Impact of Make in India on Army Operational Capability in High Altitude and Mountain Warfare: An Analysis

Dissertation submitted to the Panjab University, Chandigarh for the award of degree of **Master of Arts Public Administration and Public Policy,** in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration

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Submitted by

Brig Gurbir Singh, Indian Army

Roll No 5020

Under the Guidance and Supervision of

Dr. Sapna Chadah

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NEW DELHI

DECLARATION CERTIFICATE

It is hereby declared that this dissertation is my original piece of work and to the best of my knowledge and belief, it contains no material previously published or written by any other person. I am aware of the University's norms and regulations regarding plagiarism including the disciplinary action that it may invite. Any use of the works by any other author, in any form, is adequately acknowledged at their point of use or in the Bibliography.

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(Gurbir Singh)
Brigadier (IA)
Roll No :5020

CERTIFICATE

I have the pleasure to certify that *Brig Gurbir Singh*, *Indian Army*, has pursued his research work and prepared the present dissertation titled '**Impact of Make in India on Army Operational Capability in High Altitude and Mountain Warfare: An Analysis'**, under my guidance and supervision. The same is the result of research done by him and to the best of my knowledge; no part of the same has been part of any monograph, dissertation or book earlier. This is being submitted to the Panjab University, Chandigarh, for the purpose of **Master of Arts in Public Administration and Public Policy** in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration (APPPA) of Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of *Brig Gurbir Singh, Indian Army,* is worthy of consideration for the award of Master degree from the Panjab University, Chandigarh.

Date March

Place : New Delhi

Dr. Sapna Chadah

Indian Institute of Public Administration,

New Delhi-110002

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Mar 25 (Brig Gurbir Singh)

Roll No 5020

ABSTRACT

The "Make in India" initiative has greatly influenced the independence of India's defence industry, particularly regarding enhancing the capability of the Army for high-altitude and mountain warfare. This research considers how combat readiness, logistical efficacy, and strategic superiority in challenging environments are impacted by locally manufactured military equipment. While supply chain availability, cost-effectiveness, and adaptability to Indian operational requirements have enhanced as a result of local manufacture, technological limitations, production timeliness, and dependence on foreign components are still among the problems, as the research finds. The evidence also indicates that while weaponry and communications systems are still in need of improvement, protective gear, mobility vehicles, and surveillance technology have made the most progress.

The report also examines private industry and defense research organization (such as DRDO) cooperation, with some success but recommending better testing standards, more R&D expenditure, and faster procurement processes. In spite of these issues, most respondents believe that the project has decreased foreign dependence and raised India's defense readiness in high-altitude warfare. Although long-term success in high-altitude military operations calls for ongoing legislative reforms, augmented private-sector engagement, and technology advances, the research concludes that Made in India has contributed considerably to self-sufficiency in military manufacturing.

Keywords: Make in India, Army Operational Capability, High-Altitude Warfare, Indigenous Defense Production, Military Equipment, Self-Reliance, Defense Logistics.

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Chapter 1: Introduction

1.1 Background and Context

One of the mainstream elements of India's vision of becoming a major global manufacturing destination is the "Make in India" initiative launched in 2014. Building indigenous defence manufacturing capabilities is an integral part of it to enhance the operational effectiveness and self-reliance of the Indian armed forces. Given India's distinct security difficulties, particularly in high-altitude and hilly areas like the Himalayas, this effort is very significant to the Indian Army. These regions include some of the roughest terrain on earth, necessitating specific tools, logistics, and operational plans that can be better met by manufacturing and innovation. The purpose of this study is to present a qualitative examination of how the "Make in India" campaign has affected the Indian Army's capacity to fight in mountain and high-altitude environments[1]. Understanding this impact is crucial given the increasing geopolitical tensions in such regions, especially along India's northern and eastern borders.

The Make in India initiative aims at making India the global manufacturing hub. It emphasizes self-reliance in defense production, cutting dependency on imports of foreign arms and strengthening India's defense sector through research, development, and domestic manufacturing of advanced military equipment. Key objectives include upgrading self-reliance, driving technology development, and research-institute improvements through DRDO, public private collaboration between PSUs in Defence and private companies, increasing FDIs in the defense manufacturing unit, and increased exports of militarily equipment - to make an exporter rather an importer. The Make in India initiative has led to the development of various high-altitude weapons, surveillance systems, and logistics equipment for operations in extreme environments like Ladakh and Arunachal Pradesh. Key advancements include the Arjun Main Battle Tank (MBT), Tejas Light Combat Aircraft (LCA), Dhanush and ATAGS Artillery Guns, Pinaka Multi-Barrel Rocket Launcher (MBRL), INS Vikrant, BrahMos Missile, and SATRU Drone System. These advancements aim to reduce reliance on European imports, enhance real-time intelligence in mountain regions, and

[1] Bacon, J. M. (2019). Settler colonialism as eco-social structure and the production of colonial ecological violence. *Environmental sociology*, *5*(1), 59-69.

ensure easy transport and operation in difficult terrain. The initiative has a significant impact on India's military capabilities.

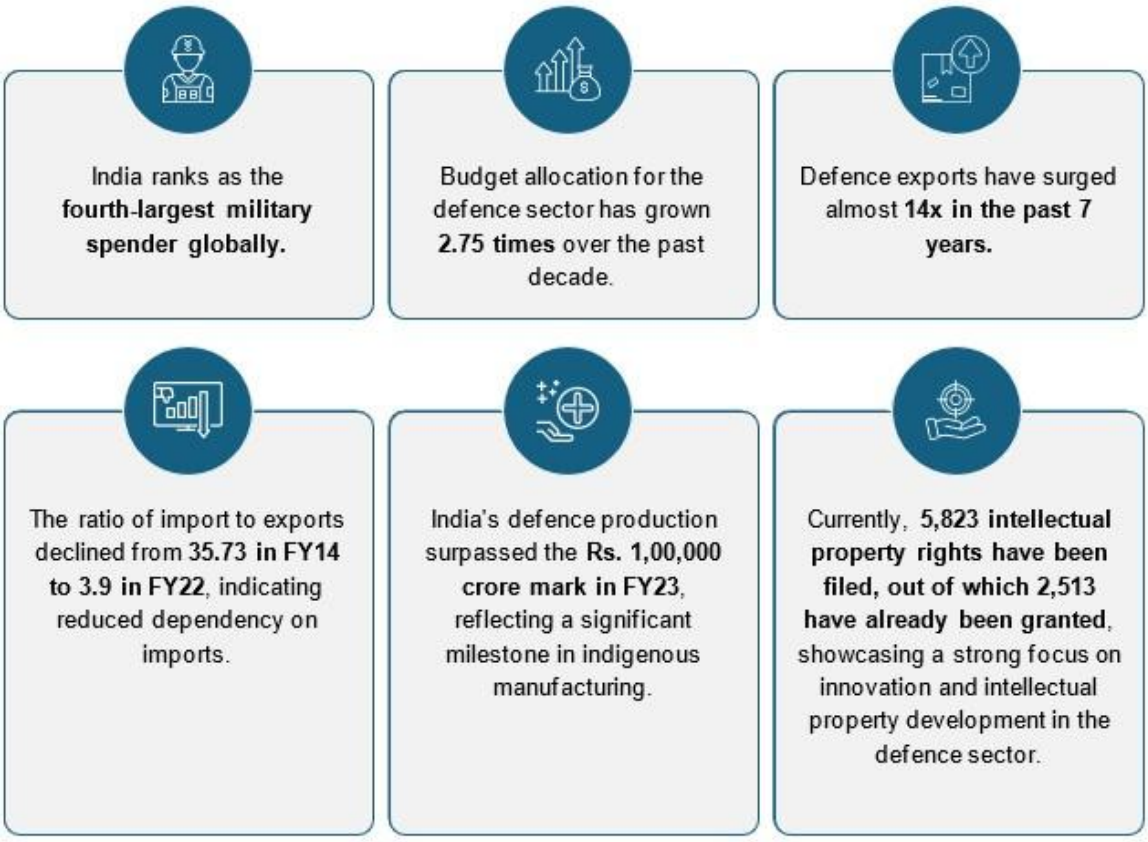

Figure 1.1.1: India's statistics on arms production

Despite the gains, challenges are still there- project implementation gets delayed, imports of foreign technologies for critical hardware, and high R&D costs. However, India is moving steadily towards Defence Industrial Self Reliance with support from the governments, enhancing operational effectiveness of armed forces in the high-altitude and mountain warfighting contexts[2]. Moreover, variations in water quality by seasons are also a significant influence on availability and accessibility of freshwater, most especially in countries with monsoon-like climes such as India. These seasonal changes reflect immense influences on quality of water on both the surface and the groundwater, and water provision. Fluctuations in water quality of these constituents depend on climatic, hydrological and anthropogenic parameters which are different for pre-monsoon, monsoon and post-monsoon periods. These seasons are unique in

[2] Bitzinger, R. A. (2021). Asian arms industries and impact on military capabilities. In *Defence Industries in the 21st Century* (pp. 115-131). Routledge.

their own ways and require study for adequate resource management and risk elimination in water resources.

The situation in the pre-monsoon season is bad for the availability and quality of water because of high temperature, little or no precipitation. High temperatures occur alongside very low amounts of precipitation; this leads to a large declination of the water table due to extraction and evaporation. These factors worsen water shortage especially in areas where groundwater is the principal source of water supply. Also, low water flow in surface water bodies during this period results in concentration of pollution materials like nitrates, phosphates and industrial drags. Amazingly, decrease in flow inhibits the natural cleansing activities of water compartments, and as a result, these pollute enhance and accumulate, consequently reducing water quality.

The lack of lightweight, high-performance weaponry, specialized clothing, and advanced communication systems in mountainous terrains, coupled with a reliance on imported technology, poses significant challenges in high-altitude warfare. Logistics issues, such as poor infrastructure and maintenance in remote locations, also hinder rapid troop movement. Research and development gaps are also evident, with a slow pace of innovation in developing specialized equipment for mountain combat[3]. In addition, training programs for troops in high-altitude combat environments are inadequate and lack acclimatization and survival techniques; training facilities also lack adequate provision to simulate high-altitude harsh conditions.

Under these circumstances the research is conducted with an aim to understand how the "Make in India" initiative influenced the indigenous production of specialised military equipment for high-altitude warfare. Therefore defining the roles that indigenous defense manufacturing plays in enhancing logistical efficiency, reducing the time factor of procurement and infrastructure development of the Indian Army in mountainous regions. The study will also focus on the concepts of how indigenisation improved troop effectiveness, sustainability, reconnaissance, surveillance and mobility of troops resulting in increase in combat potential in mountains and high-altitude warfare.

1.2 Statement of the Problem:

This study tries to assess the Impact of Make in India on Army Operational Capability in High Altitude and Mountain Warfare. Major problems with the Indian Army's

[3] Bommakanti, K. (2019). Electronic and Cyber Warfare: A Comparative Analysis of the PLA and the Indian Army. *ORF Occasional Paper*, *203*

operational capability in high altitude and mountain warfare pertaining to the "Make in India" schemes include slow development cycles, dependence on imported technologies, insufficient research and development in cold weather gear, undertraining of personnel for combat in extreme high-altitude conditions, and insufficient specialized equipment designed specifically for terrains at extremes, which prevents them from becoming effective enough against the potential adversary in mountainous regions, particularly the Chinese frontier.

The Indian Army's operational effectiveness in high-altitude and mountainous regions is a key factor in national security, especially in light of the challenges posed by neighbouring countries[4]. Historically, India has depended on foreign procurement for critical defense equipment, including items crucial for operations in extreme climates. However, these dependencies have been associated with significant challenges, such as delays, high costs, and strategic vulnerabilities due to supply chain disruptions.

The "Make in India" initiative, by promoting indigenous manufacturing and research, aims to overcome these challenges. It focuses on the development of specialized equipment and systems tailored to the Army's specific operational requirements in high-altitude areas. However, the real impact of these efforts on the Army's operational capability remains under-explored, especially in quantitative terms. This scenario has been taken into consideration as a problem and thus strategic solutions will be provided through research. It is anticipated that the study would produce factual data demonstrating the real advantages of the "Make in India" campaign in boosting the Indian Army's capacity for mountain and high-altitude combat. The study's quantitative measurements of these advantages allow it to:

• verify the strategic orientation of domestic defence production,

• determine whether areas require additional investments or improvements, and

• assist legislators in making well-informed choices about defence manufacturing and procurement regulations.

1.3 Research Objectives

The primary objective of this study is to quantify the impact of "Make in India" on the Indian Army's operational capability in high-altitude and mountain warfare. Specific objectives includes:-

[4] Choudhary, L. R. (2022). India's Defence Diplomacy Towards Central Asia. *Indian Journal of Asian Affairs*, *35*(1), 73-93.

(a)Examining the influence of the “Make in India” initiative on indigenous production of specialised military equipment for high-altitude warfare.

(b)Assessing the extent to which indigenous equipment and systems developed under “Make In India” have enhanced operational readiness in high-altitude regions.

(c)Evaluating improvements in logistics, supply chains, and infrastructure tailored for high-altitude warfare with indigenous production under the “Make In India”.

(d)Analysing changes in troop’s effectiveness, sustainability, reconnaissance, surveillance and mobility from the use of indigenously developed equipment resulting in increase in combat potential in Mountains and High Altitude Warfare.

(e)Examining strategic advantages emerged from the “Make In India” initiative in terms of reducing dependence on foreign military imports.

(f)Suggestions and recommendations for making the scheme more effective to army operations in mountains and high-altitude areas.

1.4 Research Questions

A detailed review was carried out of make in India along with the import trends of hardware by India for the past few years[5]. It was quite evident from the review that there is an over dependence on foreign military technology and there is a gap between what we desire and what we have within our country when it comes to Indigenous defense production. Defense production is a subset of Make in India, initiated by the Government of India and a large number of reforms have already been initiated to boost defense production. The literature review of the subject tends to lead to existence and confirmation to gaps and thus there is a case of researching this topic. Thus, certain questions required to be answered are:-

(a) How has the "Make in India" initiative influenced the indigenous production of specialised military equipment for high-altitude warfare?

(b) What is the extent to which indigenous equipment and systems developed under “Make In India” have enhanced operations readiness in high altitude regions?

(c) What role does indigenous defense manufacturing play in enhancing logistical efficiency, reducing the time factor of procurement and infrastructure development of the Indian Army in mountainous regions?

[5] Clary, C., & Narang, V. (2018). India's counterforce temptations: Strategic dilemmas, doctrine, and capabilities. *International Security*, *43*(3), 7-52.

(d) Has indigenisation improved troop effectiveness, sustainability, reconnaissance, surveillance and mobility of troops resulting in increase in combat potential in mountains and high-altitude warfare?

(e) What strategic advantage has emerged from the “Make In India” initiative in terms of reducing dependence on foreign military imports and will the industry be able to meet the international quality standards?

(f) What needs to be done to make the scheme more effective for army operations in mountains and high altitude terrains?

1.5 Scope and Significance of the Study

Scope

The study is expected to have some scope as follows:

(a) Whether the "Make in India" campaign has improved the Indian Army's readiness and efficacy in high-altitude warfare, and to what degree indigenous systems and equipment created under the "Make in India" initiative have improved operational readiness in high-altitude regions.

(b) It will also provide information about areas that require enhancement or additional funding.

(c) The study will identify how enhancements in infrastructure, supply chains, and logistics are necessary for high-altitude combat and aid in assessing shifts in troop mobility, sustainability, and effectiveness brought about by the deployment of locally produced equipment.

Significance of the study

Since high altitude and mountainous warfare is a strategic importance of the defense of India, an appropriate assessment about the impact of "Make in India" has to be studied on targeted as well as on data-driven manners. The rationale that justifies the study is provided below:

(a) The Strategic Significance of Mountain and High-Altitude Combat:

India's most of the borders with China and Pakistan are mountainous and go up to more than 15,000 feet in some areas. Because these areas are strategically important, the Army has to be very operationally prepared. Analyzing the ways "Make in India" enhances this preparedness can bring out valuable information about its overall effectiveness.

(b) Requirement for Empirical Evidence: Although the value of domestic manufacturing is well accepted, there are very few quantitative studies that measure its direct impact on operational capabilities in specific situations. This study aims to bridge this gap by using data-driven techniques to assess improvements in logistics, equipment performance, troop mobility, and sustainability in high-altitude environments.

(c) Strategic Relevance: The outcome of this research can be instrumental in formulating the defense strategy, especially concerning future investments and strategic decisions concerning domestic production. Knowing which areas of domestic production have the maximum impact on the operational capacity would help improve the focus of the "Make in India" campaign.

1.6 Summary

In fact, defence manufacturing has been one of the areas that the 'Make in India' initiative has best impacted. Within a span of less than a decade, India became an arms exporter in addition to indigenising the large majority of defense-related goods production. One notable aspect of this success story is the significant role of public-sector undertakings (PSUs), which were previously infamous for their slowness and inefficiency.

While defence manufacturing was one of the most areas 'Make in India' impacted, this nation, less than a decade ago, became an arms exporter even as indigenization brought a significant percentage of defense-related products to become local. What makes this particular success story interesting is the very important role played by public-sector units (PSUs) that were infamously slow and inefficient before[6].

From PSU facilities, start-ups, research institutions, and manufacturers of everything from fighter jets and BrahMos to ballistic missiles, artillery rounds, and night-vision gadgets, come a slew of large companies in India's defence-industrial complex: L&T, Godrej, Adani, and many more. India should become self-reliant in defence to maintain strategic independence and reduce dependence on imports for military complimentary items. Consider just this-it needs such high-latitude apparel in a country that relies on outside suppliers even for its most elementary defence. The need for India's self-reliance in defence systems has been underscored by the Russia-Ukraine war, where Russia could not get its military supplies from other countries

[6] Colley, C. K., & Suhas, P. H. (2021). India–China and their war-making capacities. *Journal of Asian Security and International Affairs*, *8*(1), 33-61

while the west was rushing to produce arms to sell to Ukraine. The indigenisation of defence becomes especially important for India, which is now embarking on an assertive foreign policy with great diplomatic mechanics across the board. That is the purpose of Prime Minister Narendra Modi's Atmanirbhar project.

Major megacorporations, government agencies, and incubators charged with reducing dependence on foreign suppliers for defence-related design and manufacturing are at work-counterproductive of course, yet justified to some extent by a series of national security bills aimed at replenishing indigenous production capabilities. Among various policy initiatives, notifying positive indigenisation lists and sharing 75% of the capital acquisition budget for procurements within the country are two of the most significant. The government also approved about 45 defence-related industries in collaboration with foreign original equipment manufacturers and launched the Innovations for Defence Excellence (iDEX) programme with the purpose of engaging R&D institutes, academic institutions, industries, start-ups, and individual innovators to foster an ecosystem for innovation and technology development in the defence sector.

Out of 4,666 defence products notified for indigenisation, 2,920 have been indigenised. These products consist of assemblies, sub-assemblies, raw materials, key spares, and components. Between 40 to 50 licenses for defence production are issued each year. Some major defence supplies other than expensive BrahMos missile systems are Dornier-228 aircraft, ALH helicopters, SU avionics, artillery guns, radars, armoured vehicles, rockets and launchers, torpedo loading gear, alarm monitoring and control systems, night vision monoculars and binoculars, lightweight torpedoes and fire-control systems, weapon-locating radars, HF radios, Kavach MOD, drones, artillery, and coastal surveillance radars. Overall, the continuous efforts made by the government to make India “Atmanirbhar” or self dependent in the arms sectors allows making the most of the control systems[7]. In order to salute these efforts made by the government and army this study has been undertaken which will focus hugely on the impact of Make in India on Army Operational Capability in High Altitude and Mountain Warfare.

