

## India's Ballistic Missile Defence Program in a Shifting Strategic Landscape

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### Abstract

India's Ballistic Missile Defence (BMD) program represents a crucial strategic initiative aimed at countering missile threats from regional adversaries, particularly China and Pakistan. This paper evaluates the necessity and effectiveness of India's missile defense systems, assessing whether the program is a strategic imperative or an overinvestment. With the advancements in Phase-II of India's BMD, including the AD-1 and AD-2 interceptors capable of neutralizing intermediate-range ballistic missiles (IRBMs), the system's efficacy against China's growing missile arsenal such as the DF-21 and DF-26 remains a focal point. India's BMD program, currently in its developmental stage, has demonstrated limited operational capability, with successful interceptor tests but lacking in the full scale deployment. Critical areas for improvement includes sensor network integration, rapid target discrimination, and a multi-layered interception framework to counter evolving threats, including hypersonic glide vehicles (HGVs). A comparative analysis with Israel's Iron Dome and the U.S.'s Terminal High Altitude Area Defense (THAAD) system reveals significant gaps in India's BMD coverage. While Iron Dome excels in short-range missile interception and THAAD provides high-altitude defense against long-range threats, India's system remains fragmented. Lessons from these programs emphasize the need for an integrated air defense network, real-time threat assessment, and interoperability with allied defense systems. This study concludes that while India's BMD is strategically necessary, its current limitations necessitate further technological advancements and investment in network-centric warfare capabilities to ensure credible deterrence and defense.

**Keywords:** Ballistic Missile Defence, India, Iron Dome, Strategic Deterrence, THAAD.

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## Introduction

South Asia's strategic environment consists of deeply rooted adversarial relations along with prevailing nuclear standoff along with advancing missile threat potentials. As a country located between China and Pakistan both possessing nuclear arsenals India requires powerful defensive systems to deal with its intricate regional security situation. The ballistic missile buildup by China and Pakistan includes the development of advanced systems that create significant risks towards Indian military assets and urban centers across military bases. The People's Liberation Army Rocket Force (PLARF) of China directed substantial resources into missile development thus obtaining medium-range ballistic missile (MRBM) DF-21 and sophisticated intermediate-range ballistic missile (IRBM) DF-26 which maintain conventional and nuclear capabilities (U.S. Department of Defense, 2023). The DF-26 missile stands out as the "carrier killer" with a demonstrated range of 4,000 km which enables it to strike vital Indian territories throughout the mainland. Pakistan maintains both short-range ballistic missiles called Nasr (Hatf-IX) for tactical nuclear attack and medium-range weapons consisting of Shaheen-II and Shaheen-III to target Indian Territory (NTI, 2024).

The Ballistic Missile Defence (BMD) program of India serves as a strategic defense program that aims to counter missile attack threats. Primary development activities for the Ballistic Missile Defence program's two-tiered air defense system began in the early 2000s under the Defense Research and Development Organisation (DRDO). PAD (Prithvi Air Defence) systems for exo-atmospheric interception together with AAD (Advanced Air Defence) systems for endo-atmospheric interception represent the first phase of this program that has entered its completion stages. The second phase of the project has intensified its advancement by developing interceptors AD-1 and AD-2 which can destroy IRBMs as well as ICBMs. The AD-1 interceptor missile achieved a successful test in November 2022 by India which demonstrated progress in becoming operationally ready for deployment (PIB, 2022).

The BMD system of India exists in developmental stage since its deployment capabilities and coverage extent remain restricted. The system remains challenged by three critical issues that include real-time tracking while also dealing with sensor fusion as well as intercepting sophisticated threatening weapons such as MIRVs and HGVs across multiple layers. India faces

increased defensive challenges because China has announced its HGV program which includes the DF-ZF (MIT Press, 2020).

