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Correspondence
All correspondence should be addressed to

The Editor
Dur Drishti
College of Defence Management
Sainikpuri PO, Secunderabad - 500 094, Telangana, India

Ph: +91 40 27113400
Email: editordmjcdm@gmail.com
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College of Defence Management

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College of Defence Management is a premier tri-service institution imparting management training to officers of Defence Services. The College of Defence Management is entrusted with the responsibility of instilling contemporary management thoughts, concepts and practices in the senior leadership of the three Services. Its Vision and Mission statements lead to identification of clear and unambiguous objectives.

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To be the Nation's leading Centre of Excellence in developing management thought to optimize the effectiveness of the Armed Forces for meeting the challenges to national security.

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From the Commandant's Desk

Maj Gen G Srinivas, VSM
Commandant
College of Defence Management
Secunderabad - 500 094

Dear Readers,

It is a matter of pride to release the March 2026 edition of Dur Drishti, a journal that continues to serve as a harbinger of change and a bridge to our stakeholders across the Indian Armed Forces. As this College continues to strive to be a true Centre of Excellence, our academic focus has sharpened on the intersection of National Security, Strategic Management, and the complexities of the administration and management of the modern battlefield. The articles in this issue reflect our quest to equip military leaders to consider opportunities while addressing challenges and skills necessary to evolve and be ready.

In our initiatives to continuously evolve, we have added two new sections in DMJ: a 'Re-Publication Section' and 'Practitioner's Case Study'. I am particularly pleased to see the inclusion of a review of General Anil Chauhan's 'Ready, Relevant and Resurgent II'. This work provides the foundational roadmap for a "Future Ready Force," a theme that resonates through every research paper in this issue. As we continue our journey of excellence, I encourage our alumni and the environment to actively contribute by sharing insights that challenge the status quo and promote innovation through our flagship publication.

'Jai Hind'

(G Srinivas)
Major General
Commandant

From the Editorial Team

Dear Readers,

The March 2026 issue of Dur Drishti presents an eclectic collection of research that spans the spectrum of Defence Management, from historical doctrinal analysis to the cutting edge of technological absorption.

The article by Brig DK Singh, VSM, sets the stage by exploring the pivotal role of "Strategic Leaders in Change Management," providing a panacea for the Indian Military's ongoing reforms. The technological dimension is robustly represented in this edition, as it has been in recent editions. Air Cmde Mukhvinder Pal Singh Virk reimagines Indian Air Power through the lens of AI-driven strategic autonomy. This is complemented by Col Gagan Singh's application of "Design Thinking" to accelerate technology absorption, ensuring that conceptual innovation translates into tangible battlefield capability.

We also delve into the structural intricacies of procurement and evaluation. Gp Capt Janarthan provides a "Systems Analysis" approach to technology evaluation, while Gp Capt RR Mohindru analyses the critical interplay between procurement and acquisition. To stimulate doctrinal debate and as an initiative towards greater inclusivity, we have added a Republication Section, which includes the article by Gp Capt Swaim Prakash Singh offering a perspective on the "Control of Air Littoral by Land Forces", that was originally published in CAW Journal.

A Practitioner's Case Study is included, which presents a management use case. The feature, 'Leveraging Operations Research for High Altitude Logistics Resilience,' provides a sophisticated look at how the Simplex LP model was utilised to navigate a critical stocking crisis. It is a vital read to understand how 'Resource Velocity' and mathematical rigour can underpin the 'enormity of effort' required in our high-altitude sectors.

Gp Capt Sukhminder Singh reviews Gen Anil Chauhan's latest work on future readiness, while Colonel NVSS Kumar explores the strategic culture of Pakistan's deep state in Harsh V. Singh's The Shadow Nation.

The quality of this journal remains a factor of the tireless academic and intellectual rigours of our contributors and the unprejudiced efforts of our peer reviewers. We encourage readers to consider the levers of opportunities in our journey of 'Victory Through Excellence'.

We look forward to your critiques and suggestions as we maintain Dur Drishti as the premier journal of Defence Management. Happy Reading!

'Jai Hind'

Commodore YV Ramakrishna
Chief Editor

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RESEARCH ARTICLE

Strategic Leaders and Change Management: Panacea for Indian Military's Year of Reforms

Brigadier DK Singh, VSM

(DMJ/XXV/01/2026/01)

"It became clear to me that at the age of 58, I would have to learn new tricks that were not taught in the military manuals or on the battlefield. In this position, I am a political soldier and will have to put my training in rapping out orders and making snap decisions on the back burner, and have to learn the arts of persuasion and guile. I must become an expert in a whole new set of skills."