[7] Dalal, R. S., & Malik, A. Atmanirbhar Bharat: Prospects and Challenges.

1.7 Structure of the Dissertation

Chapter 1: Introduction

- **Background and Context**: Overview of the "Make in India" initiative and its relevance to the defense sector.
- **Statement of the Problem**: The operational challenges faced by the Indian Army in high-altitude and mountainous regions.
- **Research Objectives**: Specific objectives and research questions guiding the study.
- **Research Questions:** Research questions are based on objectives
- **Rationale behind the study:** The reason behind choosing the study
- **Scope and Significance of the Study**: The importance of assessing indigenous defense capabilities and their impact on national security.
- **Structure of the Dissertation**: Brief description of the chapters.

Chapter 2: Literature Review

- **High-Altitude and Mountain Warfare: Strategic Considerations**: Overview of high-altitude warfare, unique challenges, and the importance of specialized capabilities.
- **Defense Manufacturing and Indigenous Capability**: A review of the global and Indian perspectives on indigenous defense production and its impact.
- **The "Make in India" Initiative**: An in-depth look at the origins, goals, and progress of the initiative in the defense sector.
- **Gaps in Existing Research**: Identification of the lack of quantitative studies focusing on the operational impact of indigenous defense manufacturing in high-altitude warfare.

Chapter 3: Research Methodology

- **Research Design and Approach**: Explanation of the quantitative approach, including the framework for analysis.
- **Data Collection Methods**: Sources of primary and secondary data, including operational reports, surveys, and performance metrics.
- **Sampling Strategy**: Description of the sample population, such as Army units, equipment, and case studies.
- **Data Analysis Techniques**: Statistical tools and methods used for analyzing the data, such as correlation analysis and regression models.

- **Limitations of the Study**: Potential challenges and constraints in data availability, scope, and analysis.

Chapter 4: Overview of High-Altitude Warfare and Indigenous Defense Manufacturing in India

- **Strategic Importance of High-Altitude Regions for India**: A discussion on the security context in regions like Ladakh, Siachen, and Arunachal Pradesh.
- **Challenges in High-Altitude and Mountain Warfare**: Operational and logistical challenges faced by the Indian Army in these regions.
- **Indigenous Solutions under "Make in India"**: Key defense systems, equipment, and technology developed for high-altitude operations.

Chapter 5: Impact of "Make in India" on Operational Capabilities: A Quantitative Analysis

- **Indigenous Defense Equipment and Operational Readiness**: Analyzing data on how locally produced equipment affects readiness in high-altitude regions.
- **Logistical Improvements and Supply Chain Resilience**: Quantitative assessment of how "Make in India" has influenced logistics and supply chains in difficult terrain.
- **Troop Effectiveness and Sustainability in High-Altitude Operations**: Measuring changes in troop mobility, endurance, and sustainability due to indigenous advancements.

Chapter 6: Comparative Analysis: Indigenous vs. Imported Systems

- **Performance of Indigenous Systems vs. Imported Equipment**: A comparison of key performance metrics in high-altitude operations.
- **Cost-Effectiveness and Sustainability**: Economic analysis comparing lifecycle costs, maintenance, and long-term benefits.
- **Case Studies**: Detailed examples of successful deployments or failures of indigenous systems in recent operations.

Chapter 7: Policy Implications and Strategic Recommendations

- **Assessment of Current "Make in India" Initiatives in High-Altitude Warfare**: An evaluation of existing policies, initiatives, and outcomes.
- **Strategic Recommendations for Enhancing Indigenous Capabilities**: Suggestions for improving indigenous production to better meet operational needs.

- **Future Directions for Research and Policy**: Identifying areas for further research and policy enhancement.

Chapter 8: Conclusion

- **Summary of Key Findings**: Recapitulation of the study's major findings and their implications.
- **The Strategic Value of Indigenous Defense Manufacturing**: Final thoughts on the long-term impact of the "Make in India" initiative on India's defense capabilities.
- **Final Remarks on the Operational Readiness of the Indian Army in High-Altitude Warfare**: The broader implications for national security and defense strategy.

Chapter 9: References

- Comprehensive list of sources, including academic publications, government reports, defense white papers, and primary data sources.

Chapter 10: Appendices

- **Survey Questionnaires**: Sample questionnaires used in the study.

Chapter 2: Literature Review

2.1 High-Altitude and Mountain Warfare: Strategic Considerations:

The high-altitude and mountain warfare is strategically important to the Indian defence posture, and therefore, it is essential to critically analyze the impacts of the "Make in India" campaign in a focused and data-driven manner. Since oxygen levels are lower and soldier endurance is impacted by intense cold, high-altitude warfare frequently takes place at elevations exceeding 9,000 feet. Mobility and transportation are challenging due to steep inclines, rough terrain, and unpredictable weather; this calls for specific equipment and training[8]. A complete strategy integrating technology developments, enhanced logistics, domestic equipment development, and specialised personnel training is needed for high-altitude and mountain warfare. Even though programs like "Make in India" have increased military equipment self-reliance, ongoing investments in R&D, strategic infrastructure, and international cooperation are necessary to strengthen operational capabilities in these harsh conditions.

2.2 Defense Manufacturing and Indigenous Capability

Indian Struggle for Indigenisation in Modernisation and Defence Procurement

The geopolitical environment of India is challenging because it has disputed borders with Pakistan and China, in addition to hosting numerous border wars with these countries. Therefore, India has been mainly dependent on foreign suppliers for all its defence, equipment, weapon systems, spares, and maintenance, so much so that India's army is almost completely dependent on foreign spares and supplies in times of crisis.

[8] Dame, J., Schmidt, S., Müller, J., & Nüsser, M. (2019). Urbanisation and socio-ecological challenges in high mountain towns: Insights from Leh (Ladakh), India. *Landscape and urban planning*, *189*, 189-199.

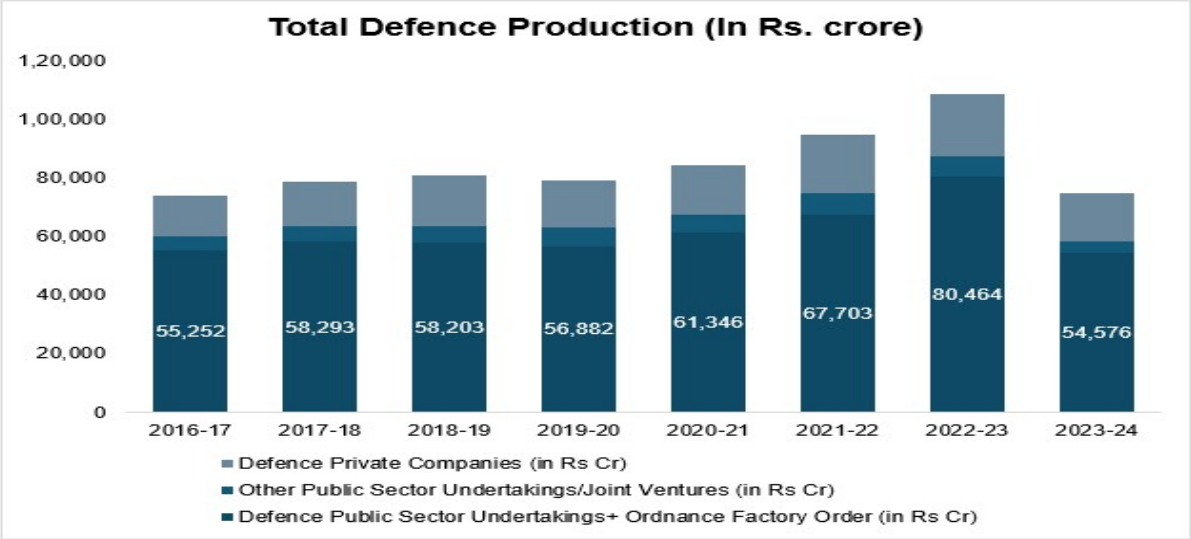

Figure 2.2.1: Total Defence Production in Crore

Increasing defence imports tend also to augment the economic costs associated with indigenisation of defence equipment in India. The country was also the largest importer of major arms in the world from 2018 to 2022, accounting for 11% of the total global arms imports. This directly affects the foreign exchange reserves of the country to the tune of a whopping US$ 23.17 billion over five years.

To curb expenditure on foreign exchange for purchasing spares and other defence equipment, the Indian government has pushed for indigenisation of imported components including special materials and alloys. A policy to this effect was unveiled in March 2019, and is expected to positively impact the import bill of DPSUs by more than US$ 1.8 billion. Up to 2021, 1,499 items have been indigenised, with a target of 5,000 components till 2025. However, the increasing share of indigenisation within the defence manufacturing sector is capable of generating jobs in connected ancillary industries like Micro Small and Medium Enterprises and Small and Medium Enterprises for the economy. However, the pace has been slow as in 2004-2005, that was 0.03 million and inching up to 0.05 million in 2011-2012.

Greater indigenisation is critical if the government is to realise its vision of defence exports into reality. At $5 billion in defence hardware exports by 2025, Prime Minister Narendra Modi issued a call for investments in the defence sector as part of many ambitious targets set by the Modi government. Defence exports will therefore strengthen the extensive defence industrial base, ensuring optimum utilisation of

trained resources, supply chain sustenance, marginal additional revenue streams, and, ultimately, greater investment into defence research and development.

India's Long-Term Defence Indigenisation Initiatives

The first and foremost point is that India, since independence, has been striving to indigenize its defence platforms and equipment, largely depending on direct government-to-government purchases. Relentless efforts have gone into this task through direct government-to-government purchases, licensed manufacturing, joint ventures, and domestic design and production[9]. The 1948 P.M.S. Blackett Report, after independence, became the cornerstone of defence modernization and indigenization policy of India. Prime Minister Nehru put in place a vast state-owned defence-industrial base that manufactured rudimentary equipment and engaged in licensed production of imported platforms.

Established in 1958, the Defence Research and Development Organisation (DRDO), is an amalgamation of the Indian Army's Technical Development Establishment, the Indian Air Force's Directorate of Technical Development and Production, and the Defence Science Organization. It aimed substantially to gain self-reliance in defence and related technologies. Indigenization of 80% of the Army's light equipment was in place by the year 1953, as was the case with India having self-sufficiency in nonlethal stores and equipment. In the late 1950s and the 1960s, some DPSUs like Hindustan Aeronautics Limited (HAL) collaborated with foreign manufacturers to manufacture Aloutte helicopters and Gnat jet fighters. HAL's capabilities were demonstrated by doing design, development, and production of India's first aircraft, HF-24 Marut fighter jet.

Post two rounds of war against Pakistan (1947 and 1965) and a border conflict with China in 1962, priority was accorded to the domestic manufacture of critical weapons, followed by the decision to import more advanced ones[10]. In the 1970s, the government decided to create new specialized facilities devoted to advanced equipment, including Bharat Dynamics (1970) for producing guided weapons systems and Mishra Dhatu Nigam (1973) in supplying and producing super alloys, special steels, and other specialized materials. By the 1980s, there was definitely a rethink of

[9] Dar, S. A., & Lone, D. N. A. (2022). Make in India an analytic study of the country's technological shift for transformation. *International Journal of Information Technology &Amp*, 6-16.

[10] Dunbar-Ortiz, R. (2018). *Loaded: A disarming history of the Second Amendment*. City Lights Books.

defence exports as DPSUs and the Ordnance Factory Board (OFB) started supplying small arms to developing countries, along with weapons spare parts. Following that, the focus shifted toward licensed production, mainly emanating from the Soviet Union under transfer of technology, instead of indigenous production. This model, however, did not lead to an augmentation of capacity in designing or developing advanced manufacturing capability.

In recent years, the focus has shifted towards co-production and co-development with foreign companies, and this process has begun with the joint production of the supersonic cruise missile, BrahMos. Despite these efforts, the indigenous development of defence platforms and equipment has been slow. The DRDO has been criticized for inefficiency, cost overruns, and time delays, while institutionalized cooperation and synergy among the user service (end-customer), designer (DRDO and its laboratories), and manufacturer (like HAL and other DPSUs) have been sorely lacking.

The Indian government has been diligently working to promote defence indigenisation, thereby reducing defence imports to the country. Various committees such as Kargil Review Committee, Group of Ministers, Kelkar Committee, Sisodia Committee, Rama Rao Committee, Naresh Chandra Committee, and Dhirendra Singh Committee have made contributions and recommendations towards all aspects of national security and defence, including indigenous defence production and self-reliance. The Kelkar committee emphasizes bolstering self-reliance in defence preparedness, while the N.S. Sisodia committee proposes that early domestic industry involvement in the defence acquisition process be included. The Rama Rao Committee examines the DRDO in its organization for improving managerial, administrative, and financial systems. Yet another committee, chaired by former Defence Secretary Dhirendra Singh, has suggested a variety of frameworks that can improve participation of the private sector in defence manufacturing[11].

The Defence Procurement Procedure (DPP) has undergone multiple revisions since 2002 to ease indigenous procurement, with the latest 2020 version called Defence Acquisition Procedure (DAP) affirming Prime Minister Modi's views on Atmanirbhar Bharat (self-reliant India) and 'Make in India' policies. A number of measures have

[11] economictimes.indiatimes.com, 2024. Available at: https://economictimes.indiatimes.com/news/defence/guns-n-growth-inside-defence-sectors-explosive-make-in-india-story/articleshow/109001658.cms?from=mdr

been taken under DAP to promote indigenisation, including the promulgation of a negative import list of weapons/platforms that cannot be imported, indigenisation of imported spares, time-bound defence procurement process, and faster decision-making.

From 2013-2017 to 2018-2022, defence imports in India plummeted by 11% on account of these measures along with the articulate government push for Atmanirbharta (or self-reliance) in defence procurement. Further, to see lightning effects, it becomes imperative for defence platforms and weapons to become designed, developed, tested, and manufactured on Indian soil. The Union government has also initiated measures to build the capabilities of the private sector by closely engaging with the vendors to indigenize items, which should otherwise be imported or have already been imported. Since the announcement of Make in India in 2014, several policy initiatives and reforms have been enacted by the government to promote indigenous design, development, and manufacturing of defence equipment. These include making defence preference to capital procurement from domestic sources under DPP/DAP; issuance of 'Positive Indigenisation lists' and 'Negative Import Lists'; simplification of industrial licensing; allowing 74% FDI under the automatic route; and the launch of Innovations for Defence Excellence.

Multidimensional data on the "Make in India" project contributing to arms production

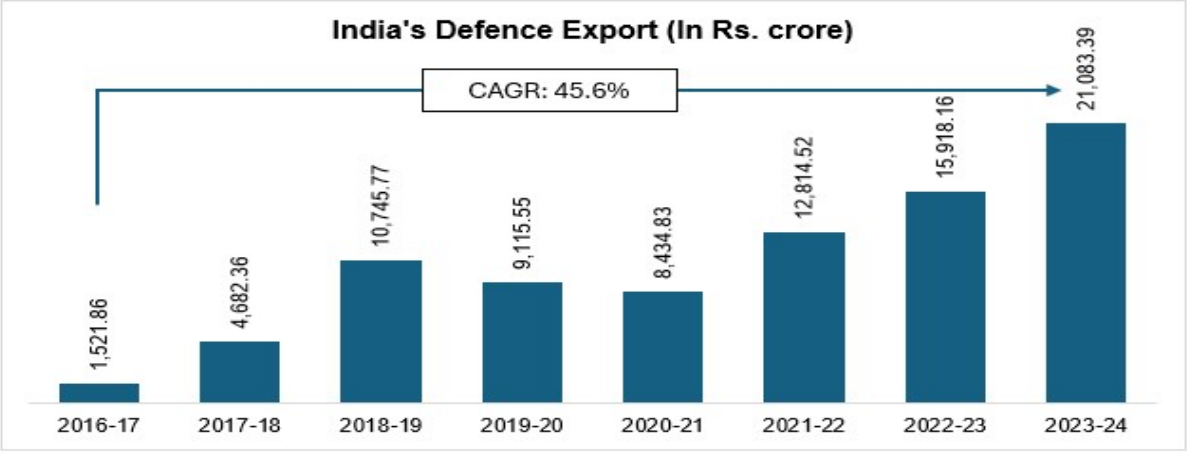

Figure 2.3.1: India's defence export

Rajnath Singh, the minister of defence, congratulated all parties concerned a few days ago for achieving a major milestone in defence exports: In 2023-24, India's defence exports slew past all records to reach Rs 21,083 crore (about $2.63 billion), which was 32.5% higher than the previous fiscal year's figure, which stood at Rs 15,920

crore. A comparison of the current growth trend with that of the previous decade shows that defence exports have grown 21 times in the last ten years from Rs 4,312 crore in 2004-05 to 2013-14 to Rs 88,319 crore in 2014-15 and to 2023-24. This tremendous uptick has been driven by the government's active promotion of indigenization, to achieve defence self-reliance as India aims at a more prominent strategic role for itself in the world while gearing up to become the third-largest economy in the world. The stocks of many PSU defence companies soared to all-time highs, as additional thrust into defence exports and industry gained traction. Defence PSUs are an important contributor, but the previous decade has been mainly driven by the private sector. The contribution split is roughly 60% from the private sector and 40% from PSUs[12].

Major public and private undertakings of defense projects

Hindustan Aeronautics Limited (HAL) - Design, development, production, overhaul and repair of aircraft, helicopters, engines and accessories.

Bharat Electronics Limited (BEL) - Development and manufacture of advanced state-of-the-art electronic equipment components to be used by the defence services, para-military forces and other government departments.

Bharat Earth Movers Ltd (BEML) - Multi-product Company involved in designing and manufacturing a diverse variety of equipment ranging from specialized heavy vehicles for defence to re-engineering solutions in aeronautics and automobiles.

Mazagon Dock Limited (MDL) - Submarines, missile boats, destroyers, frigates and corvettes for the Indian Navy.

Garden Reach Shipbuilders & Engineers Ltd (GRSE) - Constructs and overhauls warships and auxiliary ships of the Indian Navy and the Coast Guard.

Bharat Dynamics Limited (BDL) - Missiles, torpedo counter measure system, dispensing system for counter measures.

Mishra Dhatu Nigam Limited (MIDHANI) - Aeronautics, space, weapons, atomic energy, special products of navy such as molybdenum wires and plates, tubes of titanium and stainless steel, alloys etc.

Goa Shipyard Ltd (GSL) - Construct a range of medium size special purpose ships for the defence, Indian Coast Gaurd (ICG) and civil markets.

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[12] Gilio-Whitaker, D. (2019). *As long as grass grows: The Indigenous fight for environmental justice, from colonization to Standing Rock*. Beacon Press.

Tata Advanced Systems Limited (TAS) - Design, production and supply of composite parts, sub-assemblies for use in aerospace division and solutions for personal armour, vehicle armour and special purposes.

Larsen and Toubro - Design, development and production of integrated land based /naval combat/missile systems, defence electronics & control systems and integrated naval engineering systems.

