India's Defence Reforms and the Challenge of Emerging Military Technologies

Manish Kumar Yadav* and Pushkar Sejwal**

India's recent defence reforms have sought to align military preparedness with rapid advances in emerging technologies, such as artificial intelligence, unmanned systems, cyber capabilities and quantum applications. This article examines how these technologies both enable and complicate efforts to restructure India's defence research and development ecosystem, drawing on case studies of key reform initiatives, including the Innovations for Defence Excellence framework, the Defence Acquisition Procedure reforms, particularly the Make-I and Make-II categories, the SRIJAN indigenisation programme and theatre command reforms. Rather than treating technological change as a linear process, the study analyses organisational, institutional and policy-level challenges shaping innovation outcomes using official policy documents and programme-level evidence. It identifies persistent gaps between reform intent and implementation, especially in inter-service coordination, civil–military integration and industrial absorptive capacity. The article further argues that emerging technologies function less as autonomous drivers of transformation

* Dr Manish Kumar Yadav is a former Associate Professor, Department of Political Science and International Relations, College of Business and Social Sciences, National Higher Education and Research Institutions (Asmara University), Eritrea.

** Adv. Pushkar Sejwal is a Research Scholar at the Amity Law School, Amity University, Noida, Uttar Pradesh, India.

ISSN 0976-1004 (print); 2583-7567 (online)
© 2026 Manohar Parrikar Institute for Defence Studies and Analyses
Journal of Defence Studies, Vol. 20, No. 3, July-September 2026, pp. 102–133

and more as stress tests for existing defence institutions, with important implications for military modernisation.

Keywords: *Defence Reforms; Emerging Military Technologies; Defence Research and Development; Indigenous Defence Production; Military Innovation*

Introduction: Defence Reforms in a Technological Transition

India's contemporary defence reforms have unfolded against the backdrop of a rapidly evolving technological environment that is reshaping the character of military power worldwide. Advances in artificial intelligence (AI), autonomous and unmanned systems, cyber capabilities and quantum technologies, alongside developments in nanotechnology, biotechnology, big-data analytics, radar and microwave systems, satellite technologies, advanced materials and propulsion technologies, have generated renewed expectations about the transformative potential of technology in defence planning and military operations.[1] For India, these developments have coincided with a sustained reform effort aimed at addressing longstanding challenges of preparedness, indigenisation and institutional coordination within the defence establishment. This insight is particularly relevant for India, where defence reforms have historically proceeded incrementally and have been shaped by complex interactions between political leadership, the armed forces and defence production agencies.[2]

Since the mid-2010s, India has undertaken a series of reform initiatives intended to modernise its defence apparatus and strengthen domestic innovation capacities. Central among these have been changes to defence procurement frameworks that prioritise indigenous design and development, simplify acquisition procedures and encourage private sector participation under the Defence Acquisition Procedure (DAP).[3] Alongside procurement reform, the government has introduced innovation-oriented platforms, such as the Innovations for Defence Excellence (iDEX) initiative to connect start-ups, micro, small and medium enterprises (MSMEs) and academia with defence requirements.[4] At the organisational level, reforms aimed at enhancing jointness, most notably through theatre command reforms, have sought to address longstanding structural fragmentation within the armed forces.[5]

Emerging technologies have occupied a prominent place in this reform discourse, frequently framed as critical enablers for leapfrogging capability

gaps and overcoming legacy constraints in defence planning.[6] Yet, despite this emphasis, the outcomes of technology-led reforms remain uneven. For example, while innovation platforms have generated a growing number of indigenous prototypes in unmanned and software-driven systems, their translation into service-wide induction has remained limited, reflecting deeper organisational and procedural constraints rather than technological shortfalls. Official policy documents consistently highlight innovation, indigenisation and self-reliance as reform priorities. Still, implementation has been marked by coordination challenges, uneven uptake of new technologies across services and limited industrial and organisational capacity.[7] This gap between reform intent and institutional outcomes suggests that the core challenge confronting India's defence reforms is not merely technological but fundamentally organisational and political.

Empirically, the article draws on qualitative analysis of official policy documents, reform guidelines and programme-level initiatives associated with India's defence reforms. Particular attention is paid to procurement and innovation mechanisms under the DAP; the role of innovation platforms, such as the iDEX; indigenisation initiatives, including the SRIJAN programme; and organisational reforms linked to theatre command restructuring. These cases provide insight into how emerging technologies are being operationalised within India's defence institutions and where structural frictions persist.

The central research questions guiding this study are threefold. First, how have India's defence reforms sought to integrate emerging military technologies into existing institutional frameworks? Second, what organisational and policy-level constraints shape the effectiveness of these reforms? Third, what do the observed implementation divergences reveal about the prospects for technology-enabled military modernisation in India? By addressing these questions, the article contributes to defence studies scholarship by offering a grounded assessment of reform dynamics in a major non-Western military power.

Methodology and Sources

This study adopts a qualitative, document-based design to examine how defence reform instruments interact with emerging military technologies in India, focusing on institutional processes, organisational arrangements and policy mechanisms rather than technical performance. The objective is explanatory, accounting for persistent policy–practice mismatch.

Empirically, the analysis draws on three source categories: (*i*) official policy documents and institutional guidelines (including the DAP, innovation and indigenisation frameworks, audit reports and doctrinal publications); (*ii*) peer-reviewed academic literature on military innovation, defence reform and civil–military relations; and (*iii*) select policy and institutional reports from credible think tanks and international organisations. Together, these sources situate the Indian case within broader theoretical and comparative contexts.

The study is organised around three illustrative case areas: unmanned systems and AI; cyber capabilities and indigenous defence research and development (R&D), and technology transfer. These cases represent distinct, yet interrelated domains marked by uncertainty, cross-domain relevance and high coordination demands, enabling comparison across procurement, innovation and organisational reform instruments. Analytically, the study employs process tracing to identify how reform instruments interact with organisational practices over time, highlighting friction points, such as coordination failures, risk aversion and limited absorptive capacity.

As this study is based primarily on official documents, policy reports and secondary literature, it may reflect formal institutional positions rather than operational realities. While this approach enables systematic analysis of reform design and intent, it may under-represent informal practices, field-level adaptation and classified operational dynamics. The findings should, therefore, be interpreted as indicative of institutional patterns rather than exhaustive empirical verification.

Conceptual Framework: Military Innovation, Institutions and Reform

Debates on military innovation and defence reform provide a useful starting point for analysing the relationship between emerging technologies and institutional change. Early scholarship on military innovation highlighted the role of new technologies in reshaping doctrines, force structures and patterns of warfare, often suggesting a close link between technological breakthroughs and organisational transformation.[8] However, subsequent work has questioned technologically deterministic accounts, arguing that innovation outcomes are contingent on institutional structures, organisational incentives and civil–military relations.[9] This literature has underscored that technology does not enter military organisations as a neutral input, but is filtered through bureaucratic routines, professional norms and political priorities.

A central distinction in this scholarship is between modernisation and innovation. Military modernisation typically refers to the acquisition of new platforms or the upgrading of existing capabilities, whereas military innovation implies bigger changes in organisational practices, doctrine and decision-making structures.[10] While modernisation can occur without significant institutional disruption, innovation often requires sustained organisational learning and the redistribution of authority within defence bureaucracies. For states undertaking defence reform, the challenge lies in ensuring that technological adoption moves beyond platform replacement towards institutional adaptation.

Institutional theories of military innovation emphasise the importance of organisational interests and internal competition. Stephen Rosen's work highlights how innovation is shaped by promotion pathways, service preferences and intra-organisational coalitions, rather than by external technological pressures alone.[11] Similarly, Barry Posen's analysis demonstrates that doctrinal change is often driven by civilian intervention and strategic necessity, rather than by military organisations acting autonomously.[12] Together, these perspectives suggest that defence reforms centred on emerging technologies must contend with entrenched institutional arrangements that can enable, delay or dilute reform outcomes.

