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INDIA'S AEROSPACE SECURITY: TECHNOLOGICAL, BUDGETARY, AND POLICY ISSUES

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The Indian aerospace Sector is presently at an incredibly critical juncture. The push for modernisation through indigenisation by all three defence services is driving the prolonged idea of having a self-reliant defence industry, like never before. The Indian aerospace sector majorly contributes to the military capability of the Indian Armed Forces, especially to the Indian Air Force. Captivatingly, only a handful of nations possess the capability of building satellites and launching vehicles for the military sector, building IRBMs (Intermediate-range Ballistic Missiles) and ICBMs (Intercontinental Ballistic Missiles), developing nuclear weapons, and also being regarded as a leading global power in Information Technology. But the irony is that India, which possesses this capability, remains reliant on imports for defence equipment. This reliance on imports, especially for the Indian aerospace sector, has proved to be detrimental in bringing timely and necessary technological advancement and more importantly is hindering the process of making India a superior force in the skies and space.

With the defence sector taking a lot of pioneering initiatives through its Defence Procurement Procedure (DPP)¹ and Defence Production Policy², mainly due to initiatives and campaigns like ‘Make-in-India’ and ‘Atmanirbhar Bharat’, India’s defence manufacturing footprint has significantly improved since its inception³. But with this push for modernisation through indigenisation, India’s aerospace security currently faces critical challenges and issues. The aerospace sector primarily needs to address technological, budgetary and policy concerns.

This paper provides an overview of India’s aerospace security and the aerospace sector’s manufacturing and production capabilities in the last eight decades (since 1947). It will attempt to analyse India’s aerospace policies and the impact of these issues on the industry’s production capabilities. Moreover, the paper would point out the critical technological backwardness faced by

¹ Kalyani, Baba N. “Opportunities in the Indian Defence Sector - KPMG India,” 2010. <https://www.in.kpmg.com/SecureData/aci/Files/OpportunitiesintheIndianDefenceSector.pdf>.

² Ibid

³ Mehrotra, Col Manoj, and Vipul Mehrotra . “Evolution of Indian Defence and Security Industry in These Recent Years.” Diplomatist, April 13, 2020. <https://diplomatist.com/2020/04/13/evolution-of-indian-defence-and-security-industry-in-these-recent-years/>.

the aerospace industry and highlight some of the major areas in which India needs to invest to develop a formidable defence industry on a war footing. The final section includes recommendations for the aerospace sector in addressing these technological, policy and budgetary issues.

Evolution of India's Aerospace Security

Indian Aerospace Security has evolved and transformed for eight decades now. The Aerospace industry in India has been constantly growing since the industry's inception in the 1940s with Hindustan Aeronautics Limited (HAL), whose main role before independence was repairing and overhauling aircraft for the U.S and providing spare support for British aircraft involved in the Second World War. This privately owned company was soon acquired by the Indian government after independence⁴, spearheading the process of manufacturing and acquiring defence equipment. With HAL being the only organisation involved in developing India's Aerospace defence equipment until the 1960s, aerospace security was vastly dependent on this newly formed organization. During the organization's early years, the focus was mainly on conceptualizing design and producing trainer aircraft (HT-2) for the Indian Airforce and the Navy. And in the 1960s the most important project was undertaken by HAL, which was to develop HF-24 Marut, India's first fighter jet. It may not have been the ideal fighter jet, but it provided India with a platform to learn and develop fighter jet technologies.

With India's defeat in the 1962 Indo-China war, it was understood that a strong military industry was necessary for the country. As a first step to achieving it, India ventured into licenced manufacturing agreements with Russia in 1964, leading to the Transfer of Technology (TOT) concerning MiG-21 aircraft.⁵ Even today, the advanced variants of MiG-21 aircraft are in use by

⁴ Mishra, S N. "India's Aerospace Industry: Structure, Strategies, Policies and the Road Ahead." Indian Defence Review, July 5, 2022. <http://www.indiandefencereview.com/news/indias-aerospace-industry-structure-strategies-policies-and-the-road-ahead/>.

