDO's ADE and CSIR's NAL
NAL Slybird	NAL

Source: Military Drones in India.

The Aeronautical Development Establishment (ADE) and ***The Council of Scientific and Industrial Research-National Aerospace Laboratories (CSIR-NAL)*** jointly designed micro and mini-UAVs having endurance ranging from twenty minutes to an hour. Three Micro UAVs with completely autonomous capabilities were recently conceived: ***Black Kite, Golden Hawk,*** and ***Pushpak***. The ***Imperial Eagle*** and ***Slybird*** are two variations of two-kilogram class FWMUAVs. A live video surveillance system assures uninterrupted ISR throughout the entire flight, while a cutting-edge ground control facility manages the whole operation from takeoff to landing. It further allows digested info in real time, allowing users to capitalise on accessible ISR material. Imperial Eagle and Slybird are all equivalent to ***US RQ-11 Raven UAVs.***[28]

DRDO created a scanning laser system that was installed as a component of the ***C-UAS*** systems at the Red Fort before I-Day 22.[29] Depending on the wattage, it promises a long-lasting reach of 1.25 km. However, no major HPM technology has been documented in the nation to fight the UAS menace. The DRDO's indigenously designed D4 anti-drone system is manufactured by BEL. It can neutralise any potential danger within a 4 km range. It has multimodal tracking capabilities, including day/night sensors, radar systems, soft and hard kill choices through laser and jammer. The Indian Army submitted a Request for Proposal (RFP) for 20 C-UAS systems equipped to spot, track, recognise, and kill swarms/drones/UAS advancing concurrently from various directions.

Given the unclear legal future, homegrown entrepreneurs are creating and employing UAVs to achieve military and economic reasons. Drones are being utilised to deliver operations that include disaster aid to safety and monitoring of aerial imagery. Defence startups too have played an immense role in supporting the DRDO and the armed forces. Here is a list of noteworthy Indian drone startup companies:

- **Aurora Integrated Systems** offers drone-related services to both DRDO and the Indian Army independently with recon drones (Urban View), and Altius MK-II (medium-ranged, med-altitude drone capable of inspection, and targeting).
- **Edall Systems** offers design, planning, and production services, as well as drone research and education courses for learners. The firm also manufactures components for India's National Aerospace Labs and the DRDO.
- **IdeaForge** reportedly partnered with the DRDO to build the Netra UAV. The Netra UAV is a quadruple reconnaissance drone that is predominantly utilised by India's CRPF and the Uttar Pradesh Special Task Force. While IdeaForge's main business is surveillance and defence, the company also offers spatial modelling and researching, energy network recording, drone filming, managing crowds, commercial imaging, and organising events.

- **Garuda Robotic Systems** offers solutions for gathering and evaluating data received by UAVs, including agricultural and commercial questionnaires, safety, rescue operations, and transportation.
- **Zen Technology** has offered IAF with just a couple of C-UAS units with similar features but without the hard kill option however, the particulars are unclear.[30]

Under the Indian context, drones are divided into five different groups which is supported by the graph below.[31]

Type	Weight Range
Nano	≤250g
Micro	>250g<=2Kg
Small	>2Kg<=25Kg
Medium	>25Kg<=150Kg
Large	>150Kg

Source: The Print, June 29, 2021.

THE FALLACIES WITHIN THE COMBAT DRONE R&D ECOSYSTEM

While the atmosphere conducive to the R&D of combat drones appears to be emerging, significant obstacles remain unsolved throughout the past decade.

- September 1988 marked DRDO's initial attempts to develop drones domestically to meet the Army's requirements for ISR, target classification, shelling modification, damage evaluation, ELINT, and SIGINT.
  - ☞ With putting in about 90 crore for 20 years, Nishant's recurrent malfunction touchdowns, DRDO's egregious dearth of transparency and struggle to comply with the army's standards,[32] with succeeding CAG reports underscoring the department's rampant corruption. This left the military to operate without indigenous UAVs for a long time, which was supposed to be the army's eyes and ears, delivering

HDR pictures from the battlefield, aiding in target designation, and providing ELINT & SIGINT.[33]

- ☞ In March 2016, ADE presented a revised model of the Nishant UAV to be considered as an option for the second phase of deliveries. However, the Army maintained that Nishant and its modified versions were unsophisticated, and the field commanders perceived little reason to deploy them.