More recent scholarship has extended these insights by focusing on innovation ecosystems rather than individual organisations. The literature on military innovation ecosystems further emphasises the growing interdependence between defence institutions and civilian technological networks, particularly as advances in AI and autonomous systems increasingly originate in commercial sectors and require new procurement and partnership models.[13] Michael Horowitz and others argue that successful military innovation increasingly depends on the interaction between armed forces, civilian bureaucracies, industry and research institutions.[14] In this view, the effectiveness of emerging technologies is shaped by a state's capacity to integrate civilian technological advances into military structures, manage risk and adapt procurement and testing processes accordingly. This ecosystem-based approach is particularly relevant for emerging technologies, such as AI and autonomous systems, which are often developed outside traditional defence research establishments.

Applying these insights to defence reform highlights three analytically relevant dimensions. The first is institutional coordination, both within the armed forces and across civil–military boundaries. Emerging technologies typically cut across service domains and functional silos, requiring

mechanisms for joint planning, standard setting and interoperability.[15] Where coordination remains weak, technological adoption risks becoming fragmented and uneven, reinforcing existing organisational divides.

The second dimension is absorptive capacity, understood as the ability of institutions to recognise, integrate and operationalise new technologies.[16] Absorptive capacity depends not only on technical expertise but also on organisational flexibility, experimentation and feedback mechanisms. Defence reforms that prioritise procurement speed or indigenisation targets without addressing institutional learning processes may, therefore, struggle to translate technological inputs into operational capability.

The third dimension concerns civil–military and state–industry relations. As defence innovation increasingly involves private firms, start-ups and academic institutions, traditional models of state-led defence research face growing limitations.[17] Effective reform requires institutional arrangements that balance strategic control with openness to external innovation, while managing issues of security, accountability and risk. This tension is especially pronounced in contexts where defence bureaucracies are accustomed to public sector dominance in research and production.

India's Defence R&D and Innovation Architecture

India's defence R&D and innovation architecture is characterised by a complex institutional landscape shaped by historical legacies, bureaucratic segmentation and evolving reform imperatives. At its core, this architecture has been dominated by state-led institutions, particularly the Ministry of Defence (MoD) and the Defence Research and Development Organisation (DRDO), with limited but gradually expanding participation from private industry, start-ups and academic institutions. Understanding this institutional configuration is essential for assessing how emerging military technologies interact with defence reforms in practice.

State-led Origins and Institutional Dominance

Since independence, India's approach to defence R&D has been grounded in a strong preference for public sector leadership, driven by concerns over strategic autonomy, technology denial regimes and national self-reliance.[18] It is the DRDO that emerged as the central node of this system, tasked with developing indigenous defence technologies across a wide spectrum of domains, ranging from aeronautics and missiles to electronics and materials.[19] Over time, the DRDO's mandate expanded significantly, making it one of

the largest defence R&D organisations in the world in terms of personnel and laboratory infrastructure.

While this model enabled the creation of a broad indigenous knowledge base, it also produced structural limitations. The DRDO's vertical integration of research, development and limited production functions often reduced incentives for competition, experimentation and external collaboration.[20] Moreover, the close coupling between the DRDO laboratories, the defence public sector undertakings (DPSUs) and the MoD contributed to lengthy development cycles and delays in translating prototypes into deployable capabilities. These challenges became increasingly visible as the pace of global technological change accelerated.

Role of the Armed Forces and Service-specific Silos

Within India's defence innovation architecture, the armed forces have traditionally played a secondary role in shaping R&D priorities. Requirements have largely been articulated through formal qualitative staff requirements (QSRs), with limited iterative feedback between users and developers.[21] This separation between end-users and technology developers has constrained adaptability, particularly for emerging technologies that require rapid experimentation and doctrinal evolution, such as unmanned systems and AI-enabled decision tools.

Service-specific organisational cultures have further reinforced institutional silos. Each service maintains distinct procurement preferences, operational doctrines and threat perceptions, complicating efforts to pursue joint technology development or cross-domain integration.[22] As a result, emerging technologies that cut across certain domains, such as cyber and space capabilities, often lack clear ownership, leading to fragmented implementation and overlapping institutional mandates.

Defence Industry: Public Sector Dominance and Private Entry

India's defence industrial base has historically mirrored its R&D structure, with the DPSUs and ordnance factories occupying a dominant position. Despite gradual policy liberalisation since the early 2000s, private sector participation remained constrained by procedural complexity, limited access to testing facilities and uncertain demand signals.[23] These constraints inhibited the emergence of a competitive defence innovation ecosystem capable of absorbing and scaling emerging technologies.

Recent reforms have sought to address these limitations by encouraging private sector and MSME participation through procurement reforms and

innovation platforms. Various initiatives, such as the strategic partnership model, revised foreign direct investment norms and indigenisation lists under the SRIJAN programme, reflect attempts to rebalance the state–industry relationship.[24] Nevertheless, structural asymmetries persist, particularly in access to capital, risk-sharing mechanisms and long-term production orders.

Domestic Deep-Tech Ecosystem and Technology Maturation Constraints

The constraints facing India's defence innovation ecosystem extend beyond procurement procedures and institutional gatekeeping. Emerging defence technologies depend on specialised upstream inputs, including semiconductors, advanced sensors, electronic components, specialised materials and precision-manufacturing capabilities. India's continued dependence on imported semiconductors and electronic components creates supply-chain vulnerabilities for strategically important sectors, including defence.[25] Technology maturation also presents a financing challenge. Deep-tech ventures typically involve high technical uncertainty, long development cycles and substantial capital requirements, making patient and risk-tolerant financing particularly important beyond the proof-of-concept stage. India's policy and innovation assessments identify access to patient capital as a continuing constraint in the development and commercialisation of deep-tech technologies.[26]

Access to specialised testing, calibration, environmental qualification and validation infrastructure presents a further constraint. The government has recognised the importance of such infrastructure through the Defence Testing Infrastructure Scheme (DTIS), while the DRDO provides specialised testing and characterisation facilities to industry and start-ups. The continuing expansion of these facilities indicates that access to specialised testing infrastructure remains an important component of technology maturation and defence–industrial development.[27] The domestic innovation ecosystem should, therefore, be viewed as a technology maturation system whose effectiveness depends on access to critical inputs, patient capital, specialised infrastructure and systems integration capabilities.

Innovation Platforms and Ecosystem Expansion

The introduction of innovation-oriented mechanisms, such as the iDEX framework, represents a significant departure from earlier state-centric models. The iDEX aims to connect start-ups, MSMEs and academic institutions with defence problem statements through challenge-based funding and fast-track procurement pathways.[28] This approach aligns more closely with ecosystem-

based models of innovation, particularly relevant for dual-use and software-intensive technologies.

However, the integration of these platforms into the broader defence R&D architecture remains uneven. While iDEX has succeeded in generating prototypes and proof-of-concept solutions, scaling these innovations into service-wide adoption has proven difficult.[29] Institutional barriers, including testing protocols, procurement thresholds and risk aversion within user services, continue to limit downstream absorption.

Organisational Reform and Jointness

Organisational reform initiatives, particularly those aimed at enhancing jointness through the proposed theatre command restructuring, have important implications for defence innovation. Joint organisational structures are critical for integrating emerging technologies that operate across domains, such as network-centric warfare systems and integrated Intelligence, Surveillance and Reconnaissance (ISR) platforms.[30] While theatre command structures have not yet been formally implemented, ongoing discussions regarding joint operational structures indicate increasing emphasis on interoperability and integrated planning. The three Services have also moved gradually towards greater harmonisation of qualitative requirements, joint planning processes and interoperability standards, although substantial organisational integration remains a work in progress.