- General George C. Marshall

Abstract

Military organisations are characterised by a distinctive organisational culture shaped by the demands of warfighting, disciplined training regimes, and prolonged exposure to combat environments. While this culture is highly effective in producing tactically proficient leaders, its implications for the development of strategic military leadership remain under-examined. This paper investigates how specific facets of military organisational culture and the personality attributes of combat leaders influence their transition and effectiveness as strategic military leaders. It further goes on to examine the challenges of strategic military leaders as agents of change in the context of the Indian Military's Decade of Reforms and Transformation. It lays down the imperatives for strategic change and transformational leaders in the 21st century and prescribes a recipe of six factors that the Indian military leaders must embrace in the current context. The article concludes by proposing targeted institutional interventions, including career-stage educational reforms, structured transition mechanisms, enhanced civil–military engagement, and revised officer assessment systems, to facilitate the effective development of strategic military leaders.

This article was authored by the officer as part of his thesis topic 'The Challenges of Strategic Military Leadership Development: A Psycho-Social (Behavioural) Perspective', for his PhD in July 2025.

Keywords. Military Culture; Strategic Leadership; Behavioural Psychology; Personality Traits; Attributes; Competencies; Leadership Development; Training; PME.

Introduction

Leadership is an all-pervasive phenomenon in all walks of life, be it families, the military, society, politics, government, religion, etc. Great Leaders have come to be identified with the progress of their countries, organisations and societies. Leadership is the single most important factor in the growth, development, success and failure of organisations. In fact, Leadership is not merely a means; it's an end in itself. In an organisational context, leadership functions are critical to an organisation's success and effectiveness (Edgelow, 2011; Adoli & Kilika, 2020). However, strategic leaders have a larger responsibility to keep their organisation itself relevant and productive in the face of a constantly changing environment (Lee Dyer, 1884). The external environment of organisations is continuously evolving, with rapid technological changes, increased competition, globalisation and societal preferences. The military organisations have a more dynamic requirement to continuously evolve and adapt to the dynamic security environment and the societal changes (Mansaray, 2019). Many organisations fail because they are not able to change and evolve with change in the external environment. Organisational Change and Change Management are the domains of strategic leaders who are responsible for effecting changes in the internal environment of the organisation to ensure that the organisation remains relevant and effective in relation to the external factors. The strategic leaders in the military organisations are born and bred in a combat military environment at



the tactical levels and are expected to perform strategic roles, including organisational changes and change management.

Research Problem

The Military Leaders have to perform a multitude of roles during their professional career, varying from combat and operational roles in the early years to operational and strategic roles as middle-rung leaders and roles dealing with national security, National strategy and multi-agency strategic roles as strategic leaders towards the end of their professional careers. The apparent conflict between the societal/ civilisational values on one hand and the behavioural requirements of the Military/ Militarism on the other hand needs a study. The contradictions between the qualities that constitute a young military officer and a tactical military commander on one hand and the mental constitution required of a strategic leader on the other hand are equally glaring. It is yet not clear whether the very qualities/ personality traits which make an individual a good soldier, military officer and combat leader, are enablers or impediments to their growth as strategic/ visionary/ creative military leaders. There is a need to study the effect of such behavioural predispositions of military personalities on their growth and development as effective Strategic Military Leaders.

Research Questions

The research questions, answers to which are likely to indicate a solution to the defined Research Problem, are given below:-

- What are the peculiar (unique) behavioural characteristics/ predispositions of Military Leaders/ personalities acquired as part of their organisational culture?
- In what ways do the behavioural complexities (peculiarities) of Military Leaders/ personalities affect their growth and development as Strategic military leaders?

Aim

This paper attempts to bring out the challenges of military leaders in performing Strategic Roles and measures to overcome these challenges towards enabling strategic military leaders to become 'Agents of Change'.

Literature Review

The two terms 'Strategy' and 'Military' owe their origin to military organisations; however, a search of both the terms individually, together, and along with 'Change Management', throws up more research related to Corporate organisations than Military. There is adequate literature on 'Change Management' as applicable to Corporate organisations; however, little research exists on change management and strategic leadership in the military context. It would be interesting to draw some comparisons between Military and Corporate organisations. Military organisations are hierarchical, top-down, command-oriented, complex entities. The fundamental military leadership falls in the realm of combat leadership, wherein the decision paradigm is based on winning wars, saving lives, survival under extreme circumstances, and there is no room for error. In combat situations, the decision makers have to work more from fear of failure than hope of success to ensure minimum casualties. The corporate organisations are based on profit-making and growth orientation. They are driven by market forces; the fundamental leadership model falls in the realm of management, and the customer remains the ultimate. Some aspects of military organisational culture and military leadership personalities which merited special attention while studying the current topic are as follows:-

- Military organisations are complex entities fettered by rules, conventions, and rigid hierarchies.
- Hierarchical nature of decision making and information flow leading to compartmentalisation of work processes.
- Combat predominant and tactically oriented training curriculum and personality orientation of military leaders, which makes them risk-averse, need to protect lives in combat, acting from fear of failure rather than hope of success.
- Due to strict discipline, drills, procedures and Standing Operating Procedures (SOP) and the need for strict compliance, the innovative and creative thinking abilities get blunted over a period of time.
- Behavioural military traits are counterintuitive to strategic leadership and organisational

change due to conflicting leadership requirements at tactical and strategic levels.