⁵ Mishra, S N. "India's Aerospace Industry: Structure, Strategies, Policies and the Road Ahead." Indian Defence Review, July 5, 2022. <http://www.indiandefencereview.com/news/indias-aerospace-industry-structure-strategies-policies-and-the-road-ahead/>.

the Indian Airforce. India under Nehru made a significant strategic shift by producing indigenously designed aircraft and undertaking research and development. Such thought was greatly influenced by the reality of the aircraft industry's weak academic foundation.⁶ But this idea of indigenous production and manufacturing wasn't achieved mainly due to a lack of monetary resources, ineffective policies adopted by the government and increasing dependence on foreign defence manufacturers.

This overreliance on the foreign defence industry continued, hampering the domestic development of the defence industry. In 1970, India and French Société Nationale Industrielle Aérospatiale (SNIAS) worked together to manufacture the Cheetah and Chetak helicopters. In 1982, reacting to the Pakistani Airforce acquisition of US F-16 fighter jets, the Indian Airforce procured the Mirage aircraft from France, giving India's aerospace arsenal a significant boost at the time. The purchase of SU-30 MKI aircraft – a fourth-generation fighter jet,⁷ and the licencing agreement with Russia for its production have had the most impacts on the inventory of Indian aerospace. With 262 Sukhoi aircraft in its inventory⁸, the Indian Air Force (IAF) has a significant air presence, but with India's adversaries rapidly shifting to fifth-generation fighter jets,⁹ Sukhoi aircraft would fare ineffective against these advanced fighter jets, leaving the Indian aerospace vulnerable.

Furthermore, a new and important player emerged, contributing to India's airspace defence manufacturing and research capabilities. The Department of Defence Research and Development Organisation (DRDO) was established in 1958. However, the organisation was not very effective

⁶ Ibid

⁷ Zee Media Bureau. "Here's Why Rafale Fighter Aircraft Can Become a Game Changer for India with Sukhoi Su-30mki." Edited by Tanweer Azam. Zee News, July 8, 2020. <https://zeenews.india.com/india/heres-how-rafale-fighter-aircraft-can-become-a-game-changer-for-india-with-sukhoi-su-30mki-2298920.html>.

⁸ Tiwari, Sakshi. "Su-30MKI: Thanks to Mulayam Singh Yadav, IAF Realized Its Dream of Flying 'Most Powerful' Air Superiority Fighters." Latest Asian, Middle-East, EurAsian, Indian News, October 11, 2022. <https://eurasianimes.com/su-30mki-thanks-to-mulayam-singh-yadav-iaf-realized-its-dream/>.

⁹ Dangwal, Ashish. "After J-10, Pakistan to Get J-20 Stealth Fighters from China as Top Minister Calls Them 'the Most Modern Aircraft?'" Latest Asian, Middle-East, EurAsian, Indian News, March 13, 2022. <https://eurasianimes.com/after-j-10-pakistan-to-get-j-20-stealth-fighters-from-china/>.

until the 1980s. Hence the Government of India established the Aeronautical Development Agency (ADA) in 1984, under the DRDO, gradually increasing the efficiency and production capabilities of the organisation. The most anticipated production of Light Combat Aircraft (LCA) was developed by DRDO after a lot of hurdles, and with this project, HAL's monopoly ended. A new kind of partnership started to develop between DRDO and HAL. The long-delayed LCA project was finally accomplished with HAL partnering up with DRDO to produce the LCA aircraft (LCA Tejas Mk-1A/ HAL Tejas). The production of LCAs was aimed at replacing the ageing MIG-21s of the Indian Airforce, and most remarkably to make India a formidable air power by 2027. The production of Light Combat Aircraft (LCA) is considered to be the first step towards the indigenisation drive of the defence sector production¹⁰. Recently, a deal was signed between the IAF, and the HAL in which 123 LAC Tejas were ordered by the union government of India¹¹, giving a significant boost to aerospace security. More recently, the HAL-DRDO partnership has resulted in the development of many more future projects ranging from fifth-generation fighter jets,¹² strategic bombers¹³, helicopters¹⁴, Unmanned Aerial Vehicles, hypersonic cruise missiles, etc., supporting the push for making the Indian defence industry self-reliant.¹⁵