In the absence of fully realised joint command structures, technology adoption continues to reflect service-specific priorities rather than integrated operational concepts. This misalignment constrains the effective exploitation of emerging technologies and reinforces existing institutional divides within the defence establishment.

Structural Characteristics and Reform Implications

Taken together, India's defence R&D and innovation architecture exhibits three defining characteristics. First, it remains heavily state-centric, with public sector institutions exercising significant control over research priorities and development pathways. Second, institutional fragmentation across services, bureaucratic departments and industry segments limits coordination and slows adaptation. Third, recent reforms have introduced innovation mechanisms without fully resolving the legacy of organisational constraints.

These characteristics shape how emerging military technologies are absorbed within the defence system. Rather than functioning as neutral enablers of reform, technologies interact with existing institutional arrangements,

revealing capacity gaps and coordination failures. As subsequent sections demonstrate, defence reforms that prioritise technological adoption without parallel organisational consolidation risk producing incremental change rather than systemic transformation.

In practice, defence innovation involves a broader ecosystem than is often recognised in policy discussions. The process encompasses the MoD as the principal policy and procurement authority; the armed forces as capability users and requirement generators; the DRDO, start-ups, MSMEs and research laboratories as technology developers; the DPSUs, public sector undertakings (PSUs) and private industry as manufacturers and production partners; and universities and academic institutions as sources of scientific research, advanced skills and dual-use innovation. Effective defence reforms, therefore, depend upon sustained coordination among these actors across the technology development, procurement, production and operational induction cycle. Table 1 gives the principal institutional actors within India's defence innovation ecosystem and their reform-related challenges.

Table 1 Institutional Actors in India's Defence R&D and Innovation Ecosystem

Institutional Actor	**Core Role in Defence Innovation**	**Key Ecosystem and Reform Challenge**
MoD	Policy formulation and procurement oversight.	Coordination across multiple reform instruments.
DRDO	Indigenous defence R&D and technology development.	Scaling, technology transfer and timelines.
Armed Forces	Operational requirements and adoption.	Joint integration and absorptive capacity.
DPSUs/PSUs	Production, manufacturing and systems integration.	Limited flexibility and competition.
Private Industry/ MSMEs/Start-ups	Innovation and niche capability development.	Demand uncertainty, capital constraints, dependence on specialised and imported inputs and limited access to testing and qualification infrastructure.
Academia and Research Institutions	Research, scientific innovation and talent generation.	Weak defence–academia linkages.

Source: Compiled by the authors.

Defence Reform Instruments and Emerging Technologies

India's defence reforms have deployed a range of policy and institutional instruments to facilitate the integration of emerging military technologies into the defence ecosystem. These instruments operate across procurement, innovation, indigenisation and organisational reform, reflecting an effort to address longstanding structural bottlenecks while responding to rapid technological change. However, the effectiveness of these instruments varies across technology domains, revealing important limits to technology-led reform in the absence of deeper institutional alignment.

Procurement Reform and Technology Integration

Procurement reform has been a central pillar of India's defence reform agenda. The DAP 2020 represents a significant attempt to reorient procurement towards indigenisation, innovation and private sector participation.[31] The introduction of procurement categories, such as Make-I and Make-II, reflects an explicit recognition that emerging technologies, particularly AI, unmanned systems and advanced electronics, require different risk-sharing and development models than traditional platform-centric acquisitions. In addition, proposed reforms under the draft DAP 2026 indicate ongoing efforts to streamline procurement procedures, strengthen domestic industry participation and accelerate technology adoption. However, the effectiveness of these changes will depend upon their implementation and institutional acceptance.

Make-I projects involve government-funded development with assured procurement, while Make-II projects rely on industry-funded development with the prospect of future orders.[32] These categories are intended to encourage domestic firms and start-ups to invest in technologically complex projects that may not immediately meet conventional procurement thresholds. In principle, this framework aligns well with the characteristics of emerging technologies, which often require iterative development, testing and user feedback.

In practice, however, procurement processes remain constrained by lengthy approval cycles, rigid QSRs and limited tolerance for developmental risk.[33] This has been particularly evident in the case of unmanned aerial and ground systems developed under Make-II and innovation-linked procurement pathways, where repeated trials and requirement revisions have delayed movement from prototype status to committed production orders. For software-intensive and rapidly evolving technologies, such as AI-enabled

decision-support systems or autonomous platforms, these constraints can undermine responsiveness and discourage sustained industry participation. As a result, procurement reform has improved entry points for innovation without fully resolving downstream adoption challenges.

Innovation Platforms and Start-up Engagement

The establishment of the iDEX framework marks a notable shift in India's defence innovation strategy. Designed to connect start-ups, MSMEs and academic institutions with defence problem statements, the iDEX seeks to accelerate innovation through challenge-based funding, simplified contracting and faster timelines.[34] This model reflects broader global trends in defence innovation, where militaries increasingly rely on civilian technological ecosystems for emerging capabilities.

The iDEX has demonstrated particular relevance for dual-use and software-driven technologies, including unmanned systems, data analytics and cyber tools.[35] By lowering entry barriers and providing early-stage funding, the programme has expanded the pool of actors involved in defence innovation. However, the transition from prototype development to operational induction remains uneven. Limited alignment between innovation platforms and formal procurement channels often results in promising solutions failing to scale beyond pilot stages.[36] Several iDEX-supported solutions, particularly in surveillance, logistics automation and decision-support applications, including unmanned aerial and ground systems showcased through iDEX challenge pathways, have progressed through proof-of-concept stages without being absorbed into formal procurement pipelines.

This gap highlights a recurring challenge in defence reforms: innovation mechanisms can generate technological options, but institutional pathways for absorption and integration remain underdeveloped. Without clearer linkages between innovation platforms, user services and procurement authorities, the impact of start-up-driven innovation is likely to remain fragmented. Thus, while the iDEX and SRIJAN portal have generated significant momentum for defence innovation and indigenisation, both initiatives remain in a developmental stage. Their long-term effectiveness will depend upon the successful transition of prototypes and indigenous solutions into sustained procurement, production and operational deployment.

However, this transition is not solely a procurement challenge. Deep-tech defence ventures often require substantial investment beyond proof-of-concept development for engineering refinement, specialised component sourcing, systems integration, testing and qualification. For smaller firms and

start-ups, limited access to patient capital and specialised testing infrastructure can constrain the progression of promising prototypes towards production readiness. Consequently, the scaling of defence innovation depends not only on stronger linkages between innovation platforms, users and procurement authorities, but also on the availability of the financial, technological and infrastructural capabilities required for technology maturation.

Indigenisation and Industrial Policy Instruments

Indigenisation has emerged as a key strategic objective underpinning India's defence reforms. Policy instruments, such as the SRIJAN portal and successive positive indigenisation lists, aim to reduce dependence on imports by identifying items for domestic production and creating demand visibility for industry.[37] These initiatives are particularly significant for emerging technologies, where supply chains are less entrenched and opportunities for domestic capability development are greater.

The emphasis on indigenisation aligns with broader strategic concerns regarding supply chain resilience and technological sovereignty.[38] However, indigenisation policies also place additional demands on domestic industry and R&D institutions, requiring rapid capability development and sustained investment. In the absence of adequate absorptive capacity and coordination, indigenisation targets risk becoming symbolic benchmarks rather than drivers of technological capability. Moreover, tensions can arise between indigenisation objectives and the need for access to global technology ecosystems, particularly in areas such as semiconductors, advanced materials and quantum research. Balancing openness with strategic autonomy remains a persistent challenge for defence reform instruments operating in emerging technology domains.