This paper critiques the essential role and practical outcomes behind India's BMD defense plan. The primary research inquiry investigates whether BMD development in India should be considered a strategic requirement for defeating nearby missile threats or if it signifies wasting resources due to technical constraints and strategic ambiguities. This research investigates whether India's missile defense program creates acceptable deterrence together with operational capabilities or if different strategies like offensive counterforce approaches provide better security benefits to the nation. This paper has a five-part structure. This initial part analyzes regional missile threats taking China and Pakistan as primary examples of interests. The second outlines the development, objectives, and components of India's Ballistic Missile Defence (BMD) program. A detailed assessment of BMD system operational effectiveness follows while analyzing its equivalent performance against the Iron Dome system of Israel and the THAAD system of the United States. Future challenges such as hypersonic glide vehicles represent the fourth area this paper explores. The recommendations section provides strategic guidance to improve India's missile protection scheme and maintain both regional deterrence capabilities and long-lasting strategic security.

### **Strategic Context and Threat Perception**

India has developed a strong Ballistic Missile Defence program due to fast-changing regional security dynamics which include growing missile arsenals of China and Pakistan. The strategic environment of South Asia has become unstable since conventional nuclear divisions between forces require continuous threat evaluation. The strategic reality has directly triggered India to develop BMD systems to create effective ballistic missile protection measures.

The entire Indo-Pacific security environment strongly affects how India makes strategic decisions. The factors including region-wide military buildup and weapon systems advancement and multiple-use missile delivery systems deployed by nearby adversaries control how deterrence operates. The aggressive actions combined with nuclear tactical posture adopted by China alongside Pakistan result in strategic problems for India. The advanced development by adversaries in missile system capabilities has weakened India's response options because it forces a major overhaul of their defensive technologies.

**China and Pakistan: An evolving regional threat against India.**

The ability of China to build missiles to Indian national security can also be considered as one of the key position threat. People Liberation Army Rocket Force is commanded by Chinese armed forces, and this has ball Missiles that can cover both medium and intermediate ranges so that it can reach important Indian strategic locations and populations. Deployed since its development, the DF-21 (CSS-5) missile system has a maximum of 1,700 kilometers because it is controlled on mobile road platforms. Of the most interest is the intermediate-range ballistic missile, DF-21D, which is considered the most dangerous threat since it is a so-called "carrier killer" and is used to destroy Indian navy forces that are operationally deployed in the Indian Ocean (Kristensen & Korda, 2020).

DF-26 missile system- it has potential of 4,000 kilometers range which enables it to cover the whole of Indian mainland. China has implemented dual capability weapon system that makes India hard to conclude whether it is a drop or a nuclear threat (Acton, 2018). China has refined its strategic planning against hypersonic glide vehicles (HGVs) along with maneuverable re-entry vehicles (MaRVs) since the high-tech systems enable China to uncover conventional protective missiles. This new development exerts considerable tension on the BMD defense features of India since their structure is still in the testing stage and not ready to be implemented.

The tactical advancement of the missile in Pakistan extricates out of its need to counter the conventional military capabilities of India. The Nasr tactical ballistic missile (Hatf-IX) is included in the full spectrum deterrence program of Pakistan since the scope of its operation is the warning of an invasion by the enemy by a nuclear strike on the field (Khan, 2015). The Pakistani military has two medium-range ballistic missiles known as Shaheen-II and Ghauri; a combination that can be used to engage targets in almost the entire Indian land. Pakistan has a heightened threat of unintentional escalation owing to the fact that of the sophisticated missile defense system such as decoys or HGVs, but yet they rely on nuclear weapons to have an element of deterrence. Indian BMD advances in the future may force Pakistan to develop a wide range of 9 or use the asymmetric war craft strategies, which may involve cyber warfare and anti-satellite scheme to curtail its technological gap.

The development of China and Pakistan in missile capabilities is a major drain to India since it creates national security issues affecting the nation. Since ancient times, India has always

maintained the minimum deterrence policy with status of No First Use (NFU) to ensure its defenses. India must re-evaluate its defensive capability since its strategic infrastructure as well as its population centers are increasingly becoming vulnerable to missile attacks. The BMD system complements Phase-II interceptors AD-1 (previously designated as Shaanxi Design 643) and AD-2, which are in active development by trying to protect India against intermediate-range domestic threat such as DF-26. Successful development of such systems would be an important source of Indian defense forces enhancement capabilities that would ensure a dependable defense of the command and control centers and military unit retaliation capability. Several analysts assert that extensive missile defense reliance creates strategic instabilities because it creates misunderstandings of vulnerability and weakens the ability to maintain mutual deterrence (Tellis, 2021).