Kirloskar Brothers - Water supply infrastructure projects, power plants, irrigation projects, project and engineered pumps, industrial pumps.

Mahindra Defence Systems - Complete solutions for the series of light combat/armoured vehicles, simulators for weapons & weapon systems, sea mines, small arms, variants and related ammunition[13].

Ashok Leyland - Design, development and production of special vehicles, for Indian Armed Forces and other overseas customers like US army.

"Defence Industry Reforms under Make in India and Atmanirbhar Bharat Abhiyan"

India's defense R&D and manufacturing base have led to a significant increase in imports, with the armed forces dominating the global market between 2019 and 23. The Modi administration has introduced measures to revitalize the armaments industry towards self-reliance, including the creation of the Chief of Defence Staff (CDS) and the creation of the Department of Military Affairs (DMA). The CDS is expected to promote the use of indigenous equipment by the Services and end the adversarial relationship between users, developers, and manufacturers.

The DMA has released five lists of over 500 items banned from import after a stipulated time, which will be inducted in India at a later time. The government has also announced the corporatization of the Offshore Forces (OFs), which have always acted as government arsenals. 41 factories of OF will now be merged into seven distinct Defence Procurement Service Units (DPSUs), providing greater operating freedom but being answerable as business entities. This corporatization is the first step towards more reforms, which can be achieved through regrouping into fewer DPSUs, listing on stock exchanges, or privatizing these units[14].

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[13] Goswami, M., & Daultani, Y. (2022). Make-in-India and industry 4.0: Technology readiness of select firms, barriers and socio-technical implications. *The TQM Journal*, *34*(6), 1485-1505.

[14] Hefner, R. W. (2023). *The political economy of mountain Java: An interpretive history*. Univ of California Press

The Defence Acquisition Procedure (DAP) has been amended to streamline procedures for arms purchase, favouring domestic industries over global ones. The Indian industry has been bestowed the role of system integrator under the first three of the five preferential acquisition categories, with foreign corporations having a supplemental role as equity partners to Indian enterprises that execute contracts won under these categories. This foreign equity varies from 74% (in the last three priority categories) to a maximum of 49% (in the first category where the domestic sector is obliged to produce and design).

Prioritised Category	Indigenous Content (IC) Requirement	Tender issued to	Maximum FDI allowed under automatic route
Buy (Indian-IDDM)	Indigenous Design & IC of ≥ 50%	Indian	49%
Buy (Indian)	50% IC if Indigenous Design; Otherwise, IC of ≥ 60%	Indian	74%
Buy and Make (Indian)	≥50% IC in Make Portion	Indian	74%
Buy (Global-Manufacture in India)	IC of ≥50%	Foreign	74%
Buy (Global)	Foreign Vendor- NIL Indian Vendor ≥30% IC	Foreign/Indian	NA (Foreign); 74% (Indian)

Source: Compiled from Ministry of Defence, Defence Acquisition Procedure 2020.

Figure 2.4.1: Percentage and ratio information on arms utilisation

2.3 The “Make in India” Initiative

The 'Make in India' initiative, launched in September 2014, aims to promote India as the preferred global manufacturing destination. The Indian government has implemented reforms to create an environment conducive to manufacturing, design, innovation, and startups. India has become the fastest-growing economy globally, with a 7.5% growth rate. The Prime Minister has launched initiatives like 'Make in India', 'Digital India', '100 Smart Cities', and 'Skill India' to drive growth. The initiative aims to make India an integral part of the global supply chain and make Indian companies excel in a globalized workspace. India has opened up its economy for foreign direct investment in sectors like defence, railways, construction, insurance, pension funds, and medical devices, making it one of the most open economies globally.

There are specific challenges due to extreme weather, restricted mobility, and logistic constraints associated with high-altitude warfare. "Self-reliance in defense manufacture is particularly important for guarding India's border areas, Ladakh and Arunachal Pradesh, most prone to border conflicts," noted studies by Joshi (2019) and Singh (2021)[15]. According to research, operational efficacy in these areas depends on domestic manufacturing of specialised equipment, such as winter combat gear, all-terrain vehicles, and lightweight artillery. Numerous studies have assessed the development of domestic defence production under the Make in India initiative.

High-altitude combat equipment manufacture has been boosted by the Positive Indigenisation List and the Defence Procurement Procedure (DPP) 2020. To improve operational capability, indigenous systems such as the Tejas Light Combat Aircraft, Dhanush artillery weapons, and Pinaka Multi-Barrel Rocket Launcher have been created. Technology for mobility and surveillance has advanced as a result of cooperation between the Defence Research and Development Organisation (DRDO) and private defence companies. Nonetheless, some academics contend that the defence industry still confronts issues such sluggish project execution, reliance on outside components, and minimal private-sector involvement despite regulatory improvements.

Several significant developments are identified by research on high-altitude combat readiness under Make in India such as:

Weaponry: Firepower in mountainous areas has increased thanks to the development of lightweight ATAGS artillery systems.

Mobility and Logistics: The deployment of local all-terrain vehicles (ATVs) has improved troop mobility.

Surveillance and Reconnaissance: Real-time intelligence has been improved by the use of domestic unmanned aerial vehicles (UAVs), such as Rustom-2.

Several research (Chopra, 2023; Bhatt, 2023) highlight persistent difficulties in spite of advancements:

Implementation Delays: A lot of domestic initiatives have delays, which compromises operational readiness.

Foreign Dependency: Propulsion systems and sophisticated sensors, two essential defence technologies, continue to be imported.

[15] Joshi, Y., & Mukherjee, A. (2019). From denial to punishment: The security dilemma and changes in India's military strategy towards China. *Asian Security*, *15*(1), 25-43.

Problems with Testing and Deployment: Before being fully deployed, some indigenous systems need to undergo a rigorous testing process, which can result in capability gaps in high-altitude combat[16].

According to Verma's (2024) research, India's future defence strategy ought to concentrate on enhancing public-private collaborations to boost domestic manufacturing. Boosting R&D spending to create next-generation weapons designed for fighting at high altitudes. To improve production efficiency, the Defence Industrial Corridors (DICs) are being expanded. The study says promoting agreements for technology transfer can solve capacity gaps. Moreover, winter Combat Gear must be taken into consideration. Domestic manufacturing of survival and high-altitude apparel has decreased reliance on imports.

The research by Subramaniam (2023) gives an idea in the case that the war context in which a country's military is changing must be taken into account in any consideration of that change[17]. Large-scale conventional wars, limited battles, and subconventional fights in a variety of terrains—including expansive marine areas under a nuclear shadow—remain distinct from an Indian perspective. India must therefore preserve its continental stance and a sizable permanent army in order to bridge internal cracks and fissures and to maintain credible deterrence against external enemies. Deterrence, latent coercive capability, and support for the growth of interests and influence all depend on maintaining a sizable naval and air force. Nonetheless, the authors of the paper make the case that India should think about reorganising and combining its air force, navy, and army to tackle modern challenges and combine resources with allies, especially in the Indo-Pacific region where China is advancing rapidly. If this isn't done, India will be vulnerable to constant pressure from several directions. It concludes by highlighting the fact that for India's military to be a major power, it has to confront uncertainty and become the sword arm of Indian statecraft.

[16] investindia.gov.in, 2024. Available at: https://www.investindia.gov.in/team-india-blogs/indigenous-defence-manufacturing-indias-road-atmanirbharta

[17] Subramaniam, A. (2023). Pushing Boundaries: Can the Indian Military Transform?. *Journal of Indo-Pacific Affairs*, *6*(4).

As explained by Choudhary (2022) it is crucial to answer three crucial questions: (a) How has India developed ties with nations in Central Asia?[18] (b) In what ways has the structure and function of India's DD aided regional foreign policy and national security goals? (c) What are the main obstacles to India and Central Asian nations establishing robust defence cooperation? The study makes the case that India has not strengthened its military cooperation with CAS by taking use of its strategic influence and the diplomatic history between India and Central Asia. DD is conventional in nature and is spoken cautiously towards the area. For India and CAS, strengthening defence capabilities and strengthening military cooperation will foster strategic vision and confront threats in the years 2050 and beyond. In order to manage the defence the Make in India project launched in 2014 has contributed to a great extent. It has supported various warfront operations specifically, the indigenous war equipment design projects and funded them well.

Muraviev et al. (2021) explained that China's development, Russia's strategic alignment with China, and the US's ambiguous Indo-Pacific geopolitical position have all contributed to India's current security predicament. India's transition from non-alignment to strategic autonomy raises a number of concerns regarding its future strategic direction[19]. The study being reviewed exposes information on will India formally join the United States, keep up its engagement with China, maintain its deep historical ties with Russia, or more vigorously pursue its "Act East" policy? This essay makes the case that India will maintain its strategic independence even as it enters into a quasi-alliance with the United States by critically examining the various strategic alternatives that are open to it. India can simultaneously maintain relations with China, Russia, and ASEAN. To take the lead in international forums, it will, to the greatest extent possible, favor a multipolar-Asia paradigm as opposed to a zero-sum alliance structure. While doing that a reference to the make-in-india initiative has been given. Under this initiative a range of new projects on weapon making have been undertaken which are valuable in discussing the theme of Indian war ready situation.

[18] Choudhary, L. R. (2022). India’s Defence Diplomacy Towards Central Asia. *Indian Journal of Asian Affairs*, *35*(1), 73-93.

[19] Muraviev, A. D., Ahlawat, D., & Hughes, L. (2021). India’s security dilemma: Engaging big powers while retaining strategic autonomy. *International Politics (The Hague)*, *59*(6), 1119.

Kristensen & Korda (2022) explains that the Indian Air Force is facing a growing two-front conflict with China and Pakistan, and is struggling to prepare for potential collusive attacks. To address this, the IAF must rightsize its military and other establishments, which are funded by Defence Estimates[20]. The government must also enhance its defence budget to counter collusive threats effectively. Yet, a practical and proper NSS document is still not framed, and JDIAF and LWD do not contain the required details for reshuffling the armed forces. The political class in India has followed a policy of more regional defense rather than national security, thereby increasing personnel's deployments and hampering free options for operational military commanders. In this era of Hybrid/Fourth-Generation Warfare, IAF needs to be prepared for a limited war below the nuclear threshold, which is possible considering the possibility of a collusive attack by Pakistan and China. The IA will have to revisit its "general-purpose" structure and reorganize itself to a terrain-based posture, incorporating modern technology for the plains as well as the mountain forces in order to maximize operational efficiency. India's offensive capabilities, comprising Special Forces, need to be strengthened with relevant capabilities for punitive deterrence. In a post-COVID world, India must deal with shifting health, economic, and sociopolitical crises to sustain its position in the geopolitical environment. China has emerged stronger, and India must prepare itself to face Chinese aggression on its borders and review its preference for strategic autonomy and proactive response.

Rossiter, & Cannon, (2019) explains that going alone is no longer an option for the majority of governments when it comes to equipping themselves, according to specialists of comparative defence industries[21]. There are significant barriers to autarky in arms due to the processes involved in defense-industrial globalisation and the constantly rising costs of manufacturing cutting-edge weaponry systems. However, in spite of these very formidable obstacles, India has recently begun a renewed attempt to become more self-sufficient in the production of weapons as part of a larger, multisector drive called “Make in India”. This essay first situates India's

[20] Kristensen, H. M., & Korda, M. (2022). Indian nuclear weapons, 2022. *Bulletin of the Atomic Scientists*, *78*(4), 224-236.

[21] Rossiter, A., & Cannon, B. J. (2019). Making arms in India? Examining New Delhi’s renewed drive for defence-industrial indigenization. *Defence Studies*, *19*(4), 353-372.

defence indigenisation initiatives in the context of broader debates regarding state strategy and trends in the global arms industry. Second, it explains and contextualizes the motivations behind New Delhi's efforts to transition from being a major weapon importer to a significant manufacturer and exporter. Thirdly, it explains and evaluates the current approach of Indian decision-makers. Finally, the chosen paper to be reviewed assesses the chances that the current push in India's defence industry may produce results and draws the conclusion that India is likely to fall short of self-sufficiency in arms for systemic, structural, and technological reasons.

Tarapore (2022) has explained in his study that an old offensive doctrine, which focuses on massive army formations being employed independently from political guidance to inflict heavy costs on the adversary, has made the Indian army and controlled the larger slice of defence budgets and manpower. Even though India's strategic defensive war attempts to maintain the territorial status quo, it often includes appropriating enemy territories as a bargaining chip. The influence of the traditional offensive doctrine on the experience, organization, and doctrine of the Indian Army during wars since 1965, 1971, and 1999 against Pakistan defines its behaviour in crisis[22]. The fundamental geopolitics has transformed drastically since 1999, even though military coercion between India and Pakistan is overshadowed by the nuclear deterrence that exists between India and China.

The effects of such transformations on defence strategy could not be adopted or driven in the procedures of the Indian armed forces. The services of India are change-inclined, and the civilian leadership radiantly shows little resolve in achieving change; India's strategic view regularly lacks a mechanism for review. At the moment, there is a reshaping process in civil-military relations under the new Chief of Defence Staff, but no indications are that the Indian Army is about to change its traditional offensive doctrine. Under the circumstances the literature also highlights the aspects of the "Make in India" initiative which allows India's strategic position determination in the warfront. Moreover, the status of indigenous weapon development is also encouraged in the study being reviewed. This is the need of the hour to understand how operational efficiency has increased.

[22] Tarapore, A. (2022). *Army in Indian Military Strategy: Rethink Doctrine Or Risk Irrelevance*. Carnegie Endowment for International Peace

Bitzinger (2021) said that Asia is a major consumer of weapons, and forces in Asia are acquiring some of the cutting-edge-and-contemporary weapons[23]. As such, over the past few years, if not unprecedentedly, the number and quality of several Asian-Pacific militaries have vastly or significantly increased. Besides this trend, however, the continent has certainly grown in importance as an arms producer. Many countries of the region have sought to replace or at least augment foreign arms suppliers with local manufacture of needed weaponry. But local weapons can add to the military capability of most Asian-Pacific militaries only to a limited extent (China maybe being the only exception). Hence, most of the Asian-Pacific countries still rely on imports of advanced weapons. In the case of India the case is also similar. However, it turns out that India is preparing its indigenous workforce heavily so that they can have a major impact in the war front and create their own impression as a nation. This is occurring under the "Make in India" project started form 2014 which is creating India's less reliance on the foreign arms.

2.4 Research Gap

The existing literature indicates that Make in India has made substantial contributions toward enhancing the Indian Army's operational capability in high-altitude and mountain warfare. However, challenges such as slow implementation, technological dependence, and logistical bottlenecks must be addressed. Current research is focusing on evaluating the long-term impact of indigenization efforts on India's military readiness in extreme warfare conditions.

[23] Bitzinger, R. A. (2021). Asian arms industries and impact on military capabilities. In *Defence Industries in the 21st Century* (pp. 115-131). Routledge.

Chapter 3- Methodology

3.1 Introduction

The research challenge determines the research approach which must yield objective results. The present chapter addresses the choice of a suitable research paradigm, approach, design, data collection, and analysis technique with a view to answer the research questions. The term research methodology is used to understand the topic-related nature of the research and in this way, provides an elaborate and intensive examination of the research methodology. The researchers within this study collect data with the intention of detail and analysis, thereafter correlating and analysing data in accordance with the-directed research methodology. In this process, a researcher adopts a variety of theories and concepts in the analysis of the research problem. For this reason, the researcher is able to adopt various theories and concepts methodologically and analyze the research subject in a more meaningful way.

3.2 Research Philosophy

The three basic paradigms forming the philosophical outlook of epistemology are positivism, interpretivism, and realism. Positivism holds that there are material realities that exist in the universe and require scientific scrutiny[24]. In a systematic framework mimicking the procedure of an accepted science, positivism thus encourages research based on social reality. The anti-positivist thesis of interpretivism argues that scientific scrutiny does not readily apply to social research. Realists, on the contrary, hold that while things in the universe may be sensed by human senses, they exist independently of human perception and acuity. Another research philosophy, termed pragmatism, affirms that both positivism and interpretivism can be applied in research. This pragmatism would justify an objective investigation where data would be rigorously verified by scientific methodology. Interpretivism stands in contrast to the methodologies of positivism in that it is understood to encourage subjective research with the potential for extended qualitative depth and exploration.

[24] Pulicherla, K. K., Adapa, V., Ghosh, M., & Ingle, P. (2022). Current efforts on sustainable green growth in the manufacturing sector to complement “make in India” for making “self-reliant India”. *Environmental Research*, *206*, 112263

Arguments for Positivism:

According to positivism, the purpose of scientific investigation is the search of truth with forecasting and control. Scientific inquiries are therefore promoted that are objective and adhere to concepts found in the natural sciences. This is in direct contrast to interpretivism, which assesses scientific evaluations subjectively using human perceptions and reasoning. Interpretivism is poorly fitted for this study, as there cannot be reason and argument in analysing the existing concepts and giving relevant results. Thus, it is pertinent for the present study, since positivism fits well within the logical approach of this study by verifying the pre-existing beliefs with the evidence gathered through empirical research.

3.2 Research Approach

Depending on the nature of the research topic and the finer intricacies of the problems that arise, either a deductive or an inductive approach is suitable for the investigation. The abductive research method is a rare instance her[25]e. The inductive process is a theory-building mechanism that begins with data collection, observation, and preliminary hypothesis formulation, data-analysis, and finally, generation of new knowledge. The deductive approach to theory construction proceeds by an initial assessment of the existing theories, thus indicating research gaps and proposing hypotheses, which are then subjected to scientific method analysis and evaluation of the findings.

In contrast to the inductive approach, which focuses on proposing an application of an existing theory, the deductive approach derives its conclusions from empirical investigations. In contrast to a deductive approach, which tests an extant hypothesis and directs researchers in a particular direction, the inductive approach aims to discover generalizations from specific observations to deductively explain and confirm. It develops a theory based on observational data, which evolves into hypothesis formation and testing. This approach consists of applying analytical techniques to an existing theory in an effort to confirm or disprove the hypothesis.

[25] Rajagopalan, R. (2020). *Fighting like a guerrilla: The Indian Army and counterinsurgency*. Routledge India.

Rationale for the Research Method

The study is based on the deductive approach, which is the testing of empirical models drawn from literature review surveys and interviews on first-hand or primary data. The inductive approach is not appropriate for this study because there is very little room created for developing new theories on war front and indigenous weapon. Besides, inductive approaches usually depend upon quantitative interpretations of data and the analysis of secondary data to an extent, which is not majorly the case with this study. According to researchres, new information resulting from primary research findings, including observations, can hardly be supported or even counterfeited. Thus, considering these reasons, the deductive method is claimed to be feasible for accomplishing the research, and an inductive approach is avoided to extricate it from any complexity of new information emerging. In the current study, there is no possibility of an inductive approach supported by interpretivism and qualitative data analysis being utilized.

3.3 Research Design

Descriptive, explanatory, and exploratory - these three layouts of study are used in scholarly research. When the researcher intends to gather more information related to an individual field of study because that person does not have an exact idea of 'what' the research has to deal with, the exploratory type is used to collect information that may need further analysis. It provides very basic information that could be used to formulate a hypothesis for study[26]. While a descriptive design can study a research question in terms of many more than just "what," "why," "who," "how," and "when?" an explanatory design develops correlations among variables and establishes cause/effects.