Organisational Reform and Technology Enablement

Organisational reform constitutes a critical but often underappreciated dimension of technology integration. Efforts to enhance jointness through theatre command reforms are intended to improve operational integration across services and enable more effective use of emerging technologies that operate across domains.[39] Network-centric warfare systems, integrated ISR platforms and cyber capabilities, for example, require joint command structures and interoperable doctrines to realise their full potential.

However, the incremental and contested nature of organisational reform has limited its immediate impact on technology adoption. In the absence of fully institutionalised joint commands, technology integration

continues to reflect service-specific priorities and procurement pathways.[40] This fragmentation constrains the development of shared standards, joint experimentation and cross-domain operational concepts, particularly for emerging technologies that challenge traditional service boundaries.

Table 2 maps the major defence reform instruments to their institutional anchors, targeted technology domains and key implementation constraints. As the table indicates, while reform instruments span the full spectrum of emerging technologies, their effectiveness is uneven and shaped by persistent institutional constraints.

Table 2 Defence Reform Instruments and Emerging Technology Domains in India

Reform Instrument	**Institutional Anchor**	**Primary Technology Domains**	**Intended Reform Objective**	**Key Implementation Constraint**
DAP: Make-I/ Make-II	MoD/Armed Forces	AI-enabled systems, unmanned platforms and sensors	Promote indigenous development and risk sharing	Lengthy approval cycles and procedural risk aversion
iDEX	MoD/Defence Innovation Organisation	AI, robotics, drones and cyber tools	Engage start-ups and MSMEs in defence innovation	Difficulty scaling from prototype to induction
SRIJAN Indigenisation Programme	MoD/ Department of Defence Production	Components, electronics and subsystems	Reduce import dependence and enhance self-reliance	Limited industrial absorptive capacity
DRDO Technology Development and Transfer	DRDO/ industry	Missiles, electronic warfare, sensors and advanced materials	Translate R&D outputs into deployable systems	R&D–production misalignment and delays
Theatre Command Reforms	Armed forces/ Integrated Defence Staff	Network-centric systems, ISR, and cyber	Enhance jointness and cross-domain integration	Incomplete organisational consolidation

Source: Compiled by the authors, based on official policy documents and reform guidelines.

Case Studies: Emerging Technologies as Institutional Stress Tests

This section examines how emerging military technologies interact with India's defence reform instruments in practice. Rather than assessing technological performance per se, the case studies analyse how institutional arrangements shape outcomes across procurement, innovation and organisational reform. Each case illustrates how the introduction of novel technologies forces a reckoning within defence institutions, revealing coordination gaps, absorptive capacity constraints and limits of reform implementation.

Unmanned Systems and AI: From Prototypes to Operational Absorption

Unmanned systems and AI have featured prominently in India's defence reform discourse, particularly as cost-effective solutions for surveillance, logistics and decision-making support. Policy initiatives, such as the iDEX, Make-II procurement categories and service-specific challenge statements, have generated a growing pipeline of indigenous prototypes in unmanned aerial, ground and maritime systems.

Empirically, however, the transition from prototype development to operational induction has been uneven. While start-ups and MSMEs have demonstrated technical capability under challenge-based innovation programmes, service-level adoption has been constrained by fragmented requirements, overlapping procurement pathways and uncertainty regarding long-term orders.[41] In several cases, indigenously developed unmanned aerial vehicle (UAV) programmes, including the Rustom series, have remained confined to trials or limited deployment, reflecting weak mechanisms for scaling and doctrinal integration. Despite sustained investment, prolonged testing cycles and limited large-scale induction highlight a disconnect between technological development and procurement commitment, particularly in ISR and logistics-support platforms where services defer induction pending doctrinal clarity and funding.

This pattern underscores a key institutional tension. Emerging technologies such as unmanned systems require iterative user–developer interaction and flexible testing environments, but India's procurement and operational structures remain oriented towards platform-centric acquisition and predefined QSRs.[42] As a result, AI-enabled and autonomous systems expose the limits of procurement reform when organisational practices and risk management frameworks remain unchanged. Similarly, early adoption of AI-enabled decision-support tools under defence innovation initiatives

has remained largely confined to pilot projects and limited deployments, with integration into command-and-control systems constrained by data standardisation issues, interoperability challenges and the absence of mature doctrinal frameworks.

Cyber Capabilities and Information Warfare: Fragmentation and Coordination Challenges

Cyber capabilities represent a distinct category of emerging technology characterised by cross-domain relevance, rapid evolution and deep civil–military interdependence. India has taken steps to institutionalise cyber capabilities through the creation of dedicated structures and doctrinal recognition of cyberspace as an operational domain. These developments align with broader defence reforms aimed at integrating non-kinetic capabilities into military planning.

Despite this progress, the governance of cyber capabilities remains fragmented. Responsibility for cyber operations and cyber defence is distributed across multiple organisations, including service-specific units, joint structures and civilian agencies.[43] This diffusion reflects institutional caution and jurisdictional sensitivity, but complicates coordination, prioritisation and capability development. For instance, the establishment of the Defence Cyber Agency in 2019 marked a step towards institutionalising cyber operations; however, its limited mandate and the distribution of responsibilities across service-specific and civilian agencies continue to constrain unified command, strategic coherence, prioritisation, capability development and crisis-time coordination.

From a reform perspective, cyber capabilities illustrate how emerging technologies challenge traditional service-centric models of defence organisation. Effective cyber operations depend on joint planning, shared situational awareness and close coordination with civilian infrastructure and industry.[44] However, the absence of fully institutionalised joint command structures and clear civil–military coordination mechanisms limits the strategic integration of cyber capabilities. The case demonstrates that organisational reform, rather than technological availability, is the critical determinant of effectiveness in emerging technology domains.

Indigenous R&D and Technology Transfer: DRDO–Industry–Service Interaction

The third case concerns the interaction between indigenous R&D institutions, industry and the armed forces in the development and absorption of

emerging technologies. The DRDO remains central to India's defence R&D architecture, particularly in high-technology areas, such as missiles, sensors and electronic warfare. Recent reforms have sought to reposition the DRDO as a facilitator rather than a monopolistic developer, emphasising technology transfer and collaboration with private industry.[45]

Several successful programmes demonstrate the value of collaborative development models. The BrahMos supersonic cruise missile programme, the Pinaka multi-barrel rocket system and the Advanced Towed Artillery Gun System (ATAGS), all illustrate how the DRDO, production agencies and private industry can jointly contribute to successful technology development, manufacturing and operational induction. These cases suggest that institutional coordination often matters as much as technological capability in determining reform outcomes. While the widely cited DRDO-led projects, including sensors, electronic warfare and missile-related programmes, have achieved notable successes, challenges persist in translating laboratory outputs into scalable, production-ready systems.[46]

Technology transfer to industry is often slowed by procedural complexity, limited manufacturing readiness and misalignment between R&D timelines and service requirements. In several DRDO-led programmes, technologies have reached advanced stages but faced delays in production and operational integration—seen in systems like the Akash missile and Tejas aircraft—due to coordination gaps among the DRDO, production agencies and the services. For rapidly evolving technologies, such delays reduce operational relevance as prototypes mature before manufacturing is ready and service requirements shift mid-cycle. The introduction of indigenisation instruments, such as the SRIJAN portal and positive indigenisation lists, aims to address the aforementioned gaps by creating demand signals and encouraging domestic production.[47] However, without sustained coordination between R&D institutions, industry and user services, indigenisation initiatives risk reinforcing supply-side constraints rather than accelerating capability development.

Meanwhile, the maturation challenge extends beyond coordination among the DRDO, industry and the services. Defence technology development also depends upon the wider ecosystem of specialised suppliers, component manufacturers, testing facilities, engineering expertise and investment capital. Where critical inputs, such as advanced sensors, electronic components, specialised materials or other enabling technologies, remain externally dependent, or where domestic firms face difficulty accessing

specialised testing and qualification infrastructure, technology transfer may not automatically translate into production readiness.