A comprehensive air defense system in India needs a cohesive screen which fabricates the BMD operations with the S-400 deployment along with indigenous Akash missiles and forth-generation directed-energy platforms as well as other national resources to safeguard the airspace of the country. The emerging doctrine of India should integrate the real-time data fusion technology and the network-centric warfare approaches in space-based surveillance operations against rapid missile launch and improving the capabilities of early warning systems. The fact that India is unable to match U.S THAAD ballistic missile shield and Israeli Iron Dome may cause several technological and operational predicaments. The Indian BMD is a hybrid system lacking full full-spectrum coherence because its individual elements were designed separately to respond to high-altitude THAAD interceptors, as well as low-altitude, short-range Iron Dome defense but they lack proven interoperability on a battle field.

When we take into consideration the missile threats in the neighbouring areas, one cannot ignore the need of having a BMD program in India. The success of the program depends on how effectively India achieves the goal of achieving a common real-time defensive to address the current and emerging security threats. The QUIS defense doctrine is expected to stay diverse in operations and technologically proficient up to the time of successful integration of the full system, which is yet to be achieved.

## **India's BMD Program: Overview and Technological Evolution**

The Defence Research and Development Organisation (DRDO) under its Ballistic Missile Defence (BMD) program endeavors to defend against ballistic missile proliferation in the South Asian region. The defense program draws its basis from India's missions to combat potential missile strikes from China and Pakistan. During its existence since the early 2000s the BMD program underwent two essential development phases which focused on distinct missile threat groups. (Tellis, 2013). The Kargil war of 1999 along with the 2001 Indian Parliament attack made India realize its defense vulnerabilities to missile threats which led to the nationwide push to create a domestic missile interceptor shield. Researchers developed the original conception of the BMD framework because Pakistan operated nuclear-capable missiles while China maintained an expanding strategic weapons stockpile (Pant & Joshi, 2015). The DRDO started its BMD development project in 2002 by focusing on building a defense system with separate layers for interception at low and high altitudes.

Phase I focused on destroying short or medium ballistic projectiles which included Pakistani missile systems Ghauri and Shaheen series. PAD interceptor represented the exo-atmospheric defense component while AAD interceptor served endo-atmospheric interception needs as the main interceptors developed under this program. To mark this critical advance PAD achieved its inaugural successful mission in November 2006 when it intercepted a target missile which rose up to 48 kilometers altitude (Subramanian, 2014). The tests held between 2009 and 2011 proved the system workable despite its ongoing deployment and integration obstacles. The Swordfish radar system reached operational status as part of Phase II development because it had tracking capabilities that reached 600–800 km. The deployment scope of Phase-I restricted itself to Delhi and few other cities since budgetary alongside technical issues and logistical restrictions persisted.

Phase-II incorporates a strategic modernization to defend against both intermediate-range ballistic missiles and intercontinental ballistic missiles. The program developed AD-1 and AD-2 interceptors which utilize improved speed along with longer range parameters and a hit-to-kill operating system. The interception systems focus on confronting Chinese DF-21 and DF-26 precision missiles despite their range capabilities (Kampani, 2017). A recent DRDO report about AD-1 interceptor testing during 2022 illustrates a major breakthrough because the system demonstrated its ability to destroy targets belonging to the IRBM class across various heights and

distances. Despite ongoing tests the AD-2 will combine better maneuvering capabilities with kick-kill technology to intercept fast-moving targets specifically hypersonic glide vehicles (Rajagopalan, 2021).

India has achieved significant technological advancement in BMD development but the system has not achieved full operational readiness. Prior field implementations took place within simulated frameworks which make experts doubt their operational capabilities during real battle conditions (Tellis, 2013). The national implementation of BMD units in strategic areas exists at present but the full establishment of an integrated nation-wide missile defense network has not materialized. The essential limitation preventing adequate functioning exists between real-time coordination of multiple radar and interceptor systems through sensor fusion. The United States operates the THAAD and Israel operates the Iron Dome to provide demonstrated combat-proven functionality through tracked networks that employ layered defensive capabilities. The automation and interconnection methods practiced by India's system show conceptual excellence yet fail to deliver effective integration between systems and quick reaction capabilities (Ganguly & Scobell, 2018).