Justification

That is why with regards to the aspects of descriptive inquiry a research design will be considered since it presents the researcher with a much wider view towards the study that would enable him or her to sketch his or her own ideas and reasoning. Thus it

[26] Singhal, G., Bansod, B., & Mathew, L. (2018). Unmanned aerial vehicle classification, applications and challenges: A review. *Preprint, 2018110601*, 1-19

contributes a valuable and in-depth description of the subject[27]. Because exploratory research can only provide scanty information, it cannot be appropriate to understand exchange rate fluctuations and their impacts on the company. Similarly, explanatory research will not be carried out for a full qualitative analysis, but will only help to establish the relationship between the principal research variables. Hence, since the nature of the problems in this study is well defined and characterized, it has been determined that descriptive research design would be appropriate for the study. It is a descriptive design that carries the present study and combines a mixed technique for data gathering with a set number of objectives. Because the background is insufficient to address the research questions, exploratory design is considered not appropriate in this research. Thus, descriptive research enables researchers to make connections between relevant sources of data and tackle particular problems.

3.4 Nature and source of data/ information to be collected

Primary Quantitative data: Through surveying people

Secondary qualitative data: Through analysing available data on trusted academic sources and internet

3.5 Sample Design and Sampling Method

110 samples will be chosen, people from the people having army and warfront experiences. Statistical inferences on a population are based on simple random sampling. Randomization is the best method to minimize the possible influences of confounding variables and maintain strong internal validity. Likewise, a simple random sample would have high external validity when big enough since it accurately represents the characteristics of the larger population.

3.6 Tools and techniques used for data collection

In research, both qualitative and quantitative data collection techniques are applied. The following describes each type of data technology for collection. -

[27] ibef.org, 2024. Available at: https://www.ibef.org/blogs/building-a-self-reliant-defence-industry-enhancing-indigenous-defence-manufacturing-capability-in-india

Quantitative data collection: Method of quantitative data research can be statistically analysed and examined by scientific principles. The researchers mention the strong sense of objective-oriented research in quantitative data that applies numerical explanation. The instrument used is-a survey questionnaire.

Survey questionnaire: This provides a straightforward, cheap, and practical means of reaching dispersed respondents over a wide geographical area. Subsequent to that, these survey responses will be stored in an MS Excel format with each document password-protected. Each response will undergo statistical analysis and results will be presented in charts and graphs[28].

Qualitative data collection means gathering descriptive and conceptual information using questionnaires, interviews, or observations. For this particular case, secondary data will be employed. QSA is defined as the use of qualitative data collected by someone else or for another research question. Qualitative secondary analysis can thereby stretch the available assets, especially among elusive patient populations. Data were collected according to the PRISMA criteria from a wide variety of trustworthy journals so that the most relevant publications could be selected for the data analysis.

Thematic analysis: For the qualitative study to be able to be done, the best thematic analysis had to be employed. Themes emerging from the literature that provided information about the selected topic were then developed to analyze the secondary data.

3.7 Methods to be used for data collection

- **Quantitative method**

Surveys are used as quantitative method applications. These application is done based on inclusion and exclusion criteria such as:

[28] Tachine, A. R. (2022). *Native presence and sovereignty in college: Sustaining Indigenous weapons to defeat systemic monsters*. Teachers College Press.

Inclusion Criteria

1. Age limit within 50 years
2. Having experience in the army, High Altitude and Mountain Warfare.

Exclusion criteria

3. Age limit not within 50 years
4. Having no experience in the army, High Altitude and Mountain Warfare.

- **Qualitative method**

Thematic analysis will be done for the secondary qualitative data gathered.

Inclusion Criteria

1. Journals should be within range of 2018-2024
2. Journals should be from verified sources
3. Journals should be true to its content and not misleading

Exclusion Criteria

1. Journals not within range of 2018-2024
2. Journals which are not from verified sources
3. Journals which are misleading

3.8 Ethics

All participants including relevant stakeholders must give informed consent and be aware of what study goals, data usages, and participations entail to fulfill the research ethics. The participants must be able to stop attending without any repercussions. It requires anonymizing data with comprehensive guidelines on the usage and storage of such data for purposes of confidentiality. It also clears disclosures for any links or affiliations which would otherwise withhold transparency[29]. The findings of a study

[29] Weir, W. (2019). *50 weapons that changed warfare*. Permuted Press.

should be shared openly. Harm prevention is vital under careful behaviour followed by a timely resolution of issues. Conflicts of interest should be disclosed for the impartiality of a researcher. Findings can add credibility with triangulation and different data sources. With strong mechanisms, access restrictions and ethical and legal obligations make your data security. Data security also forms an important part, restricted access to designated personnel must be in place.

3.9 Limitations

- Sample bias is highly observed in the study. Since the chosen samples undertaken are from a background which is belonging to the army people are expected to talk in reference with the army initiatives and not the other way around
- Confidentiality: The topic chosen is quite confidential and hence gathering data on a confidential topic is quite risky and limited. Therefore, only a limited amount of information can be presented throughout the document.

Chapter 4: Overview of High-Altitude Warfare and Indigenous Defense Manufacturing in India

4.1 Strategic Importance of High-Altitude Regions for India

Ladakh, Siachen, and Arunachal Pradesh are vital security regions in India because they are strategically located, there exists geopolitical tensions, and they have difficult terrain. They are border areas between India and China and thus defense is an essential priority. The border dispute between India and China has been a continuous factor, especially in the region of Eastern Ladakh, which needs increased military readiness. Siachen Glacier, which is at an elevation of more than 5,400 meters, is the world's highest battlefield, and the dispute between India and Pakistan over Siachen is a result of the indeterminate boundary of the Line of Control after the 1971 war. Arunachal Pradesh and Ladakh make up India's northern and northeast border defensive shield against Chinese infiltration deeper into India. Siachen control keeps Pakistan from connecting to China in the Karakoram. Arunachal Pradesh harbors the important passes such as Bum La and Walong, significant both for defense and commerce[30].

India has increased infrastructure, such as roads, tunnels, bridges, Rafale fighter aircraft, BrahMos missiles, upgraded infantry regiments, and enhancing the Indo-Tibetan Border Police (ITBP), Assam Rifles, and the Indian Army to repel Chinese advancements. Environmental and climatic issues complicate defense operations, making it necessary to have improved logistics and technology. India holds bilateral negotiations with China and Pakistan but maintains a robust military presence to negotiate in strength. QUAD, Indo-Pacific alliances, and border pacts are some of the measures taken by India to balance the regional threat. Hence, maintaining security is a matter of concern in this areas and that is why these high altitude regions are becoming empowered with indigenous weapons.

[30] Kliman, D., Rehman, I., Lee, K., & Fitt, J. (2019). Imbalance of Power. *Center for a New American Security, October*, *23*.

4.2 Challenges in High-Altitude and Mountain Warfare

The Indian Army has major operational and logistical difficulties in Ladakh, Siachen, and Arunachal Pradesh because of hostile geography, harsh weather, high-altitude warfare, and infrastructure constraints. These difficulties are extreme climate and altitude-related, including sub-zero temperatures in Siachen, and high-altitude sickness among troops deployed above 12,000 feet. Snowfall and landslides hinder operations, destroying posts and severing access routes. Harsh terrain and mobility limitations result in slow and hazardous movement, with limited motorable roads in forward sectors such as Tawang or Depsang Plains. Bridges and river crossings in Arunachal Pradesh are susceptible to monsoon floods and necessitate airlifting of material. Hostile threats and tactical challenges involve China's swift border infrastructure buildup, regular border incursions, aggressive patrolling by the PLA, and Siachen infiltration risks by Pakistan Special Forces or terrorists[31].

Logistical issues involve constrained road and rail connectivity, supply lines dependent on weather, shortages of fuel and energy, medical and food supplies, water, maintenance of infrastructure and equipment, and communication network disruptions in outlying regions. Mitigation efforts involve infrastructure upgrading, sophisticated logistics, intelligent technology, improved acclimatization and training, and enhanced cold-weather equipment. In summary, the Indian Army is in firm defense positions in these strategically vulnerable sectors, but ongoing infrastructure development, sophisticated logistics, and technological advances are essential in order to counter these operational obstacles and guarantee India's border protection.

4.3 Indigenous Solutions under “Make in India”

India is emerging as one of the significant players on the world stage, yet equally present are the challenges in enhancing its defence capabilities. Being self-reliant is not merely a question of peace; it ensures development and social stability. Conflict, high levels of unemployment, poverty, and war casualties are prevalent in a country with an unimproved defense capability. India has improved and upgraded its defense

[31] Khattak, M. U. R. (2020). The Indian Army’s Land Warfare Doctrine 2018: A Critical Analysis. *IPRI Journal*, *20*(1), 105-134

equipment and increasingly sophisticated weapon systems during the last two decades. Spending on defense ranked India at the fourth position globally, for the fiscal year 2024-25, India proposed a massive defense budget of US$ 74.5 billion, signaling its readiness and intent to enhance the defense potential of the country and pave the road toward Atmanirbhar Bharat.

The defence production in India in FY23 surpassed Rs. 1 lakh crore (US$ 12 billion) with an over 12% YoY growth. In FY24, the figures stood at Rs. 74,739 crore (US$ 9 billion). India is again the largest importer of arms in the world, which grew by 4.7% between 2014-18 and 2019-23. Nonetheless, defence exports have picked up to a record high of US$ 2.5 billion (Rs. 21,083 crore), reflecting an exceptional growth rate of 32.5% as against the previous financial year's amount standing at $1.9 billion (Rs. 15,920 crore). Recent record shows that defence exports have grown almost 14 times from 2016-17, with a CAGR of 45.6%.

Large contributions came from the defence industry comprising the private sector and Defence Public Sector Undertakings (DPSUs) to reach the present peak in defence exports. The government is working closely with defence industries to redress their challenges for increased defence production in the country. For the past 7-8 years, more than a 200% increase in the issuance of defence licenses to industries has acted as a major catalyst in the growth of the defence industrial manufacturing sector, thus addressing unemployment at large.

The Government's initiatives propelling the industry growth are the Defence Production & Export Promotion Policy 2020, Defence Acquisition Procedure 2020, Make In India initiative, and Positive Indigenisation Lists. It endeavours to boost India's domestic industry under the aegis of Make in India, to provide a fillip to foreign direct investment, and to promote R&D and MSMEs in the defence sector. The Ministry of Defence has also introduced funding for Make-I, Technology Development Fund (TDF), and Innovations for Defence Excellence (iDEX) projects;

these new funding mechanisms will give a significant boost to the vision of 'Aatmanirbharta in defence'[32]. The most impactful project is:

Make Projects: A major thrust of the Make category under Defence Procurement Procedure in promoting the objectives of the Make in India initiative. Its primary aim is to build up domestic capabilities due to the design and production of crucial defence goods, systems, equipment, or upgrades by both public and private sector organizations within a definite time frame.

Category		Features	Maximum FDI allowed under automatic route
Make	Make-I	Up to 70% government funding for prototype development, subject to a maximum of INR 2.5 billion (approximately US$30 million) per development agency. After successful development, procurement will be through the Buy (Indian-IDDM) route.	49%
	Make-II	Self-funded by the industry for prototype development. After successful development, procurement will be through the Buy (Indian-IDDM) route. Industry can submit a suo-moto proposal.	49%
	Make-III	Primally intended for import substitution of product support of existing weapons systems. Post successful development, procurement through the Buy (Indian) route	74%

Figure 4.1.1: MakeInIndia project allocation

As per DPP-2016, there are two broad sub-categories under the Make procedure:

- In "Make-I" (Government Funded), projects under this subcategory are funded 90% by the government, disbursed in phases according to the advancement of the project, and with mutually agreed-upon conditions by the vendor and the Ministry of Defence.
- In "Make-II" (Industry Funded), the projects included in this category are given to develop prototypes of platforms, systems, or equipment or upgrade

[32] Kristensen, H. M., & Korda, M. (2022). Indian nuclear weapons, 2022. *Bulletin of the Atomic Scientists*, *78*(4), 224-236.

existing ones primarily with a view to offsetting imports or finding innovative solutions. In "Make II," no assistance from the Government is provided for the prototype development.

- Make-III takes care of the production of the defence systems, subsystems, and prototypes. Under the scheme "Make-III," purchases must gross a minimum of 60% indigenous content, remaining under the category "Buy Indian[33]."
- Defence Corridors: Two defence corridors in India have been established in Tamil Nadu and Uttar Pradesh. These corridors shall provide a specific place or area to promote the domestic production of defence and aerospace products. The estimated total investments in these corridors stand at US$4.5 billion (approx. Rs. 37,219 crore).

Starting from the fiscal year 2013-14, till the year 2021-22, the defence sector in India has seen a decrease in import-export ratio, ensuring efforts of self-reliance both for the government as well as for the private sectors. The central government has apportioned a considerable chunk of its defence capital procurement budget to its own defence industry; from the earlier 40% share, it increased to three-quarters by 2023-24 for this purpose alone, to support local design and production. Aside from this, funds have been earmarked for the internal resources procurements[34]. The Capital Acquisition Budget of the Ministry of Defence for 2023-24 earmarks 67.75:32.25 ratio of procurement budget for domestic and foreign sources, indicating the intention of strengthening domestic manufacturing capability. India is likely to see up to thrice higher annual defence production within the next four years, estimated to touch around $3 lakh crore. Another expectation is that the government will export military hardware worth $6 billion.

[33] mod.gov.in, 2024. Available at: https://www.mod.gov.in/sites/default/files/wemer7422.pdf

[34] Lauer, R. S. (2022). When states test their anti-satellite weapons. *Astropolitics*, *20*(1), 1-26.

Year	Export Authorisations to Private Companies (INR billion)	Export by DPSU (INR billion)	SCOMET Issued by DGFT (INR billion)	Contract Value (INR billion)	Total Export (INR billion)
2016-17	1.94	13.28	0.00	0.00	15.22
2017-18	31.63	15.19	0.00	0.00	46.82
2018-19	98.13	9.33	0.00	0.00	107.46
2019-20	80.08	9.05	2.03	0.00	91.16
2020-21	72.71	9.85	1.79	0.00	84.35
2021-22	59.65	3.86	0.07	64.57	128.15
2022-23	90.51	3.86	3.51	61.30	159.18
2023-24	131.40	1.09	20.90	57.65	211.05

Figure 4.1.2: India's Defence export

While the Indian defence sector has improved in recent years, it continues to be beset by several challenges. The greatest of these challenges is to increase production to at least the level that can satisfy the Indian purchasing requirements. Production has not risen in enough quantities to meet the annual procurement requirements of the armed forces, even though the government has put in place measures and an ambitious output target is laid down to achieve US$26 billion by 2025. Since 2014-15, there have been hardly any increases in the domestic procurement share of the military capital purchase, owing to the poor progress in defence manufacturing in India and a steadily increasing purchasing budget.

As for exports, albeit there has been some perceptible rise in international arms sales, the defence industry is still quite far behind the lofty ambitions laid out by the government. The largest hurdle faced on the path of export success are the DPSUs themselves, which have been lackluster in meeting expectations. There have been cases in which major systems failed to be exported in recent years. For example, Hindustan Aeronautics Limited, the largest defence firm of India, lost an international competition for its Tejas fighter light combat aircraft in Malaysia, which instead chose a Korean alternative. Prior to this, Garden Reach Shipbuilders and Engineers

lost a major tender in the Philippines, which showed that DPSUs have a difficult path to exporting their defense equipment.

Overall, the reforms in the Indian defence sector are already rewarding dividends in terms of increased exports and production. Indeed, the effect is expected to intensify in the following years because the government has set up a large bank of projects for manufacturing in India.

The performance of the Indian military sector through reforms looks quite positive, but there are a few challenges in being self-reliant, which must be addressed. Defence manufacturing needs to go to the level where it can match at least the increasing procurement of India so that, as far as possible, direct imports can be avoided. In addition, to further indigenise and avoid direct and indirect imports, the R&D capability of the industry has to be strengthened. Also, the defence procurement decision-making process has to be sped up to enable the sector to manufacture and supply the weapons in the least possible time.

The Defence Research and Development Organisation (DRDO) created and developed the indigenous Main Battle Tank (MBT) Arjun Mk-1A, which is consistent with the Armed Forces' current and future requirements. With 71 improvements over MBT Arjun Mk-1, MBT Arjun Mk-1A is equipped with the higher firepower, increased mobility, and superior protection qualities needed to meet the demanding demands of the battlefield[35].

According to DAP-2020, the government has granted Acceptance of Necessity (AoN) to 150 proposals totalling approximately Rs 2,47,515 crore under various capital procurement categories that support domestic manufacturing over the last three years, from 2018–19 to 2020–21 and this year through December 2021. Additionally, out of the 191 capital acquisition contracts that have been signed during the last three years—2018–19 to 2020–21 and this year through January 2022—23 have been with Indian suppliers for the capital procurement of defence equipment for the Armed Forces.

Existing Defence Industrial Base in India

[35] Mallet, R. T., Burtscher, J., Richalet, J. P., Millet, G. P., & Burtscher, M. (2021). Impact of high altitude on cardiovascular health: current perspectives. *Vascular health and risk management*, 317-335.

With the establishment of the Ordnance Factories (OFs) during the 1940s, India's defence industrial foundation was laid. The defence needs of the British Indian Army were met by the creation of the IOFs. The IOFs were nationalised post-independence and formed the basis of India's defence manufacturing capability. The Cabinet Committee on Security (CCS) in June 2021 approved the transformation of the Ordnance Factories Board (OFB) into seven separate Defence Public Sector Undertakings (DPSUs). This decision was made for boosting the productivity and promoting development and innovation in these Ordnance Factories. But India's present defence industrial organization, comprising DPSU and DRDO, is plagued by several weaknesses that have resulted in a disproportionate dependence on imports[36].

Private sector participation has been one of the defence industrial base's prime weaknesses. Even though IOFs were corporatised in 2022, public sector undertakings (PSUs) and IOFs accounted for most of India's defence production. The complex licensing and regulatory procedures, absence of level playing field, and limited access to technology hinder the private sector's participation in defence production. The absence of innovation and R&D capability has been another major weakness of the defence industrial base. With its overdependence on foreign technology, the Indian defence industry has not been able to develop and produce advanced technology indigenously.

Changes which are focused on

Several expert-suggested enhancements are being made to address the defence industrial base's vulnerabilities. These include:

Promoting private sector participation: Through the provision of access to technology, the levelling of the playing field, and the simplification of licensing and regulatory procedures, attempts are being made to increase the private sector's participation in the manufacture of defensive equipment. Since May 2001, when the defence industry was opened to the private sector with a 100% participation rate, 333 private organizations have been issued 539 industrial licenses, 110 of which have commenced production activities.

[36] Morton-Jack, G. (2018). *The Indian empire at war: From jihad to victory, the untold story of the Indian Army in the First World War*. Hachette UK.

Encouraging R&D and innovation: For the defence sector, an effective R&D ecosystem is being developed, which would enable in-house development of advanced technology within the country. Industry-led research and development is allocated a quarter (25%) of the R&D budget. Innovations for Defence Excellence (iDEX) was started in April 2018 to create an innovation ecosystem in the defence sector. With the participation of industry, entrepreneurs, and educational institutions, it seeks to foster technological development in the defence and allied sectors. To facilitate technology and knowledge transfer, the government is encouraging partnerships between Indian defence industry and foreign companies.