As observed in the previous section, the domestic defence industry had mostly been dormant with only limited development in advanced technology and manufacturing equipment. The major obstacle has always been the over-dependent nature of the Indian aerospace sector on foreign

¹⁰ Mundhra, Shreya. "IAF Pilot Heaps Praises on 'Make-in-India Mascot' Tejas Jets While Bhel Adds More Indigenous Tech to 4.5-Gen Aircraft." Latest Asian, Middle East, EurAsian, Indian News, February 18, 2022. <https://eurasianimes.com/iaf-pilot-heaps-praises-on-make-in-india-mascot-tejas-jets/>.

¹¹ Singh, Rahul. "Government to Sign ₹48,000 Crore Tejas Deal with Hal." Hindustan Times, February 3, 2021. <https://www.hindustantimes.com/india-news/govt-to-sign-48k-cr-tejas-deal-with-hal-101612289445706.html>.

¹² Shukla, Ajai. "Stealth Game: Hal Joins DRDO in Building 5th-Gen Advanced Combat Aircraft." Business Standard News. Business-Standard, December 31, 2021. https://www.business-standard.com/article/current-affairs/stealth-game-hal-joins-drdo-in-building-5th-gen-advanced-combat-aircraft-121123001476_1.html.

¹³ Ibid

¹⁴ Ibid

¹⁵ Shukla, Ajai. "Stealth Game: Hal Joins DRDO in Building 5th-Gen Advanced Combat Aircraft." Business Standard News. Business-Standard, December 31, 2021. https://www.business-standard.com/article/current-affairs/stealth-game-hal-joins-drdo-in-building-5th-gen-advanced-combat-aircraft-121123001476_1.html

markets. It is vastly dependent on the procurement and acquisition of defence equipment from foreign defence manufacturers, especially from the Russians and French, hampering domestic production capabilities. Indian aerospace security has mostly been defined by equipment that has been manufactured by foreign players, whether it is the newly procured Dassault Rafales, the age-old Mikoyan-Gurevich MiG-21, or the Sukhoi-30s (Su-30). Even with a decent air defence history, as the world's fourth largest airpower¹⁶ and formidable space power, India's current aerospace industry is lagging in certain areas like advanced technological developments, allocation of funds, and government policies regarding defence and space industry. India, instead of relying vastly on foreign manufacturers for aerospace security, should have focused more on developing indigenous technology and ultimately must have established a military industry which could have been export-oriented like U.S.A and France. The present military and aerospace industries have neither become self-reliant nor made any progress in terms of equipment exports when compared to other major aerospace industries in the world.

The other major part of Indian aerospace security is outer space. Indian Space Research Organisation (ISRO) has been developing various technologies not only for space research but for the armed forces. Set up in 1969, this governmental agency primarily focused on space-based applications based on scientific research and development. But outer space is gradually turning into a complex non-traditional war front. These ever-evolving security threats have driven ISRO to develop advanced technologies and satellites steading and preparing India in defending itself against space-level threats launched by the adversaries in future.¹⁷

¹⁶ India Today web Desk. "Indian Air Force Is the Fourth Strongest Air Force in the World: Facts." Edited by Roshni. India Today. India Today, September 17, 2019. <https://www.indiatoday.in/education-today/gk-current-affairs/story/indian-air-force-345577-2016-10-08>.

¹⁷ Mishra, S N. "India's Aerospace Industry: Structure, Strategies, Policies and the Road Ahead." Indian Defence Review, July 5, 2022. <http://www.indiandefencereview.com/news/indias-aerospace-industry-structure-strategies-policies-and-the-road-ahead/>.