The capability of interceptors to deal with hypersonic weapons that travel at speeds greater than Mach 5 is limited because these weapons follow unpredictable flight trajectories beyond current design specifications. India's BMD capability may fail to defend against upcoming missile threats when operated without AI-enabled target discrimination together with integrated early-warning systems (Rajagopalan, 2021).

The BMD program of India serves crucial strategic purposes because of growing missile threats within its region. The AD-1 and AD-2 systems lead technological improvements in the program yet it demands full integration combined with clear doctrine and operational readiness. India should embrace global anti-missile standards to develop real-time sensor networks combined with AI-powered tracking systems and integrated defense command architecture which will form an effective missile protection system against emerging threats.

### **Efficacy and Gaps in India's BMD Architecture**

India has run its Ballistic Missile Defence in offering security to the emergent ballistic missile that pose threats to security of the country both by its neighbors, Pakistan and China. The technology-

phase bridge of Phase-II high-altitude interceptors was the biggest accomplishment of the program and there is yet a cloud of operational and technological challenges on the whole structure. This section explores the capability of India to deal with intermediate-range ballistic missiles (IRBMs) and hypersonic glide vehicles (HGVs) in addition to the limitations observed in sensor tracking systems and a multi-layer additional defense and stresses geographic weaknesses in the proposed architecture of India. The phase-II BMD system of India works on the interceptors AD-1 and AD-2 to shoot down the IRBMs targeting that operate in the altitudes between the endo-atmosphere and the exo-atmosphere. The newly developed AD-1 interceptor system successfully completed tests in November 2022 which proved its ability to intercept IRBM threats from distances and heights (DRDO, 2022). India's BMD system now presents itself as capable of countering Chinese DF-21 missiles because it can deal with the missile's characteristics of 1,700 kilometers range and its maneuverable and precise terminal capabilities.

The testing process has not encompassed the operational combat situation on which the enemy acts on decoys and electronic counter measures with simultaneous vectors. The DF-26 missile used by China is one of the major threats since it is launched with a distance of 4,000 km and has potential conventional and nuclear warfare capabilities. The existing interceptor mechanisms of India are having a limit in their performance due to their speed and coordination capabilities as well as ascent altitude potential when they need to intercept the missiles carrying multiple warheads or penetration aids. The existing Indian defense systems are ill prepared to deal with the new dimensions of complexity owing to the aggressive deployment approach of China in relation to the hypersonic glide vehicles (HGVs) such as DF-ZF. The potential high-speed of HGVs going at more than Mach 5 allows the movement of these vessels in unexpected directions through atmosphere hence reducing considerably the amount of time required to detect the moving vessel and intercept it. In 2025, the Indian defense forces have not successfully conducted any HGV interception exercise although they are charged with the mandate of securing a vulnerable national territory with the said system. A successful BMD system requires persistent target detection from the beginning until later stages of observation. According to Raja Mohan (2023) the Swordfish Long Range Tracking Radar (LRTR) system together with other Indian radars provides tracking capability beyond 1,500 kilometers range. India is still undergoing the challenge of developing its sensor networks and also the integration algorithms between the sensor networks. The DRDO carries on with radar system integration yet real-time data relay and synchronisation procedures

are hugely undeveloped between its prospective domestic and Israeli Green Pine radar components. Target discrimination technology requires the ability to separate real warheads among decoys because the identification of the real warhead is a prolonged challenge. The contemporary Chinese and Pakistani nuclear ballistic missile systems operate in tandem with the decoy along with chaff and MIRVs (Multiple Independently targetable Reentry Vehicles) that generate too much workload to the BMD sensors causing detection clutter and misidentification of target. The threat to India is its defense capabilities in the case of the wrongful distribution of its interceptive or due to the incorrect identification of the target owing to its inability to use advanced algorithms and artificial intelligence in threat detection.

### **Geographic and Infrastructural Coverage Gaps:**

A multi-layered interception method coupled with real-time threat detection systems stands essential to defend against potential missile attacks. A functional BMD system must have three successive tiers of interceptor systems at low altitude, medium altitude and high altitude. The present Indian missile defense system comprises two organized levels which separate into exo-atmospheric Prithvi Defence Vehicle (PDV) and endo-atmospheric Advanced Air Defence (AAD). Although basic redundancy exists between the two-tiered missile defense system India has deployed it remains deficient in integrated air defense features like surface-to-air interceptors and the short-range protection capabilities found in the Israeli Iron Dome and U.S. Patriot systems.