Chapter 5: Impact of "Make in India" on Operational Capabilities: A Quantitative Analysis

5.1 Indigenous Defense Equipment and Operational Readiness

Cross tabulations

1.

		How would you rate the availability of indigenous military equipment for high-altitude warfare compared to previous years?					Total
		Much Improved	No Change	No comments	Slightly Improved	Very low improvement	
What is your current role in the armed forces	Airforce	1	1	0	6	1	9
	Army	29	5	5	47	9	95
	Defense Procurement & R&D	0	0	1	0	0	1
	Logistics & Supply Chain	1	0	0	1	0	2
	Navy	0	1	0	2	0	3
Total		31	7	6	56	10	110

Table 1: Rating the availability of indigenous military equipment for high-altitude warfare compared to previous years

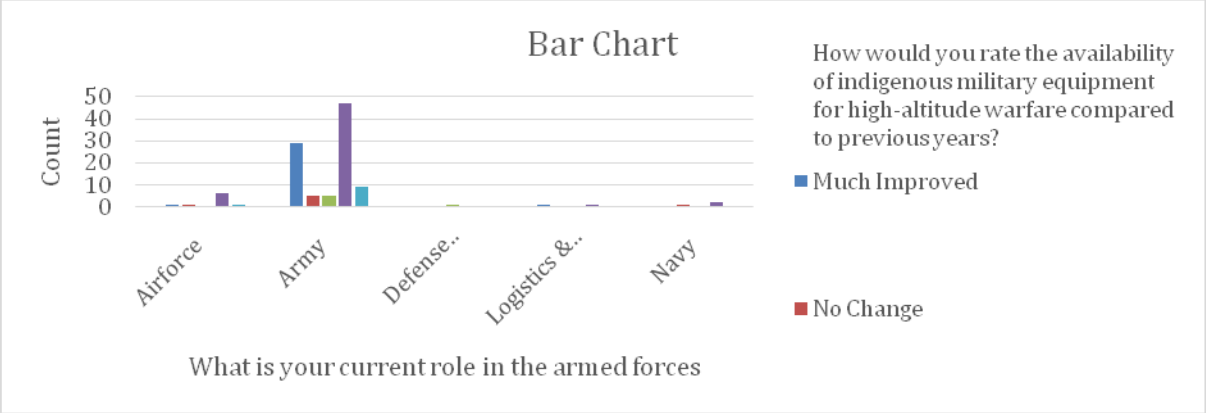

Figure 1: Rating the availability of indigenous military equipment for high-altitude warfare compared to previous years

Overall Positive Sentiment – A majority (79.1%) of respondents feel that availability of indigenous military equipment for high-altitude warfare has either slightly improved (50.9%) or much improved (28.2%). Army's perspective matters most – since army personnel represent the largest group (86.4%), their perception largely shapes the overall trend. they predominantly feel there is some improvement. limited concerns about no change or low improvement – only 15.5% (17 out of 110) feel there has been no change (6.4%) or very low improvement (9.1%). air force and navy show mixed views – the air force leans towards slight improvement, while navy responses are minimal but indicate some progress. procurement & R&D has no opinion – the only respondent in this category gave no comments, which could suggest a lack of direct involvement or insights into operational deployment.

2.

		Do you believe India's defense industry will be able to fully replace foreign military imports for high-altitude warfare in the next 10 years?					Total
		Agree	Disagree	Nuetral	Strongly Agree	Strongly Disagree	
Has the Make in India initiative improved logistics and supply chain efficiency for high-altitude warfare?		0	0	1	0	0	1
	Agree	29	16	5	3	5	58
	Disagree	2	7	2	0	2	13
	Neutral	13	18	0	1	0	32
	Strongly agree	2	2	0	2	0	6

Total	46	43	8	6	7	110

Table 2: India's defense industry being able to fully replace foreign military imports for high-altitude warfare in the next 10 years

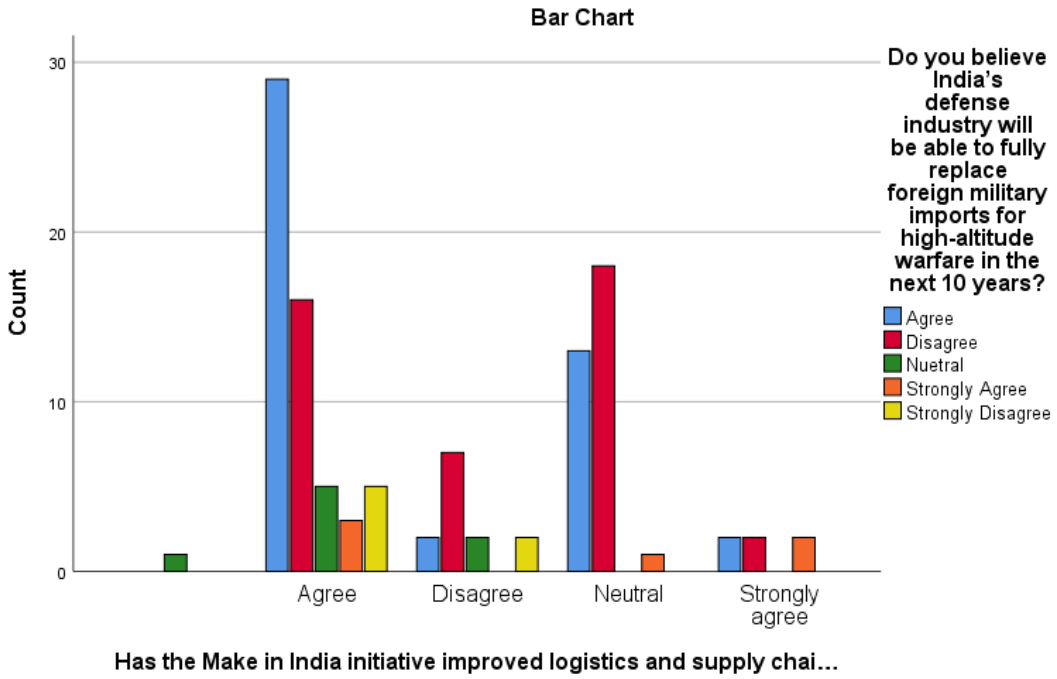

Figure 2: India's defense industry being able to fully replace foreign military imports for high-altitude warfare in the next 10 years

The majority of respondents (52.7%) believe Make in India has improved logistics and supply chains, but this doesn't necessarily translate into confidence in full self-reliance. While 46% believe India can replace imports, 39% disagree, suggesting significant challenges remain. Many acknowledge logistical improvements but remain skeptical about replacing foreign military imports within the next decade due to concerns around technology gaps, production scalability, and geopolitical dependencies. A large neutral group (29%) suggests uncertainty or lack of direct experience. To increase confidence in full import replacement, India's defense strategy should address concerns about production capability, quality control, and technological advancements. Strengthening R&D and partnerships within domestic defense sectors could help bridge these gaps.

3.

Have you operated with indigenously produced military equipment under the "Make in India" initiative? * How many years of experience do you have in high-altitude or mountain warfare operations? Crosstabulation							
Count							
		How many years of experience do you have in high-altitude or mountain warfare operations?					Total
		0-1 years	2-5 years	6-8 years	8-10 years	More than 10 years	
Have you operated with indigenously produced military equipment under the "Make in India" initiative?	No	3	10	4	7	13	37
	Yes	4	17	17	5	30	73
Total		7	27	21	12	43	110

Table 3: Operating with indigenous weapons

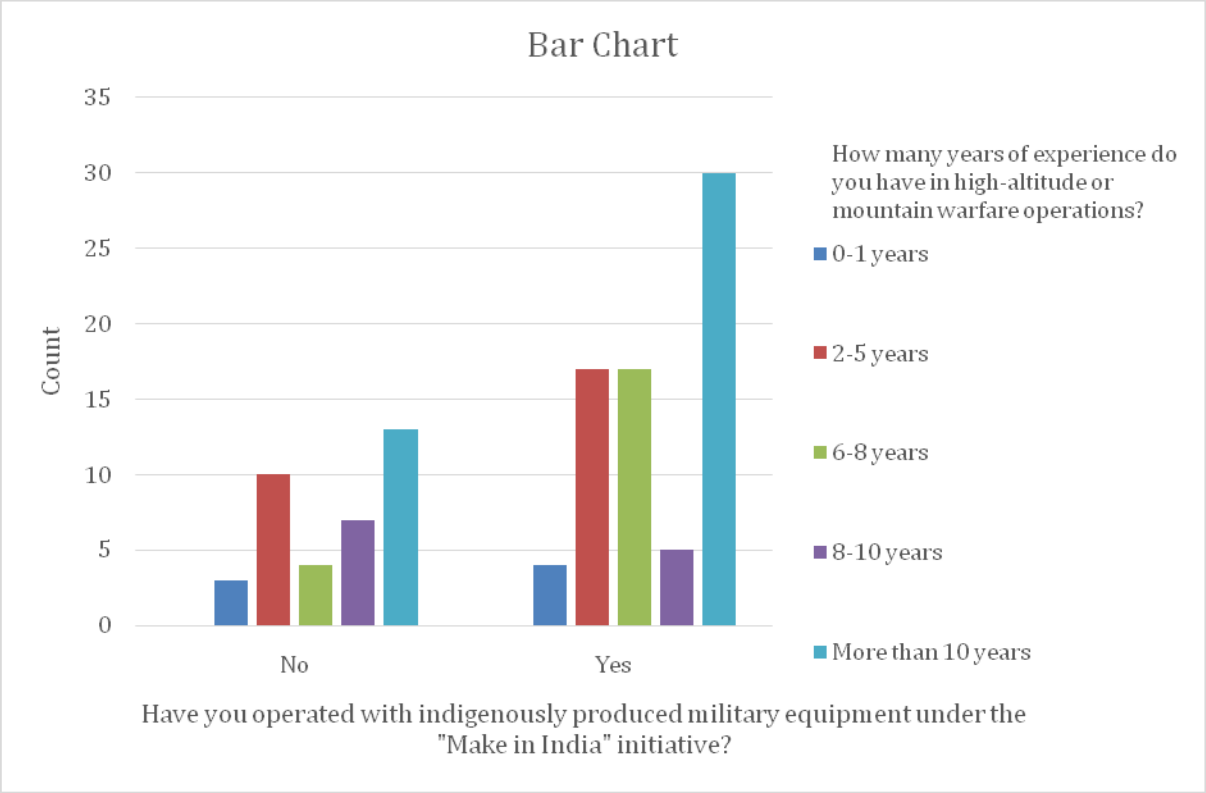

Figure 3: Operating with indigenous weapons

The use of indigenous equipment in India's military is increasing among experienced personnel, with 30 users out of 30. The adoption rate is highest among those with 6-8 years of experience (81%). However, those with 8-10 years of experience are an outlier, with only 41.7% using indigenous equipment. Early-career personnel are more likely to use indigenous equipment, with 57.1% of respondents using it. Despite the push for indigenous defense manufacturing, 33.6% of respondents still rely on foreign equipment, suggesting gaps in equipment deployment or preferences for foreign alternatives.

5.2 Logistical Improvements and Supply Chain Resilience

4.

	How would you rate the level of collaboration between India's defense research institutions (like DRDO) and private industry in developing indigenous high-altitude warfare equipment					Total
	Average	Excellent	Good	Poor	Very Poor	

In your experience, which challenges remain in reducing foreign dependency in military equipment production	Delayed production timelines	4	0	8	1	0	13
	Dependence on foreign components	17	0	8	10	2	37
	High altitude transportation cost	0	0	0	1	0	1
	Inconsistent quality of indigenous equipment	17	1	4	5	1	28
	Lack of advanced technology	11	1	8	10	1	31
Total		49	2	28	27	4	110

Table 4a: challenges remain in reducing foreign dependency in military equipment production

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	19.481[a]	16	0.245
Likelihood Ratio	19.235	16	0.257
N of Valid Cases	110		
a. 15 cells (60.0%) have expected count less than 5. The minimum expected count is .02.			

Table 4b: challenges remain in reducing foreign dependency in military equipment production

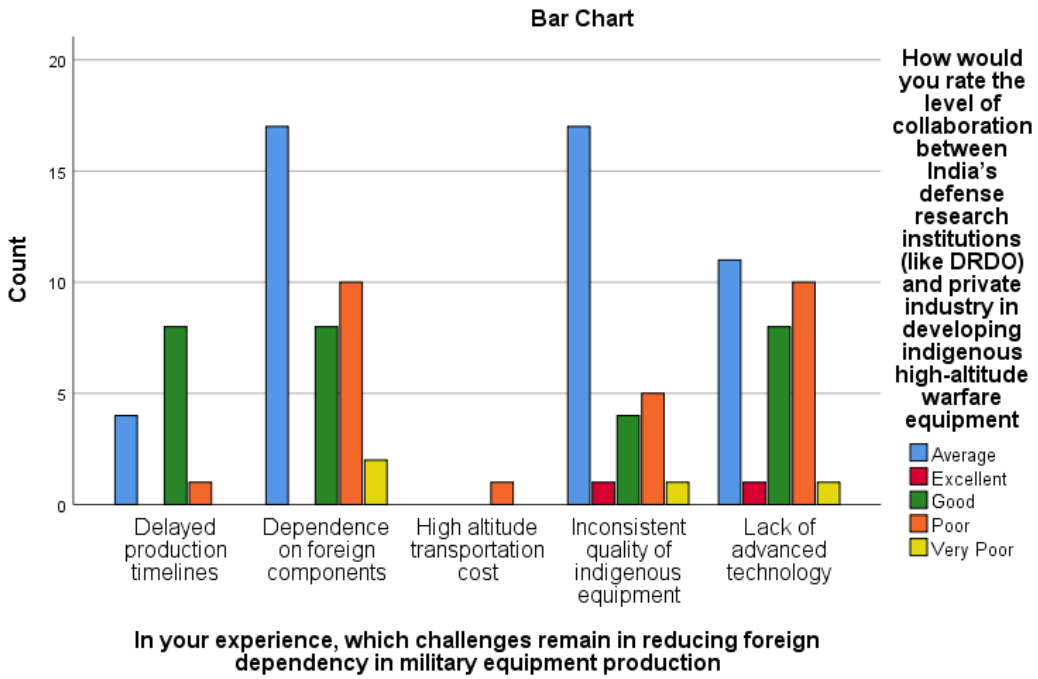

Figure 4: challenges remain in reducing foreign dependency in military equipment production

The Indian defense sector faces challenges such as dependence on foreign components, lack of advanced technology, inconsistent quality of indigenous equipment, delayed production timelines, and high-altitude transportation costs. The majority of respondent's rate collaboration as average, poor, or very poor, indicating a lack of advanced technology and reliance on imported raw materials. The lack of consistent quality of indigenous equipment is also a concern, with only one person identifying as excellent collaboration. The lack of advanced technology and high-altitude transportation costs are also significant issues. Despite these challenges, India's defense sector continues to face challenges.

5.

	What are the biggest advantages of using indigenously developed military equipment in high-altitude warfare?	Total

		Better customization for extreme weather conditions	Better governance	Cost-effectiveness compared to foreign imports	Faster adaptability to Indian operational needs	Improved supply chain and availability	
What are the biggest challenges you have faced while using indigenous equipment?		0	0	1	0	0	1
	Incompatibility with existing foreign-origin systems	3	0	1	2	6	12
	Inferior technological advancements	3	3	9	7	20	42
	Lack of adequate testing and feedback mechanisms	2	0	5	2	10	19
	Limited durability in extreme conditions	8	1	10	0	9	28
	Timely delivery	1	0	2	2	3	8
Total		17	4	28	13	48	110

Table 5a: Biggest advantages of using indigenously developed military equipment in high-altitude warfare

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	21.746[a]	20	0.354

Likelihood Ratio	25.765	20	0.174
N of Valid Cases	110		
a. 23 cells (76.7%) have expected count less than 5. The minimum expected count is .04.			

Table 5b: Biggest advantages of using indigenously developed military equipment in high-altitude warfare

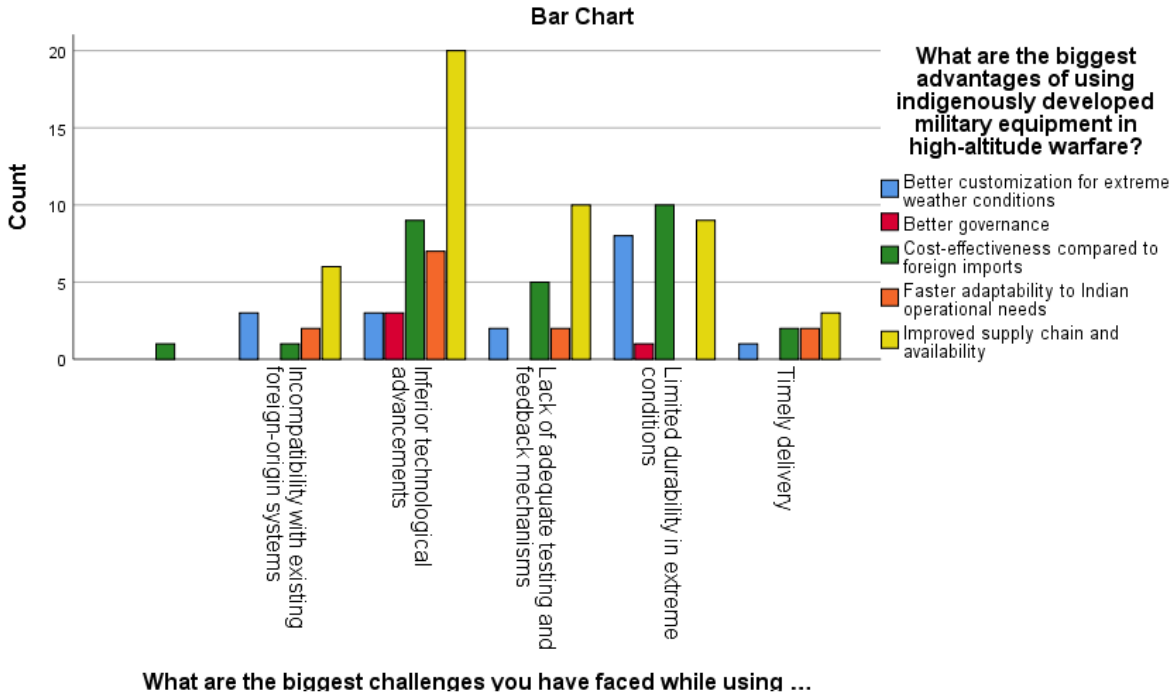

Figure 5: biggest advantages of using indigenously developed military equipment in high-altitude warfare

"Better supply chain and availability" (48 respondents, 44%) is the strongest benefit, indicating indigenous production shortens procurement time and dependence on imports.

"Cost-effectiveness" (28 respondents, 25%) is also a strong benefit, reflecting savings in relation to costly foreign substitutes.

"Faster ability to Indian operating requirements" (13 respondents, 12%) indicates indigenous designs better address local military needs.

"Better adaptation to extreme weather" (17 respondents, 15%) is an indication of locally developed hardware being optimized for war at high altitudes.

"Better governance" (4 respondents, 4%) is the least selected benefit, reflecting that better governance is not what is driving indigenous adoption.

"Subpar technological advances" (42 respondents, 38%) is the largest problem, showing apprehension over indigenous equipment being no match for global military technology.