Therefore, the ability to absorb and scale indigenous R&D depends not only on institutional coordination, but also on the depth and resilience of the domestic technological and industrial ecosystem. This highlights how emerging technologies expose structural rigidities within India's defence innovation ecosystem. The three aforementioned case studies, summarised in Table 3, illustrate how emerging technologies expose institutional constraints rather than automatically generating reform.

Table 3 Emerging Technologies as Institutional Stress Tests: Case Study Synthesis

Case Study	Technology Focus	Key Reform Instruments	Institutional Stress Revealed
Unmanned Systems & AI	Drones and AI-enabled decision support.	iDEX and Make-II procurement.	Weak absorption pathways and doctrinal lag.
Cyber Capabilities	Cyber operations and information warfare.	Joint doctrine and cyber agencies.	Fragmented authority and coordination gaps.
Indigenous R&D & Technology Transfer	Sensors, electronic warfare and dual-use technologies.	DRDO, SRIJAN and industry partnerships.	R&D–industry–service misalignment and technology maturation constraints.

Source: Authors' synthesis based on case study analysis.

Implementation Gaps and Institutional Constraints

Fragmented Institutional Coordination

A central constraint emerging across the cases is the persistence of fragmented institutional coordination. Procurement reforms, innovation platforms and organisational restructuring initiatives have been introduced largely in parallel rather than as parts of an integrated reform sequence. As the unmanned systems and AI case illustrates, innovation pathways like the iDEX generate prototypes, but downstream absorption depends on service-specific procurement authorities that operate under distinct timelines and priorities.[48] This fragmentation weakens feedback loops between developers, users and policymakers, limiting the capacity for iterative learning that emerging technologies require.

Risk Aversion and Procedural Inertia

Another implementation gap concerns risk management and institutional incentives. As India's procurement and audit frameworks remain oriented towards minimising procedural risk rather than managing technological uncertainty,[49] it has reinforced a culture of risk aversion within both procurement authorities and user services, discouraging experimentation beyond pilot projects.

The aforementioned case studies demonstrate that even where reform instruments explicitly seek to encourage innovation, such as Make-II procurement or start-up engagement under iDEX institutional practices, they continue to privilege proven platforms and predefined requirements.[50] As a result, reforms have expanded access to innovation without fundamentally altering decision-making incentives, limiting the transformative potential of emerging technologies.

Absorptive Capacity and Organisational Learning

Absorptive capacity, understood as the ability of defence institutions and domestic industrial and technological ecosystem to recognise, integrate, refine, test and operationalise new technologies, emerges as a critical constraint. India's experience with indigenous UAV development illustrates this multi-dimensional challenge. The Rustom-II UAV programme, despite prolonged development and successful test milestones, has faced delays in achieving full operational clearance and large-scale induction, reflecting challenges in aligning user requirements, testing protocols, procurement commitments and technology maturation.

These patterns point to limitations in both organisational learning and the wider ecosystem required for technology maturation. Feedback from trials and limited deployments is not systematically incorporated into doctrine, training or procurement revisions, while constraints in engineering refinement, specialised testing and industrial readiness can further slow the transition from prototype to operational capability. Therefore, without institutionalised processes for learning and adaptation, alongside adequate ecosystem capabilities for testing, refinement and scaling, emerging technologies risk remaining peripheral rather than transformative.

Civil–Military and State–Industry Interface Constraints

The cases also highlight enduring constraints at the civil–military and state–industry interfaces. While reforms have sought to expand private sector participation and re-position the DRDO as a facilitator, the defence

innovation ecosystem remains shaped by asymmetries in authority, information and risk-sharing.[51] Industry actors, particularly start-ups and MSMEs, face uncertainty regarding long-term demand, while user services retain significant gatekeeping power over adoption decisions.

Organisational Reform and the Limits of Incrementalism

Finally, the implementation gaps observed across the cases underscore the limits of incremental organisational reform. The gradual and contested nature of these reforms has limited their impact on technology integration to date.[52] As long as service-centric structures dominate operational planning and procurement, emerging technologies will continue to be adopted unevenly and in silos.

Synthesis

Taken together, the case studies demonstrate that implementation gaps in India's defence reforms arise from both institutional constraints and limitations within the domestic technology ecosystem. Organisational structures, incentive systems, fragmented decision-making and governance arrangements continue to shape technology adoption, but these factors interact with constraints in upstream technology availability, technology maturation finance, specialised testing and qualification infrastructure, manufacturing readiness and systems integration. Emerging military technologies therefore act as critical pressure points, exposing not only institutional weaknesses within the defence establishment but also capability gaps within the wider industrial and technological ecosystem.

Comparative and Forward-Looking Perspectives

Placing India's defence reforms in comparative perspective helps clarify both their distinctive features and structural limitations. Experiences of other military powers suggest that the integration of emerging technologies is less a function of technological sophistication than of institutional coherence, organisational adaptability and reform sequencing. Comparative insights, therefore, illuminate why similar reform instruments often yield divergent outcomes across national contexts.

Comparative Insights: Institutions over Technology

Comparative studies of military innovation consistently show that states with strong joint command structures, flexible procurement systems and close

civil–military innovation networks are better positioned to absorb emerging technologies.[53] Recent comparative analyses of military innovation ecosystems further reinforce this argument by demonstrating that the effectiveness of emerging technology adoption depends on the strength of linkages between military organisations, private industry and research institutions.[54] Where such institutional foundations are present, organisational learning mechanisms help narrow the gap between innovation and operational adoption.

In contrast, cases in which organisational reform lags behind technological ambition tend to exhibit fragmented adoption, limited scaling and uneven institutional ownership—patterns closely resembling those observed in India.[55] This comparison suggests that India's difficulties are not unique to emerging powers but reflect broader dynamics of defence reform under conditions of rapid technological change. However, the persistence of service-centric structures and procedural rigidity within India's defence establishment magnifies these challenges and constrains the transformative potential of emerging technologies.

Selective Adaptation and Institutional Path Dependence

Another comparative insight concerns selective adaptation. Defence institutions often adopt emerging technologies in ways that reinforce existing organisational preferences rather than disrupt them.[56] This phenomenon is evident in India's service-specific approaches to unmanned systems, cyber capabilities and indigenous R&D, where adoption pathways mirror pre-existing institutional boundaries.

Such selective adaptation reflects institutional path dependence: reforms are filtered through established practices, hierarchies and incentive systems.[57] Comparative evidence suggests that overcoming path dependence requires deliberate organisational interventions, including changes in command structures, personnel policies and budgeting processes. Without these interventions, emerging technologies are likely to produce incremental rather than transformative change.

Implications for India's Reform Trajectory

From a forward-looking perspective, India's defence reforms face a critical inflexion point. The proliferation of emerging technologies, particularly AI-enabled systems, cyber capabilities and autonomous platforms, will continue to place pressure on existing institutional arrangements. As the case studies demonstrate, these technologies demand joint planning, rapid experimentation and close civil–military–industry coordination. Therefore,

incremental adjustments to procurement or innovation mechanisms alone are unlikely to suffice.

Comparative experience suggests three broad implications for India's reform trajectory. First, organisational reform, especially the consolidation of joint command structures, will be central to realising the benefits of emerging technologies.[58] Without institutionalised jointness, technology integration will remain fragmented and service-centric. Second, procurement and innovation reforms must be aligned with organisational incentives, ensuring that risk-taking and experimentation are institutionally rewarded rather than penalised.[59] Third, sustained engagement with civilian innovation ecosystems will require governance frameworks that balance strategic control with openness and flexibility.