India's embryonic network-centric warfare capabilities remain un-operational because they attempt to connect radars, satellites, interceptors and command-control centers through integrated command and control (C2) systems. Slower data processing times and transmission delays will negatively affect the time available to intercept fast-moving targets that include cruise missiles and HGVs.

The vast extent of Indian Territory as well as its varied geography and boundary position next to nuclear powers creates the need for an extensive Ballistic Missile Defense program coverage. The presently installed BMD assets protect only strategic cities such as New Delhi and Mumbai while authorities plan to extend coverage to key military bases. Most missile attacks remain a risk for northeastern India and its southern economic development areas because of insufficient defensive capabilities. Time-consuming and costly infrastructure projects to build nationwide BMD capabilities face limitations between logistical aspects and funding problems. The entire

nationwide implementation of BMD system exceeds what the military can afford to pay for its establishment. Full deployment of BMD protection systems for Indian major cities would require an estimated budget of over \$10 billion according to Kapoor and Singh (2024) while competing with present defense requirements including cyber warfare and navy modernization.

BMD program in India keeps facing operational and technological obstacles alongside infrastructural challenges as it proceeds against strategic objectives. The evolving nature of regional missile threats, particularly with the advent of HGVs and MIRV-equipped missiles, demands urgent modernization of India's interception, sensor integration, and response frameworks. India needs to construct a multiple-layered real-time geographically wide-reaching missile defense shield by studying systems like THAAD and Iron Dome. The BMD architecture needs maturity as a developmental experiment to become a reliable and genuine defense pillar.

### **Comparative Analysis with Global Missile Defense Systems**

#### **Case Study: Israel's Iron Dome – Strengths, Adaptability, and Limitations**

Since its inception in 2011 the Israel Defense Forces have operated the Iron Dome as one of the world's most effective defense systems against short-range missiles. The interception capabilities of Iron Dome cover rockets, mortars, and artillery projectiles within a 70-kilometer distance range (later extended to 250 km) achieving greater than a 90% success rate especially during the Operation Protective Edge conflict of 2014 (Army Technology, 2023). The system remains adaptable because it uses mobile launchers combined with advanced radar systems (EL/M-2084) and Battle Management & Weapon Control (BMC) centers to perform real-time threat separation thus targeting only dangerous projectiles aimed at civilian areas.

Iron Dome shows major weaknesses when trying to defend against heavy saturation attacks or when bombarded with advanced ballistic threats. Several rockets from Hamas attacked Israel successfully during 2021 because Iron Dome was unable to handle the large number of low-flying projectiles with short flight times (Binnie, 2021). The operational costs of Iron Dome rise due to its interceptor missiles which cost between \$40,000 to \$100,000 each which makes extended wide-scale defense operations highly expensive (Postol, 2021). Though Pakistan and China operate ballistic missiles whereas Israel faces short-range projectiles Iron Dome demonstrates how to build mobile intercept systems that use cost-effective interceptor designs.

## **Case Study: U.S. THAAD – High-Altitude Defense and Interoperability**

The United States' Terminal High Altitude Area Defense (THAAD) system addresses a different segment of the missile threat spectrum, specializing in intercepting short, medium, and intermediate-range ballistic missiles during their terminal phase at altitudes up to 150 km. THAAD's hit-to-kill technology (kinetic interception without explosives) offers high kill probability, successfully demonstrated in multiple Missile Defense Agency (MDA) tests since its deployment in 2008 (U.S. MDA Report, 2023).

The major strength of THAAD derives from its capability to integrate seamlessly with U.S. defense networks and allied defense systems that operate Patriot PAC-3 systems and Aegis BMD. The AN/TPY-2 radar component connects to expanded command systems to construct multi-layered missile defense systems that protect the Korean Peninsula and Guam regions.