Technological Issues

The future of security will certainly be influenced and impacted by the technologies that states possess. Advanced technologies boost any nation's capability of modernising and developing a self-reliant defence industry. India's major issue has been its failure to develop superior technology which has proven detrimental to enhancing its present aerospace defence and security. The technological requirements of the contemporary aerospace industry are enormous. The following segments highlight the major technological requirements as per the 'Technological Perspective and Capability Roadmap' (TPCR) issued in 2013¹⁸ and 2018¹⁹, by the Ministry of Defence, India.

The aerospace arm of the Indian armed services should be modernised and supported by futuristic technology to sustain the entire array of surveillance tasks, integral combat ops, and offensive missions, ultimately securing India's fragile aerospace from existential threats. The lack of private participation and minimal adaptability to new technologies by government-run organisations like HAL, DRDO, ISRO, etc has failed to capitalise on the emerging technologies relating to aerospace. Acknowledging the fact that, the present Government of India have taken necessary steps, like the 'modernisation through indigenisation drive²⁰', increasing focus on the defence industry²¹, policies aimed at making ordinance and overhauling factories more efficient²², technical-skill development programmes for workers in the defence industry, etc., the implementation of these steps has been slow-paced, mainly due to certain political policy issues. The succeeding paragraphs highlight

¹⁸ Ministry of Defence. "Headquarters Integrated Defence Staff." Technology Perspective & Capability Roadmap 2013. Accessed October 28, 2022. <https://www.mod.gov.in/sites/default/files/TPCR13.pdf>

¹⁹ Ministry of Defence. "Technology Perspective & Capability Roadmap 2018." Defence ProAc Biz News. Accessed October 28, 2022. <https://www.mod.gov.in/technology-perspective-and-capability-roadmap>
<https://www.mod.gov.in/sites/default/files/tpcr.pdf>

²⁰ Tokas, Richa. "Modernisation of Indian Armed Forces through Indigenisation." Modernisation of Indian Armed Forces through Indigenisation | Manohar Parrikar Institute for Defence Studies and Analyses, November 5, 2021. <https://www.idsa.in/idsacomment/modernisation-of-indian-armed-forces-rtokas-051121>.

²¹ Ibid

²² Ibid

certain important technologies the present Indian aerospace lacks and advocate for rapid investment in these critical technologies.

Lack of Critical Indigenous Aircraft Structures

Aircraft structure is the most crucial technological element in developing a formidable air force. India has seen a slow-paced advancement when it comes to modernised and indigenous aircraft building and assembling technology. Most advanced aircraft possessed by the Indian Airforce have aerostructures that are not indigenously developed.²³ This reliance on foreign industries had hampered the development of indigenous aircraft structures for a long time. One might argue that India currently has developed indigenous fighter jets like the LCA Tejas. But India as the fourth largest airpower, requires a lot of other aircraft like transport and spy aircraft apart from fighter jets, which India still vastly imports. Moreover, even LCA Tejas has many components which have been imported and haven't been indigenously built. The engines are American, the weapons are majorly Russian, French and Israeli,²⁴ the ejection seat is British technology, and the radar and avionics have been taken from the French and Israelis, negating the argument of LCA Tejas being completely indigenous. Hence, India's objective of acquiring critical aircraft structures and completely indigenising them is a little far-fetched, mainly due to the budgetary and policy problems hampering the process.

Minimal Development of Geo-Spatial Information Systems

A Geographic Information System (GIS) or The Geo-Spatial Information System is a system that creates, manages, analyses and maps all types of data. It connects data to a map and combines all

²³ Ministry of Defence. "Headquarters Integrated Defence Staff." Technology Perspective & Capability Roadmap 2013. Accessed October 28, 2022. <https://www.mod.gov.in/sites/default/files/TPCR13.pdf>

²⁴ Dangwal, Ashish. "LCA Tejas: Armed with Lethal French, Israeli Missiles, India Says Indigenous Fighter Jets Part of IAF's Modernization Drive." Latest Asian, Middle East, EurAsian, Indian News, December 21, 2021. <https://eurasianimes.com/lca-tejas-armed-with-lethal-french-israeli-missiles-modernization-drive/>.