"Less than adequate durability under harsh conditions" (28 respondents, 25%) indicates reliability issues for the extreme environment.

"Insufficient testing and feedback mechanisms" (19 respondents, 17%) implies indigenous equipment must undergo more real-world testing prior to deployment.

"Combinability with foreign-origin systems in place" (12 respondents, 11%) complicates integration, indicating that a combination of imported and local equipment presents operational issues.

"Delivery issues in a timely manner" (8 respondents, 7%) represent supply inefficiencies but are less urgent than concerns regarding quality and longevity.

6.

		Which categories of specialized military equipment for high-altitude warfare have seen the most improvements under “Make in India”?						Total
			Communication systems	Mobility and transport vehicles	Protective gear and clothing	Surveillance and reconnaissance equipment	Weapons and ammunition	
How would you assess the durability and reliability of indigenous equipment under extreme cold and rugged high-altitude condition	Average	1	1	13	19	7	1	42
	Excellent	0	1	1	2	1	0	5
	Good	0	4	15	33	6	1	59
	Poor	0	0	2	0	2	0	4
Total		1	6	31	54	16	2	110

Table 6a: Genre of equipment seeing the most improvements under "Make in India"

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.207[a]	15	0.586
Likelihood Ratio	13.834	15	0.538
N of Valid Cases	110		
a. 18 cells (75.0%) have expected count less than 5. The minimum expected count is .04.			

Table 6.b: Genre of equipment seeing the most improvements under "Make in India"

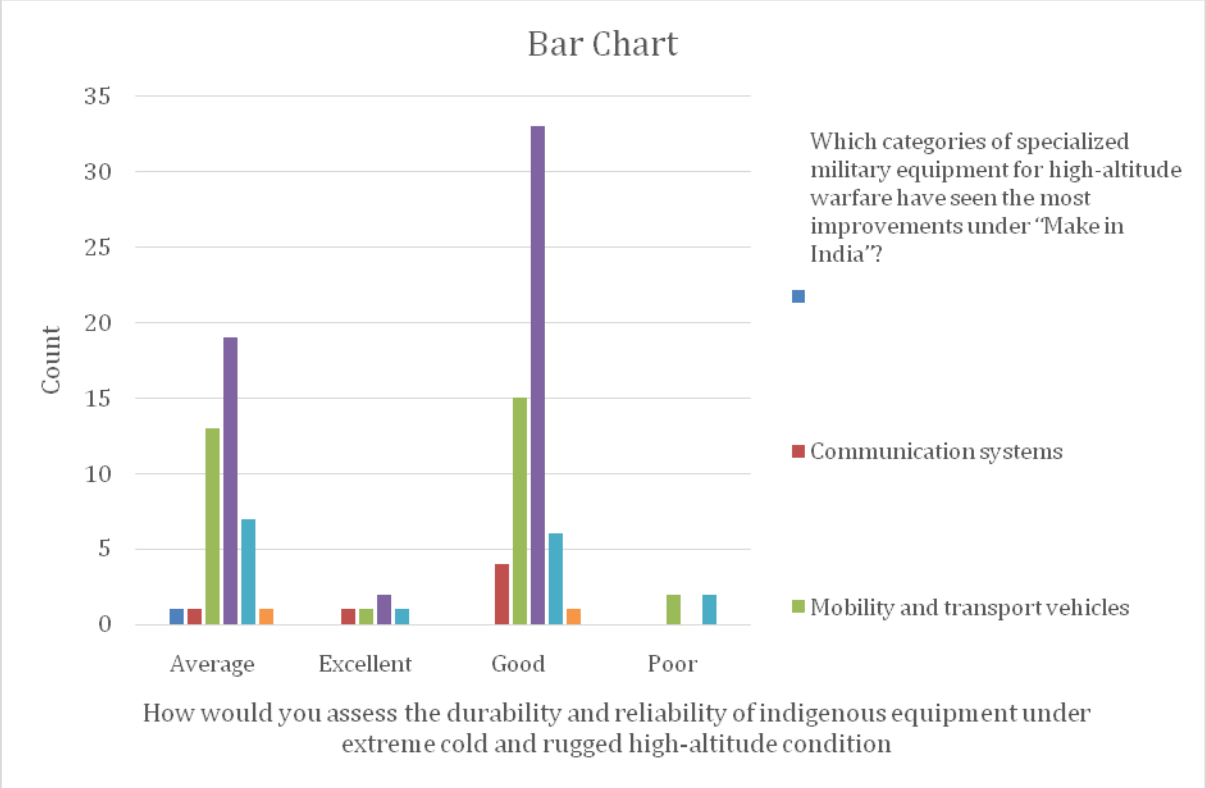

Figure 6 Genre of equipment seeing the most improvements under "Make in India"

The most notable achievement is surveillance and reconnaissance equipment. Effectiveness will be further increased by ongoing investments in satellite-based

reconnaissance, radar systems, and drone technologies. Although protective gear has improved, it still needs to be more durable. The study suggests in order to improve longevity in harsh temperatures, more material research and development as well as thorough field testing have to be given top priority. Even if there have been advancements, more attention needs to be paid to the dependability of high-altitude weapons, lightweight ammunition, and extreme-condition adaptability. More Development Is Needed for Mobility and Transport Vehicles is also suggested through the responses. To lessen dependency on imported transportation options, indigenous vehicle designs should prioritise all-terrain, snow-capable, and altitude-adapted versions. As long as communication systems that are safe, compatible with high altitudes, and free from interference have to be a primary focus of "Make in India" defence initiatives.

7.

		In your experience, which area of indigenous defense logistics and supply chain needs most improvement for high-altitude operations?					Total
		Faster procurement processes	Improved maintenance and spare parts availability	More responsive adaptation to operational needs	More robust testing and standardization	More security	
Do you believe that indigenous equipment developed under "Make in India" has enhanced the Army's operational readiness in		1	0	0	0	0	1
	Agree	17	20	9	10	0	56
	Disagree	3	2	4	4	0	13
	Neutral	4	13	7	13	1	38
	Strongly	1	0	0	1	0	2

high-altitude regions?	Agree						
Total		26	35	20	28	1	110

Table 7.a: Indigenous defense logistics and supply chain needs most improvement for high-altitude operations

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.282[a]	16	0.433
Likelihood Ratio	17.636	16	0.346
N of Valid Cases	110		
a. 17 cells (68.0%) have expected count less than 5. The minimum expected count is .01.			

Table.7.b: Indigenous defense logistics and supply chain needs most improvement for high-altitude operations

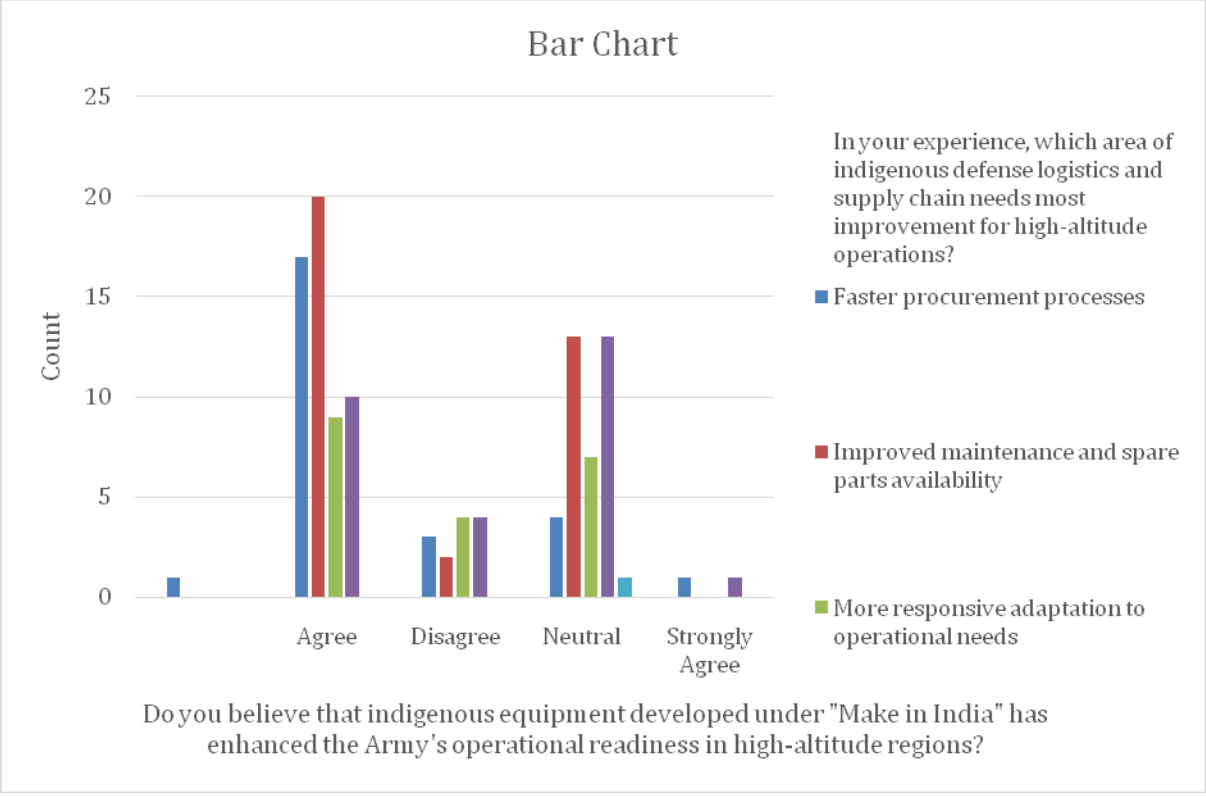

Figure 7: Indigenous defense logistics and supply chain needs most improvement for high-altitude operation

The "Make in India" initiative aims to improve operational readiness by improving maintenance and spare parts supply chains, establishing high-altitude repair hubs, implementing predictive maintenance strategies, enhancing testing and standardization for indigenous equipment, increasing real-world field testing, strengthening feedback loops, speeding up procurement processes, ensuring equipment adaptability for high-altitude conditions, developing modular designs, and improving cold-weather performance testing in extreme environments. Addressing logistical challenges is crucial for achieving full self-reliance in high-altitude warfare equipment. Even those who agree that indigenous equipment improves readiness still cite maintenance, procurement speed, and testing as weak points. Testing & standardization issues contribute to skepticism (Neutral & Disagree respondents). Adaptability concerns are common among critics, suggesting that high-altitude operational needs are not fully addressed.

8.

		What incentives would encourage private-sector participation in indigenous defense production?					Total
		Faster approval processes	Government-backed research grant	Increased collaboration with global defense companies	Rewards and Recognition	Tax benefits and subsidies	
In which categories has indigenous production	Communication and cyber warfare systems	0	2	1	0	2	5
	Firearms and	4	3	3	0	7	17

successfully reduced foreign dependency?	ammunition						
	Mobility and transport vehicles	12	16	12	1	6	47
	Protective gear and combat uniforms	8	8	8	2	5	31
	Surveillance and reconnaissance equipment	3	3	3	0	1	10
Total		27	32	27	3	21	110

Table 8.a: Incentives encouraging private-sector participation in indigenous defense production

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.970[a]	16	0.675
Likelihood Ratio	13.606	16	0.628
N of Valid Cases	110		
a. 17 cells (68.0%) have expected count less than 5. The minimum expected count is .14.			

Table 8.b: Incentives encouraging private-sector participation in indigenous defense production

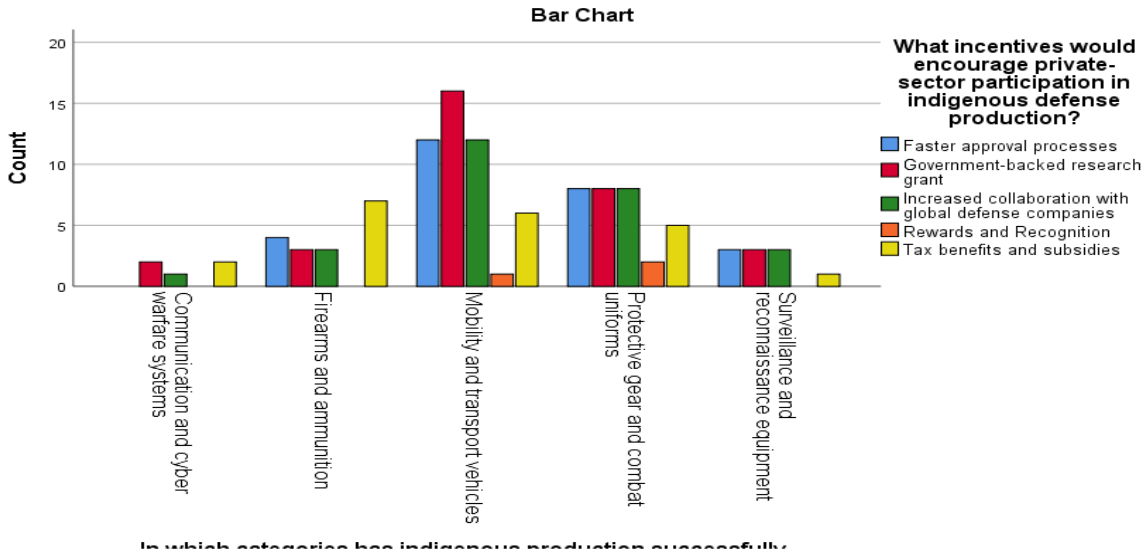

Figure 8: Incentives encouraging private-sector participation in indigenous defense production

The Indian government has shown significant progress in reducing reliance on foreign suppliers for military vehicles, with the largest success being in Mobility and Transport Vehicles (43%). However, there is still a high reliance on foreign technology in Firearms and Ammunition (15%), Surveillance and Reconnaissance Equipment (10%), and Communication and Cyber Warfare Systems (5%). The top incentive for innovation is government-backed research grants (29%), while regulatory hurdles and lack of international exposure limit private-sector engagement. Tax benefits and subsidies may encourage investments, but companies prioritize financial and strategic incentives over reputational benefits.

9.

		Do you really agree to the facts of further expansion of indigenous defense production under "Make in India" for future military needs?				Total
		Agree	Neutral	Strongly Agree	Strongly Disagree	
Has the Make in India initiative reduced dependence	Agree	34	0	16	0	50
	Disagree	14	4	5	0	23
	Neutral	20	3	6	1	30
	Strongly agree	0	0	2	0	2

on foreign military imports for high-altitude operations	Strongly disagree	3	1	1	0	5
Total		71	8	30	1	110

Table 9a: the Make in India initiative reduced dependence on foreign military imports for high-altitude operations

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	17.801[a]	12	0.122
Likelihood Ratio	19.968	12	0.068
N of Valid Cases	110		
a. 14 cells (70.0%) have expected count less than 5. The minimum expected count is .02.			

Table 9.b: the Make in India initiative reduced dependence on foreign military imports for high-altitude operations

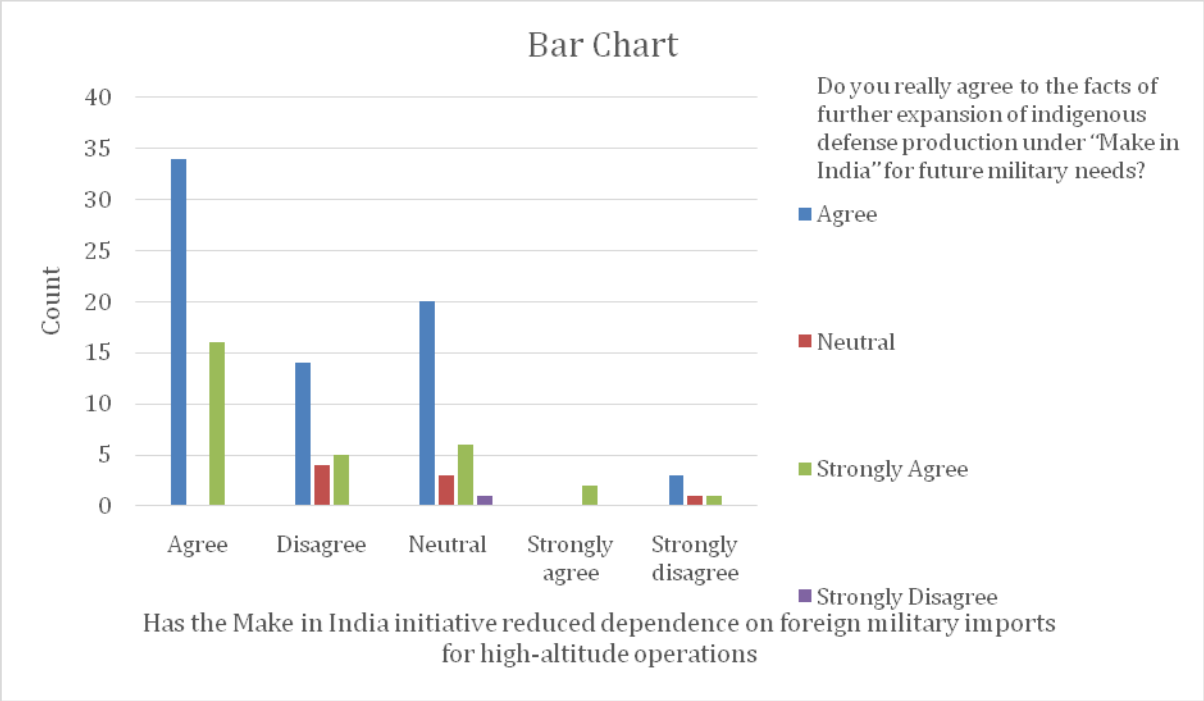

Figure 9: the Make in India initiative reduced dependence on foreign military imports for high-altitude operations

Unambiguous majority support for the expansion of indigenous defence is 100%. Eighty-three percent of those surveyed favour more growth under "Make in India." Sixty-one percent of respondents support expansion, even if they think foreign dependency has not decreased yet. Nearly all people agree, with only 1% strongly opposing it. More Concrete Outcomes Are Required to Persuade Neutral Respondents and hence enhanced openness, is required for quicker production schedules, as improved quality assurance can boost confidence. Thirty percent of respondents are either ambivalent or disagree about less reliance on foreign sources.

10

		In your opinion, has "Make in India" increased self-reliance in defense manufacturing for high-altitude warfare?					Total
		Agree	Disagree	Neutral	Strongly Agree	Strongly Disagree	
To what extent do you think the "Make	less significant	10	10	12	1	2	35

in India" initiative has contributed to the indigenous production of specialized military equipment for high-altitude warfare?	Moderately	26	5	8	0	0	39
	Not at all	0	0	1	0	0	1
	Significantly	15	0	6	0	0	21
	Very significantly	12	0	0	2	0	14
Total		63	15	27	3	2	110

Table 10.a: Make in India" increased self-reliance in defense manufacturing for high-altitude warfare

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.888[a]	16	0.001
Likelihood Ratio	45.547	16	0.000
N of Valid Cases	110		
a. 17 cells (68.0%) have expected count less than 5. The minimum expected count is .02.			