Reform Sustainability under Technological Pressure

A further forward-looking concern relates to reform sustainability. Emerging technologies evolve rapidly, often outpacing formal policy cycles and bureaucratic adaptation. Comparative cases indicate that defence reforms that rely heavily on top-down directives without embedding adaptive mechanisms tend to lose momentum over time.[60] In India's case, certain initiatives, such as innovation platforms and indigenisation programmes, have generated early momentum, but their long-term impact will depend on whether institutional learning processes are consolidated.

This perspective underscores the importance of viewing defence reforms as a continuous process rather than a finite set of policy interventions. Emerging technologies will continue to reshape the strategic environment, but their impact on military effectiveness will be mediated by institutional capacity. The comparative lesson is clear: technology-led reform must be accompanied by sustained organisational change if it is to remain effective.

Looking Ahead

In comparative and forward-looking terms, India's defence reforms occupy an intermediate position. They reflect growing awareness of the strategic importance of emerging technologies and have introduced meaningful policy instruments to harness them. At the same time, persistent institutional constraints limit the depth of transformation achieved thus far. Emerging technologies, far from resolving these constraints, make them more visible and more consequential.

As India continues to pursue defence reforms in a technologically dynamic environment, the key challenge will be to align innovation initiatives with

organisational consolidation and institutional learning. The success of this effort will shape not only India's military modernisation outcomes but also its ability to sustain reform under conditions of accelerating technological change.

Implications for Defence Reforms and Military Modernisation

Re-centering Reform on Institutions Rather than Technologies

A first implication is the need to re-centre defence reforms around institutions rather than technologies. While emerging technologies, such as AI, unmanned systems and cyber capabilities, feature prominently in policy discourse, their effectiveness depends on the organisational environments into which they are introduced. As the preceding sections demonstrate, procurement reform, innovation platforms and indigenisation initiatives have expanded access to technological solutions, but they have not consistently translated into operational capability.[61] This suggests that military modernisation cannot be achieved through technological substitution alone; it requires sustained institutional adaptation.

For defence reforms, this implies prioritising organisational coherence, decision-making authority and coordination mechanisms alongside technology acquisition. Without addressing service-level silos, bureaucratic fragmentation and misaligned incentives, emerging technologies are likely to reinforce existing patterns of incrementalism rather than enable transformation.[62]

Aligning Procurement, Innovation and Organisational Reform

A second implication concerns the alignment of reform instruments. India's defence reforms have introduced multiple policy tools, DAP reforms, innovation platforms, such as the iDEX, and indigenisation mechanisms, like SRIJAN, but these instruments often operate on parallel tracks.[63] The absence of strong institutional linkages between innovation, procurement and operational integration limits their collective impact.

For military modernisation, this misalignment results in a pipeline problem: innovation generates prototypes; procurement struggles with risk and timelines; and services remain cautious about adoption. Reform efforts would, therefore, benefit from integrating these stages more explicitly, ensuring that innovation pathways are tied to procurement planning and doctrinal development. Comparative experience suggests that such

integration is essential for translating technological experimentation into sustained capability.[64]

Managing Risk and Incentives in Emerging Technology Adoption

A third implication relates to risk management and institutional incentives. Emerging technologies inherently involve uncertainty, rapid iteration and potential failure. However, as mentioned earlier, India's defence governance structures remain oriented towards minimising procedural risk rather than managing technological uncertainty.[65] This dynamic discourages experimentation and reinforces conservative procurement behaviour.

For defence reforms, this implies a need to recalibrate incentive structures within procurement and user organisations. Creating institutional space for controlled experimentation, iterative testing and learning without disproportionate audit penalties would enhance absorptive capacity and improve technology integration. Without such changes, military modernisation efforts risk privileging mature platforms over adaptable capabilities, even where the latter may be strategically more relevant.

Implications for Jointness and Operational Integration

The integration of emerging technologies has significant implications for organisational reform, particularly jointness. Technologies that operate across domains, such as networked ISR systems, cyber capabilities and AI-enabled command-and-control tools, require joint planning and interoperable doctrines.[66] The incremental pace of theatre command reforms, therefore, constrains the operational impact of these technologies.

From a modernisation perspective, this suggests that organisational reform is not merely a parallel objective but a prerequisite for effective technology integration. Without institutionalised joint structures, emerging technologies are absorbed unevenly and remain tethered to service-specific priorities. The implication is clear: progress in military modernisation will be limited unless organisational consolidation advances in tandem with technological adoption.[67]

Rethinking Indigenisation and Strategic Autonomy

Indigenisation policies carry important implications for defence reforms and strategic autonomy. Various initiatives, such as positive indigenisation lists and the SRIJAN portal, reflect a deliberate effort to strengthen domestic production and reduce dependence on external sources.[68] However, the analysis suggests that indigenisation outcomes depend less on policy mandates

and more on ecosystem capacity, including R&D quality, industry readiness and user engagement.

For military modernisation, this implies that indigenisation should be treated as a capability-building process rather than a numerical target. Excessive emphasis on localisation, without parallel investment in innovation capacity and systems integration, risks slowing capability development. Indigenisation must, therefore, extend beyond the localisation of final platforms or components to strengthening the underlying capabilities required for technology maturation. This includes reliable access to critical technological inputs; patient capital for deep-tech engineering and scale-up; and specialised testing, calibration and qualification infrastructure. Therefore, balancing openness to global technology ecosystems with strategic autonomy remains a central challenge for defence reforms in emerging technology domains.[69]

Strategic autonomy should not be equated with complete technological self-sufficiency. Contemporary defence systems rely upon highly complex global supply chains, specialised components and international technology partnerships. Even major military powers continue to depend upon external technological inputs in selected sectors. Consequently, the objective of indigenisation should be the development of critical domestic capabilities and the reduction of strategic vulnerabilities rather than complete technological isolation.

Strengthening Civil–Military Fusion

Civil–military fusion will be increasingly important for sustaining defence reforms in an era of rapid technological change. India can strengthen such integration through: expanded university–defence partnerships; collaborative research centres linking the DRDO laboratories with civilian institutions; greater access for start-ups and MSMEs to defence testing facilities; dual-use technology funding mechanisms; and structured interaction between industry, academia and the armed forces during capability development. Such measures would improve technology transfer, accelerate innovation cycles and enhance the absorptive capacity of the broader defence innovation ecosystem.

Implications for the Research Questions

This analysis enables a direct response to the three research questions guiding the study. First, the examination of India's defence R&D architecture

and reform instruments demonstrates that emerging technologies have been integrated primarily through procurement frameworks (DAP 2020 and the 'Make' categories); innovation platforms, such as the iDEX; indigenisation mechanisms, like SRIJAN; and evolving organisational arrangements, including theatre command reforms. Second, the case studies and implementation-gap discussion show that this integration is constrained by persistent organisational and policy-level factors, including fragmented civil–military coordination, service-specific silos, risk-averse procurement routines and uneven absorptive capacity across institutions. Third, the observed institutional slippage reveals that the prospects for technology-enabled military modernisation remain conditional: emerging technologies function less as autonomous drivers of transformation and more as institutional stress tests, such that future modernisation will depend on the depth of institutional alignment rather than the mere availability of new technologies.