kinds of descriptive data with location data. This offers a basis for mapping and analysis, which is increasingly applied in military warfare and tactical operations.²⁵ GIS plays an extremely important role in securing the aerospace front of any state. In combat situations, air operations require inputs such as precise target location, the proximity of civilian areas, terrain evaluation, and weather conditions, which are all provided by GIS.²⁶

The Indian Air Force possesses a decent Geo-Spatial Information system, but with the evolving risks and threats in the air sphere, the Indian air defence must acquire advanced Geo-Spatial Information Systems. According to the ‘Technological Perspective and Capability Roadmap,’ (TPCR) issued in 2018 by the Ministry of Defence, the preferred Geo-Spatial Information System should ‘enable specialist users of IAF located at one place for producing products like Aeronautical Enroute Charts, Electronic FLIPS, Terminal Charts, Electronic Terrain and Obstacle Data and interconversion of Data formats. It should also enable generic users to utilise web browser-based applications and carry out evaluations of the data. The entire system should be database driven.’²⁷ This broad parameter laid down by the Ministry of Defence regarding Geo-Spatial Information Systems has still not been achieved and is making minimal development due to a lack of critical technology and resources. but has inspired many players like HAL and DRDO in the aerospace industry to develop and improve these types of systems.

Propulsion Technology

There has been no major achievement in the domestic production of propulsion technology. The LCA Tejas program and the 6.5-generation Advanced Medium Combat Aircraft (AMCA) program have been facing production problems mainly due to India’s reliance on imports for engine

²⁵ Unknown. “What Is GIS?” Geographic Information System Mapping Technology. Accessed November 1, 2022. <https://www.esri.com/en-us/what-is-gis/overview>.

²⁶ Contributor, GIS, and Andrew Akemu. “Military Applications of GIS.” GIS Lounge, February 22, 2021. <https://www.gislounge.com/military-applications-of-gis/>.

²⁷ Ministry of Defence. “Technology Perspective & Capability Roadmap 2018.” Defence ProAc Biz News. Accessed October 28, 2022. <https://www.mod.gov.in/technology-perspective-and-capability-roadmap> <https://www.mod.gov.in/sites/default/files/tpcr.pdf>

technology. The Kaveri Program was aimed at developing completely indigenous engines for India's fighter jets.²⁸ In 1986, the Gas Turbine Research Establishment (GTRE) which was working under DRDO, proposed the development of Kaveri Engines for LCA fighter jets. The proposal was accepted by the Government Of India. After a lot of hurdles, nine prototype Kaveri engines were developed, including four core engines which undertook 3217 hours of engine testing.²⁹ Unfortunately, these engines failed to meet the requirements and parameters to power a fighter jet and the program was decommissioned in 2008,³⁰ citing cost overrun and delay in production (about 13 years).

As per the recent 'Technology Perspective & Capability Roadmap' released by the Ministry of Defence,³¹ high-performance turbofan engines are needed by the Indian Air Forces for their fighter and transport aircraft, which presently have been provided to a few fighter jets. Also, the upcoming generation of fighter aircraft should all be equipped with three-dimensional thrust vectored nozzles. The variable bypass engine would require construction to begin within the following ten years. Fundamental engine technologies, such as single crystal blade design, high-temperature materials, combustion chamber design, and Computational fluid dynamics (CFD) programmes, should advance in the coming years³². All these requirements, as advocated by the Ministry of Defence, have not been achieved. The lack of private-public partnerships has made the process of developing advanced propulsion and engine technology snail-paced.

²⁸Philip, Snehash Alex. "Why Likely €1 Bn French Deal Is a Reminder of India's Failure to Build Indigenous Jet Engine." ThePrint, June 9, 2022. <https://theprint.in/defence/why-likely-e1-bn-french-deal-is-a-reminder-of-indias-failure-to-build-indigenous-jet-engine/988571/>.