Table 10.b: Make in India" increased self-reliance in defense manufacturing for high-altitude warfare

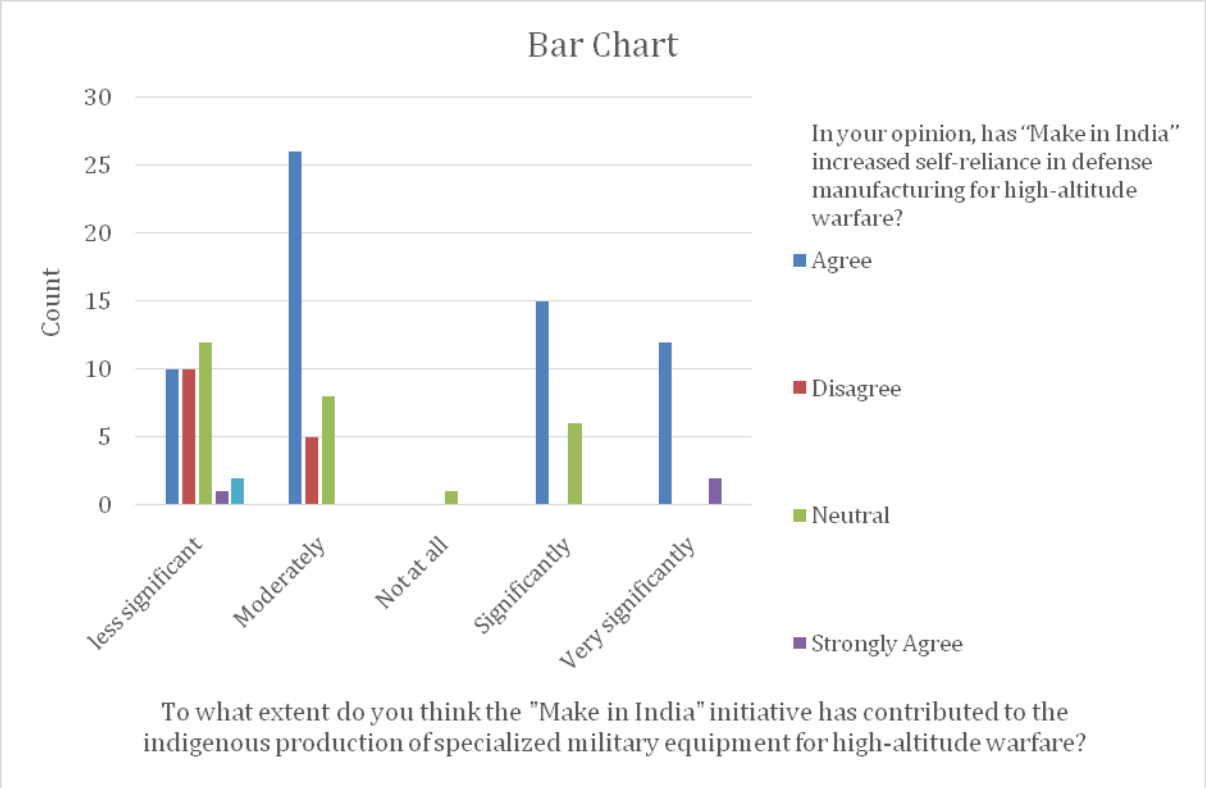

Figure 10: Make in India" increased self-reliance in defense manufacturing for high-altitude warfare

The majority of respondents (60%) agree that "Make in India" has improved self-reliance, with 63% or "strongly agree" with this statement. The initiative has also had a moderate impact on indigenous production, with 35% of respondents stating it has been significant. The higher the contribution, the more likely respondents are to agree on the increase in self-reliance. However, 67% of respondents who disagree with the initiative view the contribution as less significant, suggesting that doubts about self-reliance may stem from perceptions of slow progress rather than outright rejection. This suggests that doubts about self-reliance may stem from perceptions of slow progress rather than outright rejection.

5.3 Troop Effectiveness and Sustainability in High-Altitude Operations

11.

	Which categories of specialized military equipment for high-altitude warfare have seen the most improvements under "Make in India"?	To tal

			Communication systems	Mobility and transport vehicles	Protective gear and clothing	Surveillance and reconnaissance equipment	Weapons and ammunition	
How would you rate the quality and reliability of indigenously developed equipment compared to imported alternatives?	Comparable to imported alternatives	0	3	7	15	3	0	28
	Not at all acceptable	0	0	3	1	0	0	4
	Significantly inferior to imported alternatives	1	1	7	9	5	1	24
	Slightly inferior to imported alternatives	0	2	14	29	8	1	54
Total		1	6	31	54	16	2	110

Table: 11: Rating the quality and reliability of equipment

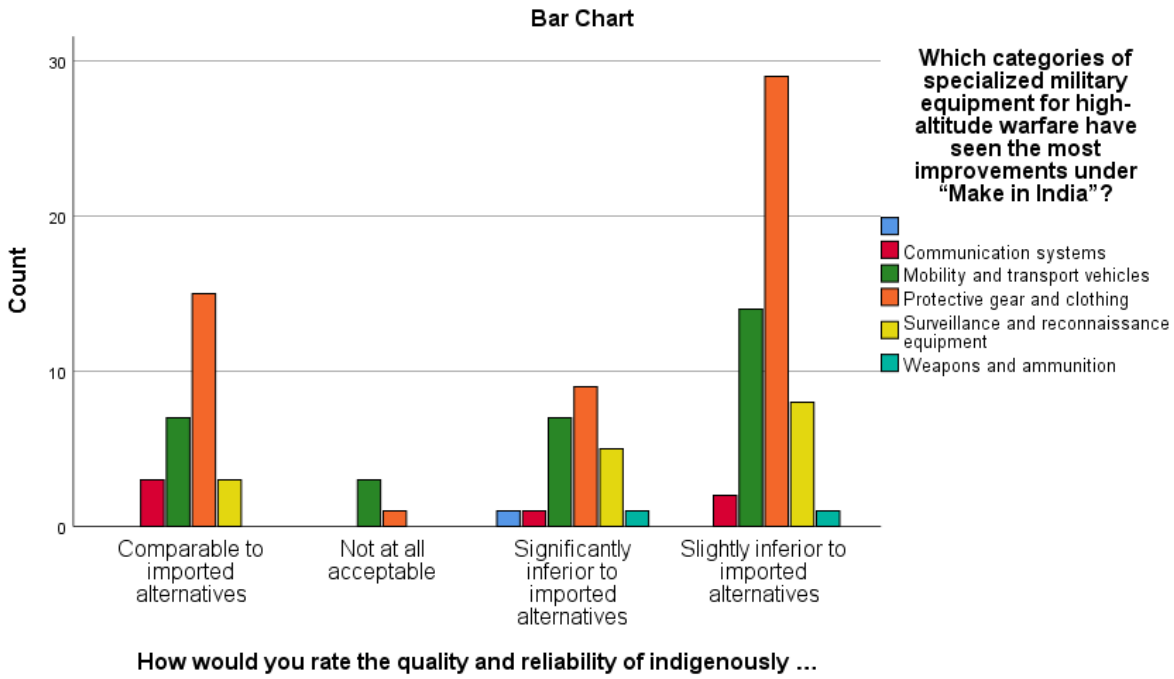

Figure 11: Rating the quality and reliability of equipment

The majority of respondents (49%) believe indigenous equipment is slightly inferior but usable, with 22% finding it significantly inferior to imported alternatives. However, only 3.6% feel indigenous equipment is not acceptable at all. Despite this, 25% believe it is comparable to imported alternatives, indicating growing confidence in local production. Surveillance and reconnaissance equipment have seen the most improvements, with 54% of respondents stating improvements in these areas. Protective gear and clothing have seen steady progress, with 67% rating them as either "slightly inferior" or "comparable" to imports. However, mobility and weapons still fall behind imports, with only 3 out of 6 respondents rating mobility and transport vehicles as "comparable" to imports. This indicates that weapons and mobility solutions still struggle with quality and reliability issues compared to foreign alternatives.

12.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Comprehensive Mountain Warfare Training	24	21.8	21.8	21.8

	Creating more dependency on indigenous equipment	51	46.4	46.4	68.2
	Dependency on foreign equipment while empowering indigenous equipment	28	25.5	25.5	93.6
	Leadership Development	5	4.5	4.5	98.2
	Psychological Training	2	1.8	1.8	100.0
	Total	110	100.0	100.0	

Table 12: Suggestions and recommendations

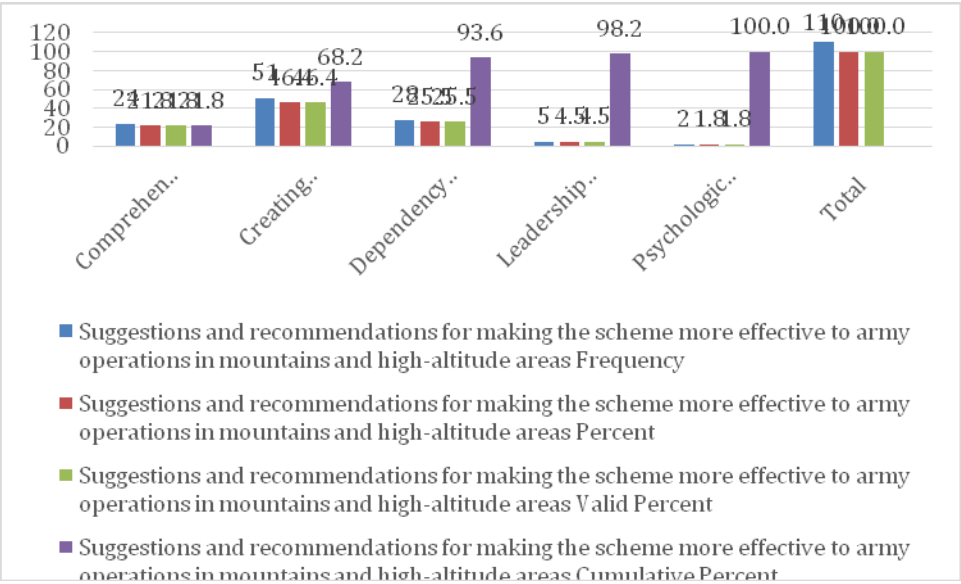

Figure 12: Suggestions and recommendations

Nearly half of respondents in India's survey support the adoption of locally produced military equipment, aligning with the country's "Atmanirbhar Bharat" vision. A balanced approach of maintaining foreign imports while strengthening domestic production is supported by 25.5% of respondents, acknowledging that certain technologies still require foreign support. The majority of respondents (21.8%) believe in comprehensive mountain warfare training, with 21.8%) highlighting the need for specialized tactical programs for high-altitude combat. Only 6.3% prioritize leadership and psychological preparedness, indicating an awareness of mental resilience as a crucial component in harsh mountain environments.

13.

Do you really agree to the facts of further expansion of indigenous defense production under "Make in India" for future military needs?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	71	64.5	64.5	64.5
	Neutral	8	7.3	7.3	71.8
	Strongly Agree	30	27.3	27.3	99.1
	Strongly Disagree	1	0.9	0.9	100.0
	Total	110	100.0	100.0	

Table 13: Indian government support on indigenous weapons

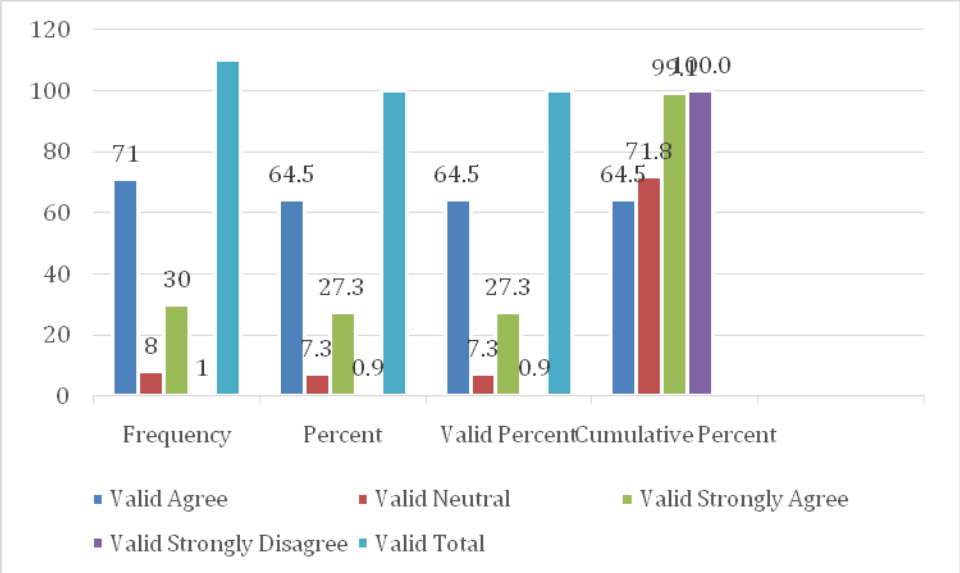

Figure 13: Indian government support on indigenous weapons

The Indian government has received a majority of support for expanding indigenous defense production, with 91.8% of respondents agreeing and 27.3% strongly agreeing. This indicates a strong approval rate for strengthening local manufacturing under "Make in India." However, only 0.9% strongly disagree, indicating minimal opposition. A small neutral segment (7.3%) remains, possibly due to concerns about quality, efficiency, or strategic feasibility. The government recommends accelerating "Make in India" for defense with a clear roadmap, investing in domestic R&D, expanding private sector collaboration, and ensuring timely procurement and quality control. It also suggests addressing neutral concerns through evidence-based policies, strengthening public-private partnerships, and providing fiscal incentives to attract private defense investment.

Chapter 6: Comparative Analysis: Indigenous vs. Imported Systems

6.1 Performance of Indigenous Systems vs. Imported Equipment

The argument of indigenous military systems against imported hardware has attracted substantial interest, particularly with programs like "Make in India." Imported hardware is superior in terms of higher R&D spending and providing state-of-the-art features in domains such as artificial intelligence, cyber warfare, and stealth capabilities. Indigenous systems are typically inferior in terms of technological advancement but are catching up with focused R&D spending. They are more responsive to local operational requirements and terrain-based needs, e.g., HAL Dhruv helicopters for high-altitude missions[37].

Indigenous systems are developed for universal deployment, which usually needs to be adapted to suit Indian conditions. Imported systems are not always completely optimized for extreme weather or high-altitude warfare. Indigenous systems, however, are developed with India-centric requirements, making them more adaptable to high-altitude regions such as Ladakh, Siachen, and Arunachal Pradesh. Indigenous systems are superior in customization and adaptability for India's varied landscapes. The comparison can be shown as follows:

Technological Advancement and Innovation

Imported Equipment

- Generally more advanced due to higher R&D investments by global defense leaders.
- Offers cutting-edge features in areas like artificial intelligence, cyber warfare, and stealth technology.

Example: Rafale fighter jets (France) vs. Tejas (India) – Rafale has **better combat-proven capabilities** and avionics.

Indigenous Systems

- Often lag in technological sophistication, but improving with targeted R&D investments.
- More adaptable to local operational needs and terrain-specific requirements.

[37] Muraviev, A. D., Ahlawat, D., & Hughes, L. (2021). India's security dilemma: Engaging big powers while retaining strategic autonomy. *International Politics (The Hague)*, *59*(6), 1119.

Example: HAL Dhruv helicopters designed for high-altitude operations perform well in Ladakh and Siachen.

Customization for Indian Operational Needs

Imported Equipment

- Designed for global deployment**,** often requiring modifications to function in Indian conditions.
- Some imported systems may not be fully optimized for extreme weather or altitude warfare**.**

Indigenous Systems

- Built with India-specific requirements, ensuring better adaptability to high-altitude environments like Ladakh, Siachen, and Arunachal Pradesh.

Example: Indigenous BAEV (Battlefield Assault & Evacuation Vehicle) outperforms foreign models in rugged Himalayan terrain[38].

6.2 Cost-Effectiveness and Sustainability

Cost effectiveness

Imported Equipment

Frequently entails costly upkeep, reliance on foreign exchange, and high purchase prices.

Operational expenses rise with prolonged reliance on overseas servicing and spare components.

Indigenous Equipment

Reduced initial expenses, simpler upkeep, and domestic access to replacement parts. Boosts R&D and the domestic defence economy by generating jobs. For instance,

[38] Musgrave, P., & Nexon, D. H. (2018). Defending hierarchy from the moon to the Indian Ocean: Symbolic capital and political dominance in early modern China and the cold war. *International Organization*, *72*(3), 591-626.

compared to comparable imported artillery systems, the K9 Vajra-T howitzer, which is produced under the Make in India label, is less expensive.

Conclusion: Long-term economic gains and greater cost efficiency are provided by indigenous systems.

Sustainability

Imported Equipment

- Rigorously tested under extreme conditions but not always optimized for Indian terrain.
- Issues with cold-weather operations—some foreign electronics and hydraulics struggle in Siachen-like conditions.

Example: Certain Russian-origin UAVs faced performance issues in high-altitude regions.

Indigenous Systems

- Designed for Indian operational challenges, ensuring reliability in extreme cold, rugged terrain, and monsoon conditions.

Example: Indigenous winter combat gear has improved, reducing dependence on imports.

Verdict: Indigenous systems outperform in durability and adaptability for extreme Indian environments.

6.3 Case Studies

"The Government has taken several policy initiatives in the past few years under the 'Make in India' program and brought in reforms to encourage indigenous design, development and manufacture of defence equipment in the country, thereby expanding the production of indigenous defence equipment. These initiatives, inter-alia, include according priority to procurement of capital items from domestic sources under Defence Acquisition Procedure (DAP)-2020;"

- Notification of two 'Positive Indigenisation Lists' of total 209 items of Services and one 'Positive Indigenisation List' of total 2851 items of Defence

Public Sector Undertakings(DPSUs), for which there would be an embargo on the import beyond the timelines indicated against them;

- Simplification of Industrial licensing process with longer validity period; Liberalisation of Foreign Direct Investment (FDI) policy allowing 74% FDI under automatic route; Simplification of Make Procedure;
- Launch of Innovations for Defence Excellence (iDEX) scheme involving Startups & Micro, Small and Medium Enterprises (MSMEs);
- Implementation of Public Procurement (Preference to Make in India) Order 2017[39]".
- Launch of an indigenization portal namely SRIJAN to facilitate indigenisation by Indian Industry including MSMEs;
- Reforms in Offset policy with thrust on attracting investment and Transfer of Technology for Defence manufacturing by assigning higher multipliers; and Establishment of two Defence Industrial Corridors, one each in Uttar Pradesh and Tamil Nadu.
- "Many significant products including 155mm Artillery Gun system 'Dhanush', Light Combat Aircraft 'Tejas', Surface to Air Missile system 'Akash', Main Battle Tank 'Arjun', T-90 Tank, T-72 tank, BMP-II/IIK, Su-30 MK1, Cheetah helicopter, Advanced Light Helicopter, Dornier Do-228, High mobility Trucks, INS Kalvari, INS Khanderi, INS Chennai, Anti-Submarine Warfare Corvette (ASWC), Arjun Armoured Repair and Recovery Vehicle, Bridge Laying Tank, Bi-Modular Charge System (BMCS) for 155mm Ammunition, Medium Bullet Proof Vehicle (MBPV), Weapon Locating Radar (WLR), Integrated Air Command and Control System (IACCS), Software Defined Radios(SDR), Lakshya Parachute for Pilotless Target Aircraft, Opto Electronic Sights for battle tanks, Water Jet Fast Attack Craft, Inshore Patrol Vessel, Offshore Patrol Vessel, Fast Interceptor Boat, Landing Craft Utility, 25 T Tugs, etc. have been produced in the country during the last few years which are being used by the Indian Armed Forces."