Conclusion

This article analyses India's defence reforms through emerging military technologies, arguing that AI, unmanned systems, cyber capabilities, quantum technologies and related emerging domains, such as advanced materials, biotechnology and space systems, act as stress tests for institutions rather than autonomous drivers of change. It finds that reform outcomes depend primarily on institutional capacity, organisational alignment and governance, while also being shaped by the capabilities and constraints of the domestic technology ecosystem. While certain initiatives, such as the DAP, the iDEX, SRIJAN and jointness reforms, signal strategic intent, persistent gaps remain between policy and implementation due to fragmented coordination, procedural risk aversion, uneven institutional and industrial absorptive capacity, upstream technology dependencies, technology maturation constraints and weak integration from innovation to operational deployment.[70]

Conceptually, the article contributes to defence studies by reframing technology-led reform as an institutionally mediated process. Rather than assuming a linear relationship between technological adoption and military effectiveness, it highlights how emerging technologies amplify existing organisational strengths and weaknesses. This perspective aligns with broader scholarship on military innovation that emphasises the centrality of institutions, incentives and learning processes in shaping reform outcomes.[71]

Applied to the Indian context, this framework helps explain why incremental progress has coexisted with enduring structural constraints.

From a policy perspective, the findings suggest that the future trajectory of India's military modernisation will depend less on accelerating the acquisition of technology and more on deepening institutional alignment. Procurement reform, innovation initiatives and indigenisation policies will yield limited returns unless they are integrated with organisational reform, particularly in relation to jointness, civil–military coordination and industry engagement. Therefore, emerging technologies increase the urgency of such reforms by raising the costs of fragmentation and delay.[72]

More broadly, this study underscores the importance of viewing defence reforms as a continuous and adaptive process, rather than a finite agenda tied to specific technologies or policy announcements. As emerging technologies continue to evolve rapidly, defence institutions will face sustained pressure to learn, adapt and coordinate across traditional boundaries. The Indian case illustrates both the possibilities and the limits of reform under such conditions.

In conclusion, emerging military technologies do not resolve the challenges of defence reform; they expose them. India's experience suggests that technology-enabled military modernisation is ultimately a question of institutional reform. Recognising this distinction is essential not only for assessing India's defence trajectory but also for understanding how states, more broadly, navigate military reform in an era of accelerating technological change.

Notes

1. '*Emerging Military Technologies: Background and Issues for Congress',* CRS Report No. R46458, Congressional Research Service, Washington, DC, 2024, available at https://www.congress.gov/crs-product/R46458, accessed on 1 February 2026.
2. V. Kotha, K. Vaddadi, P. Midhun, N. Bommena and M. Sachdeva, 'India's Defence Modernization and the Pursuit of Technological Autarky: Policy Reforms, Persistent Gaps, and Strategic Pathways', *International Journal of Advanced Research and Interdisciplinary Scientific Endeavours, Vol.* 3, No. 3, 2025, pp. 916–935, available at. https://doi.org/10.61359/11.2206-2547, accessed on 1 February 2026.
3. *Defence Acquisition Procedure 2020*, Ministry of Defence (MoD), Government of India, New Delhi, 2020, available at https://www.mod.gov.in/dod/en/news/defence-acquisition-procedure-dap-2020, accessed on 1 February 2026.

4. 'Scheme for Innovations for Defence Excellence (iDEX)', Defence Innovation Organisation, Department of Defence Production, Ministry of Defence, Government of India, May 2021, available at https://www.ddpmod.gov.in/offerings/schemes-and-services/idex, accessed on 3 February 2026.
5. 'Ministry of Defence Declares 2025 as "Year of Reforms"', Press Information Bureau, Ministry of Defence, Government of India, 1 January 2025, available at https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2089184, accessed on 5 February 2026.
6. Kartik Bommakanti (ed.), '*Indian Military Platform Modernisation: Uncertainties, Challenges, and Progress'*, ORF Special Report No. 162, Observer Research Foundation, New Delhi, 29 September 2021, available at https://www.orfonline.org/research/indian-military-platform-modernisation-uncertainties-challenges-and-progress, accessed on 7 February 2026.
7. 'Ministry of Defence Declares 2025 as "Year of Reforms"', n. 5.
8. Williamson Murray and Allan R. Millett (eds), *Military Innovation in the Interwar Period*, Cambridge University Press, Cambridge, 1996, available at https://www.cambridge.org/core/books/military-innovation-in-the-interwar-period/4696BA76BB4B57169F739975EA4BA6C1, accessed on 10 February 2026.
9. Theo Farrell and Terry Terriff, *The Sources of Military Change: Culture, Politics, Technology*, Lynne Rienner Publishers, Boulder, CO, 2002, available at https://www.rienner.com/title/The_Sources_of_Military_Change_Culture_Politics_Technology, accessed on 12 February 2026.
10. Adam Grissom, 'The Future of Military Innovation Studies', *Journal of Strategic Studies*, Vol. 29, No. 5, 2006, pp. 905–934, available at https://www.tandfonline.com/doi/abs/10.1080/01402390600901067, accessed on 12 February 2026.
11. Stephen Peter Rosen, *Winning the Next War: Innovation and the Modern Military*, Cornell University Press, Ithaca, NY, 1991, available at https://www.cornellpress.cornell.edu/book/9780801481963/winning-the-next-war, accessed on 15 February 2026.
12. Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars*, Cornell University Press, Ithaca, NY, 1984, available at https://www.cornellpress.cornell.edu/book/9780801416330/the-sources-of-military-doctrine, accessed on 15 February 2026.
13. James Johnson, *Artificial Intelligence and the Future of Warfare: The USA, China, and Strategic Stability*, Manchester University Press, Manchester, 2021, available at http://www.jstor.org/stable/jj.21996280; Michael C. Horowitz, 'When Speed Kills: Lethal Autonomous Weapon Systems, Deterrence and Stability', in Todd S. Sechser, Neil Narang and Caitlin Talmadge (eds), *Emerging Technologies and International Stability*, Routledge, London, 2021, pp. 144–168, available at https://doi.org/10.4324/9781003179917-6, accessed on 19 February 2026.

14. Michael C. Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics*, Princeton University Press, Princeton, NJ, 2010, available at https://press.princeton.edu/books/paperback/9780691143965/the-diffusion-of-military-power, accessed on 19 February 2026.
15. Anit Mukherjee, 'Fighting Separately: Jointness and Civil–Military Relations in India', *Journal of Strategic Studies*, Vol. 40, Nos 1–2, 2017, pp. 6–34, available at https://doi.org/10.1080/01402390.2016.1196357, accessed on 21 February 2026.
16. Wesley M. Cohen and Daniel A. Levinthal, 'Absorptive Capacity: A New Perspective on Learning and Innovation', *Administrative Science Quarterly*, Vol. 35, No. 1, 1990, pp. 128–152, available at https://www.jstor.org/stable/2393553, accessed on 21 February 2026.
17. T.M. Cheung, 'A Conceptual Framework of Defence Innovation', *Journal of Strategic Studies*, 22 June 2021, pp. 775–801, available at https://www.tandfonline.com/doi/full/10.1080/01402390.2021.1939689, accessed on 24 February 2026.
18. Kanti P. Bajpai and Harsh V. Pant, *India's National Security: A Reader*, Oxford University Press, New Delhi, 2013, available at https://global.oup.com/academic/product/indias-national-security-9780198081753, accessed on 27 February 2026.
19. 'About DRDO', Defence Research and Development Organisation (DRDO), Government of India, available at https://drdo.gov.in/drdo/en, accessed on 27 February 2026.
20. Ajai Shukla, 'DRDO: More Failures than Successes', *Business Standard*, 9 May 2006, available at https://www.business-standard.com/article/opinion/ajai-shukla-drdo-more-failures-than-successes-106050901103_1.html, accessed on 2 March 2026.
21. *Defence Acquisition Procedure 2020*, n. 3.
22. Mark Cozad, Maria McCollester, Jonathan Welch and Matthew Fay, 'Rethinking Jointness? The Strategic Value of Jointness in Major Power Competition and Conflict', Report No. RR-A1560-1, RAND Corporation, Santa Monica, CA, 2023, available at https://www.rand.org/pubs/research_reports/RRA1560-1.html, accessed on 2 March 2026.
23. Richard A. Bitzinger, 'India's Defence Industrial Base: Decay and Reform', in Sumit Ganguly, Nicolas Blarel and Manjeet S. Pardesi (eds), *The Oxford Handbook of India's National Security*, Oxford University Press, New Delhi, 2018, pp. 132–148, available at https://global.oup.com/academic/product/the-oxford-handbook-of-indias-national-security-9780199480135, accessed on 5 March 2026.
24. 'SRIJAN: Indigenisation Portal', Ministry of Defence, Government of India, available at https://srijandefence.gov.in/About, accessed on 5 March 2026.
25. '*Future of India's Semiconductor Industry',* NITI Frontier Tech Hub, NITI Aayog, New Delhi, May 2026, p. 12, available at https://www.niti.gov.in/sites/default/files/2026-05/Future-of-India-Semiconductor-Industry.pdf, accessed on 9 March 2026.