²⁹Ibid

³⁰SV, Vikas. "Importance of AMCA Program: Why Is It Key for IAF's Future?" <https://www.oneindia.com>, October 30, 2019. <https://www.oneindia.com/india/importance-of-amca-program-why-is-it-key-for-iafs-future-2963119.html?story=2>.

³¹ Ministry of Defence. "Headquarters Integrated Defence Staff." Technology Perspective & Capability Roadmap 2018. Accessed October 28, 2022. <https://www.mod.gov.in/technology-perspective-and-capability-roadmap> <https://www.mod.gov.in/sites/default/files/tpcr.pdf>

³² Ministry of Defence. "Headquarters Integrated Defence Staff." Technology Perspective & Capability Roadmap 2013. Accessed October 28, 2022. <https://www.mod.gov.in/sites/default/files/TPCR13.pdf>

Other Critical Technological Issues

Apart from these major technological backwardness, many other requirements currently have not been accomplished by the aerospace industry. For instance, technologies that are eco-friendly, consume minimal fuel, reduce pollution and provide better energy efficiency while helping aircraft operate silently³³ are still unexplored by the Indian Airforce. Also, with the advent of anti-satellite weapons, India has done an excellent job by developing anti-satellite missiles under the project named 'Shakti'.³⁴ But the concept of 'watchdog satellite' to guard other satellites against these anti-satellite missiles, hasn't been developed yet³⁵. Technologies like Vertical Take-Off and Landing (VTOL) Unmanned Aerial Vehicles (UAVs), High Altitude Long Endurance (HALE) UAVs, Enhanced Legacy Weapons (all-weather weapons), Anti-Air Warfare etc., have still not been completely explored by the Indian aerospace defence forces³⁶, placing the aerospace security under imminent threat from technologically advanced adversaries like China.

Governmental organisations like Hindustan Aeronautics Limited (HAL), the Defence Research Development Organization (DRDO), the National Aerospace Laboratories (NAL), the Indian Space Research Organization (ISRO), etc., have been a boon and bane to the aerospace industry. India has seen a slow-paced advancement in research and development with regard to defence technology. To an extent, India is better off when compared to most of its neighbouring countries. Unfortunately, however, governmental organisations have limited private sector participation in R&D, which has hampered the modernisation of the aerospace industry. This has made the aerospace industry a third-tier supplier of defence equipment, with a focus mainly on low-tech

³³European Defence Agency. "Green Defence - How Is the EDA Contributing to the Energy Transition and Circular Models in Defence." Default, 2022. <https://eda.europa.eu/news-and-events/spotlight/green-defence-how-is-the-eda-contributing-to-the-energy-transition-and-circular-models-in-defence> .

³⁴ Pubby, Manu. "Mission Shakti: India Tests Its First Anti-Satellite Missile System, Codenamed Mission Shakti: PM Modi." The Economic Times, March 28, 2019. <https://economictimes.indiatimes.com/news/politics-and-nation/pm-modis-big-announcement-india-successfully-tests-anti-satellite-weapon/articleshow/68592702.cms?from=mdr> .

³⁵ Moser, Roger, Heiko A. von der Gracht, and Tobias Gnatzy. "Assets.kpmg ." The Indian Aerospace Industry 2019. BrainNet Supply Management Group AG, 2019. <https://assets.kpmg/content/dam/kpmg/pdf/2013/01/brainnet-Indian-Aerospace-2019-20121206-kpmg.pdf>.