The operation of THAAD encounters several performance restrictions. THAAD shows reduced effectiveness against modern counter missile weapons such as maneuverable re-entry vehicles (MaRVs) and hypersonic glide vehicles (HGVs) that China continues to develop for its missile capabilities (Defense Intelligence Agency, 2022). Because THAAD systems demand significant costs both for development and deployment the system struggles to extend its presence into new locations effectively (GAO Report, 2022). The Indian government must prioritize high-altitude interception technologies since China's DF-21D and DF-26 IRBMs represent serious threats to national security. Collaborative defense effectiveness between different missile defense systems also becomes crucial.

## **Lessons Learned for India**

### **(i) Integrated Air Defense Networks**

Both Iron Dome and THAAD highlight the critical importance of an integrated air defense network rather than isolated interception capabilities. Israel's multi-tier system combining Iron Dome, David's Sling, and Arrow-2/3 offers a spectrum defense from short to long-range threats (IISS, 2023).<sup>2</sup> Similarly, the U.S. layered approach allows tracking and engagement at various stages of a missile's flight. Currently, India's BMD architecture with Phase-I primarily countering 2,000 km

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<sup>2</sup> International Institute for Strategic Studies (IISS) (2023). *The Military Balance*. [https://www.iiss.org/publications/the-military-balance/the-military-balance-2023?utm\\_source](https://www.iiss.org/publications/the-military-balance/the-military-balance-2023?utm_source)

range threats and Phase-II extending to 5,000 km remains largely segregated (DRDO Annual Report, 2023). Full integration of the Swordfish LRTR radar, AD-1/AD-2 interceptors, and future multi-domain sensors is necessary to establish a resilient, flexible shield capable of absorbing saturation attacks and sophisticated decoys.

### **(ii) Rapid Response and Data Fusion Systems**

Iron Dome's success relies heavily on real-time data fusion and automated decision-making. Similarly, THAAD's integration with space-based and ground-based radars allows preemptive launches. India must invest heavily in AI-enhanced battle management systems (BMS) capable of fusing satellite, radar, and electronic surveillance data in real-time. India's ongoing development of the Netra AEW&C and integration with the Defence Space Agency's (DSA) satellite surveillance assets offer pathways, but significant gaps in rapid cueing and early warning capabilities persist.

### **(iii) Civil-Military Integration and Allied Interoperability**

Israel demonstrates perfect civil-military cooperation through Rafael Advanced Defense Systems which works together with the Israel Defense Forces (IDF) to develop successive enhancements. The U.S. missile defense sector works through joint efforts between Lockheed Martin Raytheon and DARPA as well as a range of civilian defense contractors. Indian defense research must prioritize the quick development of private sector participation for artificial intelligence and cybersecurity as well as sensor technologies to support DRDO's BMD advancement. Furthermore, interoperability with friendly countries like the U.S., Israel, Japan, and France could offer access to critical missile tracking and early-warning data a potential game-changer in crisis scenarios.

The strategic requirements of India's BMD program emerge through the dangers created by Chinese and Pakistani missile programs. India needs to shift its BMD program toward full integration between its defense components and networked interoperable operations by examining Iron Dome and THAAD systems. Future success relies on developing quick data fusion capabilities along with multi-layered interception capacity through public-private alliances to stay technologically agile in a growing strategic competition.

## **Strategic Imperative vs. Overinvestment: Policy and Budgetary Considerations**

### **Cost-Benefit Analysis of BMD Investments**

The Ballistic Missile Defence (BMD) program of India enters Phase-II thanks to its newly developed interceptors known as AD-1 and AD-2 at a substantial financial cost and technological investment. The cost-benefit evaluation demonstrates both positive and negative aspects. Security gains from BMD capabilities become extremely important because they allow interception of Intermediate-Range Ballistic Missiles launched by Pakistan and China thus saving numerous citizens and critical national infrastructure during times of war. The AD-1 interceptor test from November 2022 proved technological advancement according to DRDO (2022). BMD systems cost an exorbitant amount of money. A nationwide BMD shield provider for critical Indian metropolitan areas will require an estimated expenditure in the range of ₹50000 crore (\$6000 million) without factors accounting for upkeep or system improvements. Each interceptor missile unit has an estimated price ranging from ₹10 crore to ₹20 crore (\$1.2 to \$2.5 million). Sustainability becomes an issue because potential enemies might successfully deploy less costly decoys along with saturation attacks that could overwhelm the system. The strategic benefits are evident but the complete effectiveness requires tremendously high marginal costs.