26. '*National Deep Tech Startup Policy Framework (NDTSP)*', Office of the Principal Scientific Adviser to the Government of India, 2023, available at https://www.psa.gov.in/deep-tech-policy, accessed on 9 March 2026.
27. 'Defence Testing Infrastructure Scheme', Press Information Bureau, Ministry of Defence, Government of India, 16 August 2021, available at https://www.pib.gov.in/PressReleasePage.aspx?PRID=1746365, accessed on 15 March 2026.
28. 'Scheme for Innovations for Defence Excellence (iDEX)', n. 4.
29. Ibid.
30. 'Ministry of Defence Declares 2025 as "Year of Reforms"', n. 5.
31. *Defence Acquisition Procedure 2020*, n. 3.
32. *Draft Defence Acquisition Procedure 2026*, Ch. III (Procedure for Procurement Under 'Make' Category), Ministry of Defence, Government of India, available at https://mod.gov.in/sites/default/files/DRAFT-DAP-2026_0.pdf, accessed on 19 March 2026.
33. Angad Singh, 'Indian Defence Procurement: Righting the Ship', ORF Issue Brief No. 443, Observer Research Foundation, New Delhi, February 2021, available at https://www.orfonline.org/research/indian-defence-procurement-righting-the-ship accessed on 9 February 2026.
34. 'Innovations for Defence Excellence (iDEX): About the Programme', Ministry of Defence, Government of India, available at https://www.idex.gov.in/about-idex, accessed on 15 March 2026.
35. Oishani Mitra, 'A Swarm of Indian Defence Tech Startups Emerges in Push for Self-reliance', *Global Corporate Venturing*, 3 April 2025, available at https://globalventuring.com/corporate/asia/indias-defence-tech-ecosystem/, accessed on 9 February 2026.
36. 'Scheme for Innovations for Defence Excellence (iDEX)', n. 4.
37. 'SRIJAN: Indigenisation Portal', n. 24.
38. Laxman Kumar Behera, 'India's Defence Industry: Achievements and Challenges', ORF Issue Brief No. 708, Observer Research Foundation, New Delhi, May 2024, available at https://www.orfonline.org/public/uploads/posts/pdf/20240506122616.pdf, accessed on 9 February 2026.
39. 'Ministry of Defence Declares 2025 as "Year of Reforms"', n. 5.
40. Mark Cozad, Maria McCollester, Jonathan Welch and Matthew Fay, 'Rethinking Jointness?', n. 22.
41. 'Scheme for Innovations for Defence Excellence (iDEX)', n. 4.
42. R.P. Rajagopalan and R. Krishna, 'Drones: Guidelines, Regulations, and Policy Gaps in India', ORF Occasional Paper, 5 March 2018, available at https://www.orfonline.org/research/drones-guidelines-regulations-and-policy-gaps-in-india, accessed on 9 February 2026.
43. *Joint Doctrine of the Indian Armed Forces 2017*, Headquarters Integrated Defence Staff, New Delhi, April 2017, available at https://cms.spacesecurityportal.org/

uploads/1718bbb2_cb9c_4ef5_9843_cb670e58afb7_324809bdc3.pdf, accessed on 9 February 2026.
44. Pulkit Mohan, 'Ensuring Cyber Security in India's Nuclear Systems', ORF Issue Brief No. 412, Observer Research Foundation, October 2020, available at https://www.orfonline.org/public/uploads/posts/pdf/20230511115624.pdf, accessed on 9 February 2026.
45. 'DRDO Policy for Transfer of Technology 2025', DRDO, Government of India, 13 January 2026, available at https://drdo.gov.in/drdo/en/documents/acts-and-policies/drdo-policy-transfer-technology-2025, accessed on 9 February 2026.
46. Amit Cowshish, 'Challenges in Reforms of the Defence Research and Development Organisation (DRDO)', Vivekananda International Foundation, 5 October 2023 available at https://www.vifindia.org/article/2023/october/05/challenges-in-reforms-of-drdo, accessed on 9 February 2026.
47. 'SRIJAN: Indigenisation Portal', n. 24.
48. 'Scheme for Innovations for Defence Excellence (iDEX)', n. 4.
49. *Performance Audit Report on Capital Acquisition in the Indian Air Force*, Report No. 3 of 2019, Comptroller and Auditor General of India, Union Government (Defence Services), 13 February 2019, available at https://prsindia.org/policy/report-summaries/capital-acquisition-indian-air-force, accessed on 9 February 2026.
50. Angad Singh, 'Indian Defence Procurement', n. 33.
51. Richard A. Bitzinger, 'India's Defence Industrial Base', n. 23.
52. Anit Mukherjee, 'Fighting Separately', n. 15.
53. Theo Farrell and Terry Terriff, *The Sources of Military Change*, n. 9.
54. Elsa B. Kania, 'Artificial Intelligence in China's Revolution in Military Affairs', *Journal of Strategic Studies*, Vol. 44, No. 4, 2021, pp. 515–542, (DOI:10.1080/01402390.2021.1894136); and Kenneth Payne, 'Artificial Intelligence: A Revolution in Strategic Affairs?', *Survival*, Vol. 60, No. 5, 2018, pp. 7–32 (DOI:10.1080/00396338.2018.1518374).
55. Adam Grissom, 'Future of Military Innovation Studies', n. 10.
56. Williamson Murray and Allan R. Millett (eds), *Military Innovation in the Interwar Period*, n. 8.
57. Paul Pierson, 'Increasing Returns, Path Dependence, and the Study of Politics', *American Political Science Review*, Vol. 94, No. 2, 2000, pp. 251–267, available at https://www.jstor.org/stable/2586011, accessed on 15 March 2026.
58. Anit Mukherjee, 'Fighting Separately', n. 15.
59. Angad Singh, 'Indian Defence Procurement', n. 33.
60. Barry R. Posen, *The Sources of Military Doctrine*, n. 12.
61. 'Scheme for Innovations for Defence Excellence (iDEX)', n. 4.
62. Adam Grissom, 'Future of Military Innovation Studies', n. 10.
63. *Defence Acquisition Procedure 2020*, n. 3.
64. Michael C. Horowitz, *The Diffusion of Military Power*, n. 14.

65. *Performance Audit Report on Capital Acquisition in the Indian Air Force*, n. 49.
66. *Joint Doctrine of the Indian Armed Forces 2017*, n. 43.
67. Anit Mukherjee, 'Fighting Separately', n. 15.
68. 'SRIJAN: Indigenisation Portal', n. 24.
69. Laxman Kumar Behera, 'India's Defence Industry', n. 38.
70. 'Scheme for Innovations for Defence Excellence (iDEX)', n. 4.
71. Adam Grissom, 'Future of Military Innovation Studies', n. 10.
72. Michael C. Horowitz, *The Diffusion of Military Power*, n. 14.