- ***ADE*** recognised the need to create an ***Autonomous Rotary Unmanned Aerial Vehicle*** (RUAV) in 2013. The authorization was obtained in March 2014, and Rs 10.69 crore had been allocated for the intended use. Surprisingly, the ADE failed to formulate a strategy for outcome realisation, with no representation of user bodies on the board of directors during the development phase as well as the production stage. Missing the deadline, the project was finally wrapped up in November 2015, with a Rs 6.53 crore expenditure.[34]
  - ☞ An investigation led by the ***Comptroller and Auditor General's*** (CAG) audit report investigated the rationales for stopping the project, rendering it infructuous spending. The ADE justified its position by stating the UAV failed to operate in semi/autonomous mode and hence the technology acquired during the project would be used in another project ***'Naval Rotary Unmanned Aerial Vehicle (NRUAV)'***, ensuring there was no squandering of capital. Following ADE's response, a thorough investigation was carried out into the NRUAV project and additional concerns were flagged.[35]
  - ☞ The authorization request for NRUAV was filed in July 2015, when RUAV was still operational. The project deadline was in May 2017, but the authorisation was approved in November 2015 with the understanding that one Chetak procurement under the Indian Navy would be calibrated with flight and data records. With HQ IDS alluding to the shortcomings of awarding the helicopter to the Indian Navy, the project proceeded to IAF to transform the manned helicopter into a rotary UAV.[36]

- ☞ The project was revamped from NRUAV to ***HELIDRONE*** in September 2017. In 2018, a corrigendum was issued against the project for modifying helicopters of any class into UAVs, further pushing the due date to November 2019. With the audit flagging these revisions, the ADE maintained ***'Chetak'*** had a significantly shorter operational life and that the amended mandate would assist in establishing in-house capabilities required for the upgrade of any chopper to a rotary UAV.[37]

- The ***Fixed Wing Mini UAV (FM-UAV)*** programme, approved in July 2010 suffered an identical outcome. The project was initiated to address the needs of the military and paramilitary groups. The CAG revealed that the project failed to involve any end-user representatives in the peer review committee.[38]
- The auditing team discovered that eleven of the sixteen endeavours assessed failed to include an outcome realisation strategy. With the issue of both labour and cost overruns, most of these projects were postponed from six months to six years. The report indicated at least the estimated expenditure of three projects increased from INR 40 lac to INR 369 crore.[39]

THE RISING IMPETUS FOR THE INDIAN DRONE ECOSYSTEM

While the market for combat drones still needs to materialise, drone makers can pique significant interest within the MNCs for various civil uses. Initially, the drone R&D sector was less explored, compared to the present with more than 300 start-ups and PSUs involved in the production and delivery alone. Until 2021, roughly sixty per cent of drone supplies were sourced from China, with around five percent of supplies coming from Western States. Third-party suppliers would often assist UAV/drone manufacturers and assemblers with components and additional necessities. The implementation of ***'Liberalised Drone Rules (2021)'*** opened avenues for sector-wise drone R&D. Since UAV acquisition is currently not permitted

under ***'Completely-Built-Up (CBU), Semi-Knocked-down (SKD) and Completely-Knocked-down (CKD)'*** forms, a surge in patronage for ***Made in India*** drones has generated demand and created enormous opportunities for R&D within the MSMEs.[40]

- The Indian MSMEs at present are unable to match the capabilities of drone parts and critical tech and must rely heavily on imports. Under the Drone Rules, 2021 drone spare parts can be acquired either for defence or for research & development, or service repairs.[41]
  - ☞ Addressing the challenges, the Central government has launched a ***Production-Linked Incentive (PLI),*** initiative (2021) to boost the indigenous R&D of drone equipment.
  - ☞ The central government promised to retain the PLI value fixed at 20% for the entire 3 years, with consideration offered to the drone companies, as against the PLI rates of other sectors' PLI schemes that decrease with every year.[42]
  - ☞ The government has also set the minimum value addition standard for drones and their parts at forty percent of net revenue rather than fifty percent, giving a further boost to the drone sector.
  - ☞ The PLI Scheme includes a broad spectrum of drone elements including propulsion systems, batteries and related parts, flight and recovery mechanisms, power systems, airframes, navigation systems, flight control modules, cameras, communication systems, spraying systems, sensors, ground control stations, payload capacities, 'Detect and Avoid' mechanism, trackers, and other important security components. The authorities can periodically extend their inventory of appropriate elements as the drone industry improves. Further, the government has decided to expand the initiative's scope to cover the manufacturers of drone-related technologies.[43]
  - ☞ In addition to the broad parameters for selecting potential recipients, the government has indicated that the PLI System might be expanded or revised after assessing its effect in partnership with the intended sectors.