### **Opportunity Costs and Allocation in Defense Spending**

The defense budget for India in 2024–25 amounted to ₹6.2 lakh crore (\$74 billion) and yielded substantial spending on modernization programs according to the Ministry of Defence (2024). The evaluation of BMD funding needs consideration regarding essential military requirements of immediate nature. The Indian military requires immediate conventional modernization efforts which include delayed artillery acquisitions combined with the necessity to name a next-generation fighter program. Heavy expenditures on BMD would likely result in reduced funding for conventional requirements as well as cyber-defense operations alongside maritime forces which remain essential due to India's developing security environment. Despite their lower total cost and adaptability BMD programs have, asymmetric warfare threats such as terrorism and cyber-attacks usually need solutions which cost less than national missile defense initiatives. Other crucial components of opportunity costs include the delayed accomplishment of joint operations among military services and the limited development of local defense industries and increased capacity in

cyber and space warfare fields which are fundamental for modern multi-domain deterrence operations.

### **Role in India's Broader Deterrence Strategy**

The BMD system integrates into the Indian deterrence strategy by enhancing the survivability of Indian second-strike capabilities. India's BMD system enhances deterrence stability since it lowers the potential for a successful first strike against India through its coverage of both Pakistan's Nasr tactical nuclear missiles and China's expanding DF-21 and DF-26 arsenal. Those who analyze BMD systems warn about possible deterrence reduction because leaders might become more daring due to their mistaken belief of being invulnerable to counterattacks which leads to the condition of deterrence instability. The Chinese advancements in Multiple Independently Targetable Reentry Vehicles (MIRVs) coupled with hypersonic glide vehicles (HGVs) will likely advance beyond India's ability to defend its territories thus nullifying any partial BMD protection. The benefits derived from BMD for broader deterrence become more effective with the addition of powerful retaliatory forces that convey decisive signals.

### **BMD within India's No First Use (NFU) and Second-Strike Capability**

According to India's stated NFU policy the country depends on guaranteed retaliation following a nuclear attack. The main purpose aims to sustain a second-strike survival ability through underground silo deployment along with mobile launch platforms and submarine-based deterrence systems and protective shields that guard vital assets. BMD functions as a protection plan for this strategic outlook because it safeguards vital political and military elements which serve to retain retaliatory assets after withstanding nuclear initial attacks. BMD systems operate as a supplement to secure strategic nuclear forces rather than serving as an alternative for them. The Indian nuclear doctrine benefits from BMD systems that achieve two objectives: they impede enemy attack planning and extend national leadership time available for crisis decision-making. The constant use of BMD systems risks undermining India's NFU approach since it might lead political decision-makers toward false confidence in their ability to navigate or survive a nuclear crisis against the basic concept of massive retaliation doctrine (Sethi, 2023). BMD deployment operates best as an enhancement to NFU while replacing it might result in the strategic weakening of India's credible retaliatory nuclear forces.

India's BMD program, while a strategic imperative given regional missile threats, must be pursued with careful cost-management and strategic clarity. A balanced approach investing in both offensive and defensive capabilities, learning from global best practices like Israel's multi-tiered air defense system, and focusing on technological self-reliance is essential to avoid the pitfalls of overinvestment and ensure credible deterrence in an increasingly complex security environment.

## **Recommendations and Way Forward**

### **(i). Strengthening Sensor Fusion and Network-Centric Capabilities**

The Ballistic Missile Defence (BMD) program of India faces a primary challenge because it does not use effective sensor integration and network-centric operations. BMD's effectiveness depends on real-time tracking because effective interception can only be possible after combining advanced sensor fusion techniques. The present Indian missile defense system operates with Swordfish (indigenous Long Range Tracking Radar) and early-warning systems and various ground station radars. India needs to build a comprehensive sensor network which includes ground-based and airborne and space-based sensor systems to combat threats such as MIRVs (Multiple Independently targetable Reentry Vehicles) and decoys. Version 2 of network-centric warfare framework enables real-time threat information sharing across air-borne early warning systems like Airborne Early Warning and Control and research stations as well as satellite platforms. Sensor fusion remains fundamental for developing multiple levels of missile defense systems according to lessons learned from US Patriot and THAAD systems. India must expedite efforts on the Network for Electronic Target Recognition and Acquisition framework and unite this initiative with Ballistic Missile Defense to develop a single integrated sensor system.