³⁶ Ministry of Defence. "Headquarters Integrated Defence Staff." Technology Perspective & Capability Roadmap 2013. Accessed October 28, 2022. <https://www.mod.gov.in/sites/default/files/TPCR13.pdf>

design and engineering activities. India still has a long way ahead and should make massive investments in future technologies given the current shortage of defence-related aircraft and technologies.³⁷

Budgetary and Policy Issues

The aerospace industry is plagued by constrained budget allocation and policies formulated regarding the production and procurement of defence equipment, especially by the Indian Air Force. Firstly, the budget allotted to defence services, especially the air force is meagre and constrained.³⁸ With such a limited budget most of the necessary technological advancement mentioned in the previous section would remain unattainable. The IAF's desire to have 42-45 squadrons of advanced fighter jets by 2027,³⁹ which is approximately 750-800 jets, would be highly unachievable, as the aerospace industry has been stymied by serious constraints in India's defence budget. The restrained budget not only hampers the domestic industry but also inhibits the capabilities of the Indian Air Force. Not only is the air force impacted by the deficit of funds, but the Indian space sector too. Most advanced technologies related to space were developed much later when compared to the other space powers (U.S.A, Russia, China, etc.). Even today, the budget issue is the biggest hindrance to several Indian space programmes. In short, India currently requires extremely strong aerospace security as it faces threats on the eastern and western fronts. A potential two-front war requires India to possess formidable air power, superior technology, and

³⁷ Moser, Roger, Heiko A. von der Gracht, and Tobias Gnatzy. "Assets.kpmg." The Indian Aerospace Industry 2019. BrainNet Supply Management Group AG, 2019. <https://assets.kpmg/content/dam/kpmg/pdf/2013/01/brainnet-Indian-Aerospace-2019-20121206-kpmg.pdf>.

³⁸ Chafekar, Suryakant Chintaman. "Does the IAF Have Enough Planes to Safeguard Our Skies?: India News - Times of India." The Times of India, March 22, 2022. <https://timesofindia.indiatimes.com/india/does-the-iaf-have-enough-planes-to-safeguard-our-skies/articleshow/90378834.cms>.

³⁹ Gady, Franz-Stefan. "India's Air Force Will Field 42 Combat Squadrons by 2027." – The Diplomat. for The Diplomat, October 6, 2015. <https://thediplomat.com/2015/10/indias-air-force-will-field-42-combat-squadrons-by-2027/>.

advanced logistics⁴⁰. But with the present defence budget, India cannot afford to have superior air power or advanced logistics in comparison to its adversaries, limiting the Indian side when it comes to air warfare.

Another significant hurdle to Indian aerospace security is the government's policy on aerospace security and domestic defence manufacturing. Moreover, policies relating to foreign acquisition and procurement have taken a back seat, especially after the 'Make In India' initiative and a push for the modernisation of defence equipment through indigenisation. In the long term, the push for a self-reliant defence industry has a lot of positives for India, as it would become a formidable air power in South Asia. But, with this indigenisation drive, the short-term problems for the Indian Air Force have gradually increased. For example, the manufacturing and production of indigenous fighter jets and other transport aircraft is a costly affair and demands tremendous time, which India currently can't afford. This is because focusing only on building a self-reliant industry would leave India vulnerable to its adversaries, as there won't be an expansion in its inventory to match adversarial air power, mainly due to the minimal acquisition of foreign equipment which has served as the backbone to Indian aerospace security. Recent policies like 'Make In India' and 'Modernisation through Indigenisation' have been aimed at reducing foreign acquisition and procurement. This might lead to a gradual decrease in dependency on foreign equipment in the future. However, many defence analysts fear that if these policies are not properly implemented, the Indian Air Force might have to face a power crunch due to the lack of adequate future-generation fighter jets and crucial technologies, completely jeopardising its long-term goals of becoming a formidable air power in South Asia.

⁴⁰Chafekar, Suryakant Chintaman. "Does the IAF Have Enough Planes to Safeguard Our Skies?: India News - Times of India." The Times of India, March 22, 2022. <https://timesofindia.indiatimes.com/india/does-the-iaf-have-enough-planes-to-safeguard-our-skies/articleshow/90378834.cms>.