[39] pib.gov.in, 2024. Available at: https://pib.gov.in/PressReleasePage.aspx?PRID=1805750

Chapter 7: Policy Implications and Strategic Recommendations

7.1 Assessment of Current "Make in India" Initiatives in High-Altitude Warfare

Over the years, the Indian defence industry has seen a series of reforms that have transformed it into a new entity; indeed, between 2021-22 and 2022-23, production turnover reached nearly constant growth, with explosions in figures amounting to INR1087 billion (US$ 13.5 billion)[40]. This shows growing capability in the manufacture and supply of a large number of defence equipment. More and more, complex projects are being awarded by the Ministry of Defence (MoD) to the domestic industry across both private and public sectors. In 2023, the MoD signed projects, which include contracts for medium power radar and an integrated electronic warfare system, HTT-40 basic trainer aircraft, Dornier-228 aircraft, cadre training ships, improved Akash Weapon System, Offshore Patrol Vessels and Missile Vessels, Fleet Support Vessels, and upgraded super rapid gun mount.

Defence exports have improved visibly because of government reforms, such as that of 2023-24, when it reached the highest level ever in history: INR 210.83 billion (about US$2.63 billion). Defence exports from 2014-15 to 2023-24 totalled about INR 883.19 billion (approximately US$11 billion), or about 21 times more than the pre-reform decade, which amounted to a mere INR 43.12 billion (USD517 million) in exports from 2004-05 to 2013-14. Saluting the fruitful endeavor, the government has set up a target of achieving INR 500 billion export turnover (approximately US$6.0 billion) every year by 2028-29.

India now exports arms, ammunition, and allied items to about 85 nations, and 100 domestic firms are doing business internationally. Major items exported include Dornier-228, 155 mm Advanced Towed Artillery Guns, BrahMos Missiles, Akash Missile System, Radars, Simulators, Mine Protected Vehicles, Armoured Vehicles, PINAKA Rockets & Launchers, Ammunitions, Thermal Imagers, Body Armours, Systems, Line Replaceable Units, and Parts & components of Avionics and Small Arms.

[40] orfonline.org, 2024. Available at: https://www.orfonline.org/research/india-s-defence-industry-achievements-and-challenges

To deepen the public involvement of the domestic industry, the government has been progressively assigning a greater share of fiscal acquisition budgets for procurements from the domestic industry each year. For instance, in 2022-23, the MoD accorded AoN for proposals to the tune of INR 2710 billion (approximately US$32.5 billion), 99 percent of which is intended to procure from the domestic industry.

7.2 Strategic Recommendations for Enhancing Indigenous Capabilities

Indigenous capabilities

- Augment Public-Private Collaboration: In cooperative development, DRDO ought to strengthen collaboration with Indian start-ups and overseas defence firms[41].
- Establish Defence Industrial Corridors: Enhance indigenous production through the establishment of defence industrial clusters in Uttar Pradesh and Tamil Nadu.
- Faster Indigenisation and Procurement Goals: Minimise import dependency by adopting new schedules for the adoption of indigenous technology.
- Incentives for Private Sector Investment: Offer research grants, tax relief, and streamlined approval processes to encourage defence innovation.
- Strategic Export Policies: Position India as a leading exporter of defence equipment for extreme conditions and high-altitude warfare technology.

Enhancing Supply Chain Resilience

- Lessening Foreign Component Dependency: Develop domestic alternatives to critical defence components like avionics and semiconductors.
- Localised Spare Parts Manufacturing: To enhance supply chain responsiveness in high-altitude areas, establish regional production facilities.
- Leverage Blockchain for Defence Logistics: Utilize blockchain-based inventory tracking to enhance supply chain security and transparency.

7.3 Future Directions for Research and Policy

- Improving Indigenous technologies: Give special focus to electronic warfare systems, cyber defence, AI-based combat, and advanced stealth technologies.

[41] Patel, P., Patil, S., & Vishwanathan, A. (2023). India's Quest for Defence Indigenisation: A Case Study of the Indian Navy. *Journal of Asian Security and International Affairs*, *10*(3), 364-394.

- Material Science for Extreme Conditions is the study of lightweight, highly resilient materials for high-altitude combat.
- Robotics & Autonomous Systems: Spending on autonomous surveillance drones and unmanned ground vehicles (UGVs) that are adapted to India's mountainous terrain.
- Artificial Intelligence in Defence Logistics: Applying AI to enhance operational effectiveness through battlefield analytics and predictive maintenance.
- Simulation of Advanced Mountain Warfare: To simulate high-altitude warfare scenarios, employ virtual reality (VR)-based combat training.
- Cross-Military Collaboration: Train jointly with countries with high-altitude combat experience, including France and the United States.
- Uphskill defence personnel in the maintenance and operation of indigenous high-tech weaponry through technical specialized training.

There are differences in the effectiveness of domestic defence systems compared to foreign gear. While indigenous systems are superior in terms of adaptability, cost effectiveness, and long-term sustainability, imported systems now lead in terms of technology and battle experience. However, the study finds that India's domestic defence industry can close technological gaps and lessen reliance on foreign suppliers with sustained R&D investment, public-private partnerships, and policy backing, positioning it as a major player in the world of military production[42]. Hence, the future of India's defense manufacturing depends on sustained R&D investment, policy support, and strategic partnerships. By focusing on technological innovation, self-reliance in critical components, and strengthening supply chains, India can enhance its military preparedness in high-altitude warfare and reduce dependence on imports.

[42] Pant, H. V., & Bommakanti, K. (2019). India's national security: challenges and dilemmas. *International Affairs*, *95*(4), 835-857

Chapter 8: Conclusion

8.1 Summary of Key Findings

Although there is potential for improvement, the results point to a generally favourable view for the availability of domestic military hardware for high-altitude combat. Given their substantial presence in the responses, the Army's viewpoint is crucial. Additional investigation might concentrate on certain operational difficulties or equipment deficiencies that caused some people to believe there had been little to no change. Despite improvements in logistics and supply chain efficiency brought about by Made in India, the defence industry remains sceptical about a complete import replacement within the next ten years. To increase trust in long-term self-sufficiency, the emphasis should be on increasing output, decreasing reliance on technology, and maintaining investment in domestic R&D. The use of Made in India is growing, according to the results, particularly among new hires and mid-career employees (6–8 years of experience). Even though veterans with ten or more years of experience are heavily exposed to domestic equipment (69.8%), they nevertheless exhibit a dependence on foreign substitutes. Use among those with 8–10 years of experience has decreased (41.7%), maybe as a result of previous procurement practices that favoured imports. There is still need to improve supply chain and operational deployment, as evidenced by the fact that one-third of respondents have not used domestic equipment.

Even though Made in India has advanced, issues including reliance on imports, technological gaps, and uneven quality continue to be significant barriers. Achieving complete self-reliance in high-altitude military equipment requires improved cooperation between DRDO and the private sector. There are major gaps in technology, durability, and integration that make it difficult to reduce reliance on foreign military equipment. To keep up with international alternatives, Indian military hardware needs more sophisticated R&D, improved testing, and ongoing updates. Procurement strategy should incorporate feedback loops and long-term field testing. Faster customisation and adaptability are helpful, but performance problems still exist. For high-quality results, cooperation between the armed forces, commercial sector, and DRDO is required. Programs for interoperability should be created to

guarantee smooth operation of both domestic and foreign machinery. Stronger R&D, testing, and feedback systems are essential to addressing these problems and achieving complete military self-reliance. "Made in India" is becoming increasingly popular, with 46.4% of respondents favouring a total emphasis on domestic manufacturing. However, 25.5% of respondents continue to recognise the need for a hybrid approach that blends local skills with global knowledge. Training and operational preparation remain critical, as 21.8% of respondents want improved preparedness for mountain combat. The strategic goal should be to gradually transition to independence while retaining operational effectiveness in high-altitude conflict.

The "Make in India" policy has gone a long way in indigenous defense manufacturing, especially in mobility, protective equipment, and surveillance technology. Still, there are issues like dependence on imported components, production timelines, and irregular quality checks that continue to hamper complete self-sufficiency. According to a survey, 91.8% of the respondents favour increasing indigenous defense manufacturing for future military requirements. 45.5% believe that the programme has minimized dependence on foreign things, especially on mobility vehicles, protective equipment, and weapons. Yet, the use of foreign components, inadequacy in cutting-edge technology, and discrepancies in quality still remain significant setbacks.

Mixed opinions about indigenous equipment performance are present, with 59 of the respondents evaluating the reliability and durability of indigenous equipment as "good" but 24 considering it "significantly inferior" to imported ones. Some challenges in becoming fully self-sufficient within 10 years are logistical and supply chain constraints in the form of delays in procurement and production, spare parts and maintenance facility limitations, and poor quality control and inspection. Finally, though the "Make in India" program has been successful in indigenous defense manufacturing, there are still challenges like speeding up research and development of high-tech weaponry, increasing coordination between the Defence Research Department (DRDO), the private sector, and foreign companies, streamlining supply chain efficiency and maintenance facilities, and maintaining strict quality testing and certification processes.

8.2 The Strategic Value of Indigenous Defense Manufacturing

Indigenous defense production is an important component of a country's security, economic strength, and strategic independence. For nations such as India, minimizing reliance on foreign military imports is essential to ensure operational preparedness and self-sufficiency. Programs such as "Make in India" seek to enhance indigenous capabilities and enhance national defense infrastructure. The main strategic advantages of indigenous defense production are self-sufficiency and national security, cost-effectiveness, technology growth and innovation, quicker procurement and tailoring, enhancing defense diplomacy, and immunity to supply chain disruptions. Yet, defense production in indigenous terms is challenged by technological disparities, the high cost of production, and foreign dependency for crucial systems in components. It will call for higher spending on R&D, government policies and incentives to engage private participation, and increased interaction among defense research establishments and industry[43].

In summary, the strategic importance of indigenous defense production is that it can improve national security, stimulate economic growth, and enhance technological prowess. As programs such as "Make in India" mature, a continued emphasis on innovation, indigenization, and defense exports will be critical to making India a global leader in defense production.

8.3 Final Remarks on the Operational Readiness of the Indian Army in High-Altitude Warfare

The survey answers point to both achievements and issues in the implementation of the "Make in India" program for high-altitude warfare. There are gains in self-reliance, logistics, and surveillance capacity, but issues persist regarding indigenous equipment quality, flexibility, and technological developments. The study fulfils all the questions by addressing the research objectives such as:

(a) Impact on Indigenous Production of Specialized Military Equipment

- Most (60%) concur that "Make in India" has enhanced self-reliance, with 35% reporting a considerable impact on indigenous production.

[43] Popplewell, R. J., & Popplewell, R. J. (2018). *Intelligence and imperial defence: British intelligence and the defence of the Indian Empire 1904-1924*. Routledge.

- Surveillance and reconnaissance gear have recorded the highest advances, with 54% confirming improvement.
- Protective equipment and attire are better but still in need of development for durability under harsh conditions.
- Firearms, mobility options, and transport vehicles remain behind in quality and dependability in relation to imports.

(b) Improvement of Operative Readiness in High-Altitude Areas

- The drive has resulted in enhanced maintenance, spare parts supply chains, predictive maintenance, and standardization efforts.
- Indigenous high-altitude war equipment is concerned with adaptability, reliability, and durability in harsh environments.
- Gaps in testing and standardization continue to raise doubts among respondents.
- 49% think indigenous equipment is slightly below par but functional, and 25% assess it as comparable to imports, reflecting increasing confidence.

(c) Logistics, Supply Chains, and Infrastructure Improvements

- 52.7% of the respondents think "Make in India" has enhanced logistics and supply chains, but confidence in complete self-reliance is moderate.
- Logistical enhancements consist of high-altitude repair bases, modular configurations, and enhanced cold-weather performance testing.
- Foreign component and raw material dependency continues to present challenges to scalability and procurement velocity.
- Transportation expenses at high altitudes and production hold-ups inhibit optimum efficiency.

(d) Effect on Troop Effectiveness, Sustainability, and Combat Potential

- Surveillance and reconnaissance are greatly enhanced, particularly with satellite systems and drones.
- Protective equipment is enhanced but requires more R&D to last through harsh environments.
- Light ammunition and weapon reliability at high altitudes demand greater focus.
- Snow, terrain, and altitude capability enhancements are necessary for mobility and transport vehicle development.

- More secure and interference-free communication systems are required for the effectiveness of mountain warfare.

(e) Strategic Gains and Minimum Foreign Import Dependence

- 46% think that India can substitute imports, while 39% do not agree, pointing towards technology and production scalability challenges.
- 25.5% favor an optimal blend of domestic production and judicious foreign imports.
- There has been improvement, but there is doubt owing to slow pace in quality control, technology development, and procurement efficiency.
- India's dependence on foreign military imports continues to be high, especially for cutting-edge components and raw materials.

(f) Recommendations for Increasing Effectiveness in High-Altitude Warfare

- Boost R&D: Prioritize material ruggedness, light ammunition, and high-altitude capabilities.
- Enhance Quality Control: Correct standardization and testing problems to increase confidence in indigenous platforms.
- Improve Logistics & Supply Chains: Lower transportation expenses and enhance spare parts availability.
- Speed up Private Sector Cooperation: Raise investment in defense production and research collaborations.
- Improve Troop Training: Increase mountain warfare and tactical training for improved high-altitude combat preparedness.
- Ensure Speedier Procurement: Overcome delays in production schedules and simplify acquisition procedures.

Although the "Make in India" campaign has improved logistics and self-reliance, complete import replacement is still a ways off. Mobility, weapon systems, and adaptability continue to be major obstacles, despite advancements in surveillance, reconnaissance, and protective gear. To make domestic military production genuinely competitive for high-altitude combat, it will be essential to close technology gaps, enhance quality control, and bolster research and development. This study has provided a comprehensive analysis of how the Army's operational capabilities in such challenging situations are being shaped by indigenous solutions. The results has provide practical insights for maximising upcoming projects under the "Make in

India" banner and add to the continuing conversations over the importance of independence in India's defence strategy.

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Chapter 10: Appendices

•**Survey Questionnaires**:

Demographics

What is your current role in the armed forces?

- Army
- Airforce
- Navy
- Logistics & Supply Chain
- Defense Procurement & R&D

How many years of experience do you have in high-altitude or mountain warfare operations?

- 0-1 years
- 2-5 years
- 6-8 years
- 8-10 years
- More than 10 years

Have you operated with indigenously produced military equipment under the **"Make in India"** initiative?

- a) Yes
- b) No

Knowledge based questions

To what extent do you think the **"Make in India"** initiative has contributed to the indigenous production of specialized military equipment for high-altitude warfare?

- a) Very significantly
- b) Moderately

- c) Significantly
- d) less significant
- e) Not at all

Which category of **indigenous** equipment have you used in high-altitude operations?

- a) Clothing & extreme cold-weather gear
- b) Lightweight, high-altitude weaponry
- c) Surveillance & reconnaissance systems
- d) Communication & navigation systems
- e) Armored mobility vehicles & transport systems

In your opinion, has “Make in India” increased self-reliance in defense manufacturing for high-altitude warfare?

- Agree
- Disagree
- Neutral
- Strongly Agree
- Strongly Disagree

How would you rate the availability of indigenous military equipment for high-altitude warfare compared to previous years?

- Much Improved
- Slightly Improved
- No Change
- Very low improvement
- No comments

Which categories of specialized military equipment for high-altitude warfare have seen the most improvements under “Make in India”?

- Weapons and ammunition
- Protective gear and clothing
- Surveillance and reconnaissance equipment

- Communication systems
- Mobility and transport vehicles

How would you rate the quality and reliability of indigenously developed equipment compared to imported alternatives?

- a) Superior to imported alternatives
- b) Comparable to imported alternatives
- c) Slightly inferior to imported alternatives
- d) Significantly inferior to imported alternatives
- e) Not at all acceptable

In your experience, which challenges remain in reducing foreign dependency in military equipment production

- Lack of advanced technology
- Inconsistent quality of indigenous equipment
- Delayed production timelines
- Dependence on foreign components
- High altitude transportation cost

How would you rate the level of collaboration between India's defense research institutions (like DRDO) and private industry in developing indigenous high-altitude warfare equipment

- Excellent
- Good
- Average
- Poor
- Very Poor

What are the **biggest advantages** of using indigenously developed military equipment in high-altitude warfare?

- a) Faster adaptability to Indian operational needs
- b) Better customization for extreme weather conditions

- c) Improved supply chain and availability
- d) Cost-effectiveness compared to foreign imports

How would you rate the quality and reliability of indigenously developed equipment compared to imported alternatives?

- Superior to imported alternatives
- Comparable to imported alternatives
- Slightly inferior to imported alternatives
- Significantly inferior to imported alternatives
- Not at all acceptable

What are the **biggest challenges** you have faced while using indigenous equipment?

- a) Limited durability in extreme conditions
- b) Inferior technological advancements
- c) Lack of adequate testing and feedback mechanisms
- d) Incompatibility with existing foreign-origin systems

What are the biggest challenges you have faced while using indigenous equipment?

- Limited durability in extreme conditions
- Inferior technological advancements
- Lack of adequate testing and feedback mechanisms
- Incompatibility with existing foreign-origin systems
- Timely delivery

Do you believe that indigenous equipment developed under **"Make in India"** has enhanced the Army's **operational readiness** in high-altitude regions?

- a) Agree
- b) Disagree
- c) Neutral
- d) Strongly Agree
- e) Strongly Disagree

Has the **Make in India** initiative improved logistics and supply chain efficiency for high-altitude warfare?

- a) Agree
- b) Disagree
- c) Neutral
- d) Strongly Agree
- e) Strongly Disagree

In your experience, which area of indigenous defense logistics and supply chain needs **most improvement** for high-altitude operations?

- a) Faster procurement processes
- b) Improved maintenance and spare parts availability
- c) More robust testing and standardization
- d) More responsive adaptation to operational needs

Has the **Make in India** initiative reduced dependence on foreign military imports for high-altitude operations?

- a) Yes, significantly
- b) Partially, but foreign imports are still dominant
- c) Yes, moderately
- d) No, the reliance on foreign imports is unchanged
- e) No, reliance on imports has increased

Do you believe India's defense industry will be able to fully replace foreign military imports for high-altitude warfare in the next **10 years**?

- a) Agree
- b) Disagree
- c) Neutral
- d) Strongly Agree
- e) Strongly Disagree

In which categories has indigenous production successfully reduced foreign dependency?

- Firearms and ammunition
- Surveillance and reconnaissance equipment
- Communication and cyber warfare systems
- Mobility and transport vehicles
- Protective gear and combat uniforms

What incentives would encourage private-sector participation in indigenous defense production?

- Tax benefits and subsidies
- Faster approval processes
- Increased collaboration with global defense companies
- Government-backed research grant
- Rewards and Recognition

Suggestions and recommendations for making the scheme more effective to army operations in mountains and high-altitude areas

- Comprehensive Mountain Warfare Training
- Psychological Training
- Leadership Development
- Portable Oxygen Systems and medical support
- Base-camp infrastructure

Do you really agree to the facts of further expansion of indigenous defense production under “Make in India” for future military needs?

- Agree
- Disagree
- Neutral
- Strongly Agree
- Strongly Disagree