### **(ii). R&D for Counter-HGV and Directed Energy Systems**

Hypersonic glide vehicle development by China through tests of the DF-ZF creates an exceptional obstacle for traditional missile interception methods (Talmadge, 2022). HGVs move much faster than Mach 5 speed while displaying unpredictable flight patterns that makes interception and tracking processes very challenging. The Indian AD-1 and AD-2 BMD interceptors perform well against IRBMs but lack proper capabilities to thwart hypersonic threats. Counter-HGV technology research and development needs significant funding from India to advance its defense capabilities. Development work should focus on creating interception systems which combine speed and agile

flight capabilities and software that predicts paths of non-ballistic objects. The future of defense systems is likely to include Directed Energy Weapons (DEWs) especially in the form of high-energy lasers. DRDO launched its ADITYA program as early development of laser weapons while this research program remains at an initial stage. The U.S. military demonstrates DEW deployment potential through its LaWS (Laser Weapon System) installed on naval vessels for defending against high-speed targets. To overcome high-speed intercontinental missile threats India should invest defense funds in independent research facilities that exclusively study countermeasures against HGVs along with direction energy weapons.

### **(iii). Enhancing Indigenous Production and Public-Private Partnerships**

DRDO's native successes with the BMD program demonstrate Indian prowess but full-scale technological autonomy requires enhancement of the defense industrial market. Future development requires public-private partnerships (PPPs) to form its foundational principle. Larsen & Toubro and Bharat Forge have successfully joined defense projects which demonstrates that government R&D can work effectively with private manufacturing capabilities. India's Defence Acquisition Procedure (DAP) 2020 Strategic Partnership Model allows private companies to participate in BMD projects under the alignment framework mentioned in Section 8.4.1. Interceptor missiles and radar systems and command-and-control units for BMD projects can be mass-produced by private manufacturers who demonstrate capability to decrease both import dependence and speed up delivery schedules. Through its Strategic Partnership Model India can achieve better cost control and technology infusion alongside a thriving defense industry that develops export capabilities illustrated by the BrahMos missile export to the Philippines.

### **(iv). Integration with Air Force and Space-Based Surveillance Systems**

To establish credibility in missile defense shields they must connect with other air defense infrastructure. The BMD system in India needs total integration among its air defense command systems with main focus on the Indian Air Force command structures. Through establishment of Integrated Air Defence Command (IADC) India gains an opportunity to merge ballistic missile defenses with fighters along with UAVs and surface-to-air missile systems that include Akash and Barak-8. The overall surveillance system must have a significant presence in space-based platforms. EMISAT alongside RISAT enabled India to gain initial abilities for electronic intelligence and earth observation through satellite launches. A ballistic detection system like

America's Space-Based Infrared System (SBIRS) would generate much longer warning and interception times for defensive operations (Goswami, 2021). The satellites operated by the Defence Space Agency in the future need to track ballistic missiles and provide infrared signatures which serve as quick cues for interception.

#### **(v). Potential for Strategic Cooperation with Allies**

Active partnerships with fellow nations having shared interests generate increased operational power. The Quad framework which includes India along with the U.S. and Australia and Japan creates significant grounds for missile defense cooperation. The U.S. leads in technology while Japan excels at space-based surveillance and Australia utilizes its southern position for tracking so all these strengths combine well with India's capabilities. India should adopt cooperative BMD collaboration strategies with the U.S. Japan like their existing program to exchange sensor information along with technology development initiatives. Strategic deterrence posture would significantly improve for India by expanding Basic Exchange and Cooperation Agreement (BECA) mission domain sharing to include geospatial intelligence access from the U.S. Multination joint missile defense drills with members of the Quad would enhance both deterrence posture readiness, as well as operational interoperability and operational preparedness.

Note: I hereby declare that, I used the Perplexity AI with ethical intentions i.e., to summarize long scholarly articles/papers and extract their main ideas yet not misrepresent original content.

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