Conclusion and Recommendations

As discussed in the previous sections, the issues faced by aerospace security are majorly technological, budgetary and policy oriented. These issues mainly stem from India's dependence on foreign defence markets and domestic public sector enterprises which have been troubled by budgetary constraints. The current idea of having a protectionist export-oriented defence market is shaping the policymaking of the present Indian government, which unquestionably is beneficial in the long term. Nevertheless, in the short period, these policies, if not systematically implemented, would limit the acquiring and procuring capabilities of the aerospace industry. They would also impose tremendous pressure on the domestic public sector to produce defence equipment and infrastructure to keep up with evolving risks and threats in the aerospace domain. Furthermore, these policies are considered to have negative effects on Foreign Direct Investment (FDI) in the defence industry, harming its short-term growth. The limited participation of the private sector in manufacturing and technological development has also immensely hindered the advancement of aerospace security.

Having addressed all the issues faced by the aerospace sector and the causes due to which these issues crop up and manifest gradually, the paper would decisively conclude by proposing some response strategies that the aerospace industry could adopt to mitigate these issues along with the inherent problems that cause the emergence of these issues.

The recent decision by the Indian government to open defence manufacturing to the private sector has given hope for faster technological advancement. But a mere opening would not appeal to a lot of private companies. Incentives and priority-based facilities must be provided by the government which would ultimately bring in private investment and participation. Continuous effort must be made by both the government and the public sector to establish public-private partnerships that would promote innovation and cost-effectiveness in developing new technologies.

Setting up a corpus fund exclusively for the aerospace sector is crucial. It would automatically provide a continuous supply of working capital for manufacturing units with budget constraint issues. It would also attract a lot of medium and small enterprises as the corpus fund would provide start-up capital. This initiative would also help in reducing India's dependency on defence and

aerospace imports as it would offer financial concessions and incentives to create indigenous technologies in the aerospace sector and establish “anchor units” to build an ecosystem.⁴¹ Anchor units are the first two manufacturing enterprises with minimum employment of 100 members and a minimum investment of Rs. 50 Crore in each of the Sub-Divisions.⁴²

The need for a defence white paper has been debated for a very long time now. This idea calls for an articulated white paper defining India’s defence needs and mapping its strategic concerns. The paper would help India undertake a cost-benefit analysis. The paper would also focus on effective policy formulation advising the government and the defence agencies on their priorities and focus when it comes to acquisition, procurement, and manufacturing.

The availability of highly skilled personnel for research and development is essential for the Indian aerospace sector over the next decade. It is also necessary to build appropriate technical education and training facilities for each of these activities to develop advanced indigenous technology. Finally, the Indian government will also need to outline clear guidelines for future policy execution. Although most experts concur that the fundamental policies to support the aerospace sector are established, there are reservations about their execution. Hence, the government will need to focus on forming implementation strategies that proceed more quickly and efficiently.⁴³

With these recommendations and strategies in place, India would be able to envision a self-reliant and export-oriented aerospace industry. The objective of becoming a superior South Asian air power will be achieved with these reforms. Most importantly, a strong domestic defence industry would give India the necessary strategic autonomy with regard to defence equipment and technology. India can overcome these issues and achieve aerospace security only if it adopts more

⁴¹ Ghadyalpatil, Abhiram. “Maharashtra Unveils Defence and Aerospace Policy to Attract \$2 Billion Investment in Five Years.” *mint*, February 6, 2018. <https://www.livemint.com/Politics/fEux0qgXnOgi7kOMsJepkK/Maharashtra-unveils-defence-and-aerospace-policy-to-attract.html>.

⁴²Law Insider. “Anchor Unit Definition.” Law Insider. Accessed October 28, 2022. <https://www.lawinsider.com/dictionary/anchorunit#:~:text=Anchor%20Unit%20means%20the%20first,and%20above%20exist%20at%20present>.

⁴³ Moser, Roger, Heiko A. von der Gracht, and Tobias Gnatzy. “Assets.kpmg .” *The Indian Aerospace Industry 2019*. BrainNet Supply Management Group AG, 2019. <https://assets.kpmg/content/dam/kpmg/pdf/2013/01/brainnet-Indian-Aerospace-2019-20121206-kpmg.pdf>.

effective and efficient policies to strengthen domestic public-private participation and strategically budget expansion to its aerospace sector.

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