- Facilitating and clarifying the ***'Special Chemicals, Organisms, Materials, Equipment and Technologies (SCOMET)'***[44] licencing procedure, the Indian govt. has made attempts to identify drones as one of three major groups in the SCOMET list:[45]
- The ***Digital Sky platform*** is an effort by the ***Directorate General of Civil Aviation (DGCA)*** to offer a reliable and flexible structure that enables drone-related regulations such as ***NPNT*** (no permission, no take-off), which allows for flight authorizations electronically while also effectively overseeing autonomous flight operations and traffic. Digital Sky is designed as a practical, single-window platform that requires little user interaction and most licences are provided automatically. Dynamic aerial mapping is also offered on the Digital Sky portal, distinctly into three zones: green, yellow, and red. UAVs are forbidden to operate in green zones.[46]
- The extended border clashes and claims with the Chinese have exacerbated the demand for drones in ISR, operations, logistics, and target frontier posts. Under various initiatives, the Ministry of Defence (MoD) is assisting India's defence drone infrastructure.
  - ☞ ***The Innovations for Defence Excellence (iDEX)*** program supports the production of military-grade UAVs, presenting the current challenges and the needs of the troops. Startups bid their proposals to match those demands, and the most compelling proposal wins the funding to build their product. Most military-grade drones are currently being manufactured under this initiative. Further, for upgrading weapon systems as per requirement, ***The Technology Development Fund (TDF)*** issues credit to defence start-ups. The ***DGCA*** has also been granting nearly 7000 ***unique identification numbers (UINs)*** and close to 14 specific licenses for certain drones to the original equipment suppliers.[47]
  - ☞ The Indian Army alone has acquired nearly two thousand drones to improve ISR along the ***Line of Actual Control (LAC)*** and transmit supplies to outposts. It is additionally looking to procure UAVs that

can steer artillery fire, to improve the precision and efficacy of the weapons positioned across the border.

- ☞ The IAF's ***'Mehar Baba Competition'*** aims to encouraged domestic R&D, which is crucial for the advancement of specialised swarm drone system, stipulating a starting point for the application of these drones in combat.[48] In 2022, the Indian Army started the 'Him Drone-a-thon' initiative jointly with the '***Drone Federation of India,'*** boosting India's drone industry to improve competencies to comply with the Army's mandates.[49] Although these efforts are beneficial for developing India's defence drone sector, they should be supported by acquisition requests.

WAY FORWARD

- Given that the existing start-ups already stand to benefit from it, there is room for MoD to expand its investment and assist other defence start-ups. In general, civil-military fusion is crucial to the development of the drone ecosystem.
- Government intervention is the key to generating economic viability for drones, allowing this nation to realise its unique technological capacities. The MoD should expand the iDEX, given its enormous scope for assisting with the design of military drones. At present, iDEX offers funds worth INR 1.5 crore for startups which is too little to expand the drone industry. Hence, the MoD as the intermediary holds the ability to generate a demand of nearly INR 75,000 crore within the civil domain plus INR 23,000 crore within the armed forces and security agencies.
- A pressing concern for start-ups is the dearth of R&D. These small firms have limited funds and are often reluctant to invest in producing items that the Indian troops are apprehensive about purchasing. To stimulate R&D, the military should allocate a small percentage of investments to test out pilot projects and accordingly give their feedback to the startups for further improvement of their goods, and if required to integrate additional indigenous spare parts.

- It remains unrealistic to anticipate any drone ventures to produce all its components. To be a pioneer in the indigenous drone sector, India needs to establish an optimal climate capable of supplying drone start-ups with locally built hardware like chips, propellers, engines, LiDAR, flight control systems, and so on.
- It may be predicted that the security and surveillance industry will see significant activities by big companies such as Google, Apple, Infosys, TCS and Wipro offering AI, IoT and machine learning coupled drone solutions.
- Atmanirbhar Bharat[50] is the final approach, but it needs to be hastened.
  - ☞ Research and development are typically an intensive process that should be carried out in conjunction with the acquisition. Nonetheless, the imbalance across the drone threats and solutions continues to exist.
  - ☞ Radars customised for LSS[51] threats, sophisticated jamming devices tailored made for unconventional bands, the production of secure and high-power lasers, HPM technologies, and unmanned counter drones with AI/ML features, are some of the immediate needs within the drone ecosystem.
  - ☞ The government needs to build strategies and bring in reforms to reduce red-tapism and make realistic goals. 100 percent indigenous projects will face certain obstructions that will cause unwanted delays. Hence, India can take lessons from the ***KF21 project of South Korea,*** instead of developing all the technology alone and loosing critical time, collaborating with nations and companies that have developed the tech is the most viable option. Developing tech while signing MoUs for ToTs will not only help cover the crucial gap and help mitigate the tactical gaps and provide the troops with necessary equipment at the earliest while incubating country's manufacturing and technological development capabilities.

- ☞ Prospective platforms like light utility helicopters (LUH), light combat helicopters (LCH), and Hindustan Turbo Trainer-40 (HTT-40)—could all be outfitted with anti UAV technologies. Given their slow pace operating qualities, excellent maneuverability, fast launch capabilities, and enough payload carrying capacity, they have the capacity for serving out counter drone duties in particular threat situations.

- Agencies like MoCA, DGCA do not often lead projects for R&D. As a result, it's necessary to adapt and embrace a research and development-led strategy. Hence, the govt should set up an Inter-Ministerial Committee having representation from agencies and ministries engaged specifically with the UAV and Counter-drone sectors. This committee should be tasked with debates periodically to solve industry challenges and bottlenecks. The panel could also incorporate ideas suggested by any additional division, ministry, participants, or specialists as requested by the Chair. To render this industry economically viable and to grow the globe's leading center, the committee ought to investigate every challenge in design, inventions, restrictions, modern technical advancement, international supply chains, assessments, job creation, education and training, international standards, reciprocity complications, and tariffs. Moreover, India should formulate and have an anti-drone policy in place.
- For defence acquisition, India relies heavily on G2G agreements.
  - ☞ However, G2G transactions frequently succumb to a lack of sourcing viability. In addition, technology transfer is often obsolete, with minimal local production. The government should allow applicable Transfer of Technology in G2G Military transactions under the framework of UAV manufacture.
  - ☞ G2G-Strategic Partnerships ought to be geared towards solving Technology Readiness Level (TRL) deficiencies in studies,

development, production, and assessment technologies that have been recognised by DPSU's,[52] Indian R&D, and businesses.

- Drone evaluation architecture is an important component of the research & development ecosystem because it allows drone makers and experts to test the technology in real-life situations in a secure setting. Hence govt. intervention is necessary at several levels:
  - ☞ The government should formulate a centralised system through which states may submit proposals for testing locations.
  - ☞ There should be designated road maps for developing indigenously built drones and key initiatives should be in place for their induction under certain duration like 5-year plan, 10-year plan and so on.
  - ☞ Designated 'Sandbox' laboratories must be established in secure areas throughout the country. By expediting the design and development of UAV and C-UAV tools, testing facilities may bring in funds.
  - ☞ Governments must use public-private partnership (PPP) structures to incentivise spending on setting up, operating, and maintaining trial facilities.

CONCLUSION

Drone management is being considered by governments all over the world to keep up with the latest technology breakthroughs while also ensuring national security. Several countries, particularly America, Singapore, Australia, and South Africa, have authorised policies on drones, while some are discussing and debating on final rules. India has also taken an initiative in the right direction, providing greater flexibility in operating drones throughout the country, enabling the growth and establishment of a range of industries that wish to employ drones for their services. Despite the new laws that have entirely offered up the drone business to both domestic and foreign competition, the task is not finished. As the sector expands, new ethical and safety risks will develop that all parties must evaluate. To increase the general confidence in drones, every stakeholder must work together to guarantee that drone operations remain safe and beneficial.

Given the evolving R&D landscape, industry stakeholders may consider comprehensive conversations on regulations to be imposed, as well as an autonomous structure to ensure that the actions of certain reckless users don't give rise to a poor general perception of drones.

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