- Rooted in traditionalism, culture and a conservative outlook, there is an aversion to change.
- Core values include loyalty, courage, honour, integrity, and commitment, formalised through a specific ethos or creed and serve as the standard of conduct, which are reinforced through indoctrination of the warrior ethos.
- Intense physical and psychological training leads to a new self-concept and identity that separates military personnel from the rest of the population.

Theoretical & Conceptual Framework. Based on the Problem Statement, the theoretical & conceptual framework for the Research is based on some well-established theories and concepts as given in Table 1.

Theory	Concept	Constructs
OCTAPACE Framework	Org Culture of Military Organisations	Military Org Culture has certain peculiar and specific Characteristics which shape the personalities of its members
Neo-PI-3 Personality and Trait Theory	Effect of Training, Grooming & Combat Experiences on Military Personalities	Military Training, grooming and combat experience shapes personality of its members
SLDI for strategic Leadership Development	Competencies & Attributes of Strategic Military Leaders	Strategic Military Leaders can be identified with certain specific Traits, Competencies, Attributes and Skill Sets

Table 1: Theoretical & Conceptual Framework

Methodology

Given the author's philosophical assumptions and the nature of research, like the lack of data, insufficient tangible parameters to gauge leadership performance in the military and the nature of confidentiality of data, the methodological choice was based on a combination of Qualitative and Quantitative, i.e., Mixed Methods Research. The research is based on a Convergent mixed methods study design, wherein it lends itself more towards Qualitative than Quantitative Method, with the former playing the dominant role and the latter the support role. Desktop Research, employing content analysis (of secondary data), was used to further reinforce the findings of the first two methods by establishing correlations using various existing psychological and behavioural theories and concepts from existing literature.

Quantitative Phase

Research Hypothesis. The Organisational Culture in the Military and the peculiar Behavioural Patterns, Mindsets, Traits and Skill Sets of Military Personalities have an adverse effect on the growth and development of Military Leaders as Strategic Leaders. The Hypothesis was tested in three parts:-

- **Sub Hypothesis1**. Organisational Culture in the military has certain unique/ peculiar characteristics.
- **Sub Hypothesis2**. Early Military Training and Combat experience of military officers have long-lasting psychological effects on the personality and behavioural patterns of military personalities.
- **Sub Hypothesis3**. The peculiar Behavioural Patterns, Mindsets, Traits, and Skill Sets of Military Personalities have an adverse correlation with the desired skills/ competencies/ attributes/ traits required of Strategic Military leaders.

Sampling Plan. Simple random sampling and stratified random sampling were used to draw samples from the population that comprised all the officers of the Tri services (60,000 approx) and intelligentsia, academia and those officials of the government who deal with the Ministry of Defence at appropriate levels, particularly at strategic and decision-making levels (1000 approx) for the data survey.

Data Collection. The quantitative research was carried out by collecting primary data through a Google Form, "Survey Questionnaire" in two stages, i.e., Pilot and Final Survey, using the attitudinal scale and quantitative data that were recorded using a 5-point Likert scale, ensuring

consistency in data measurement. The final questionnaire was formulated after the iterations in Pilot 1 & Pilot 2 surveys, and it received 417 responses.

Data Analysis. Descriptive and inferential statistical techniques of Correlation/ Regression Analysis, One Sample T- Test and ANOVA tests were applied using Jamovi & MS Excel. Scale Reliability and Validity were established through Cronbach's Alpha and appropriate techniques of Factor Analysis.

Qualitative Phase

Sampling Plan. The Sampling Plan was Purposive and Judgemental based on the expertise and experience in the field of strategic military leadership. The Sample primarily consisted of senior armed forces officers of the three services, senior civil servants who have exposure to military officers and certain members of the intelligentsia. 20 Senior Officers, Bureaucrats, Technocrats, Journalists with experience in dealing with strategic military leaders and military Organisations.

Data Collection. Semi-structured interviews of stakeholders were conducted as close to natural settings as possible. Changes to the initial Interview Guide emerged as further insights were gained during the interviews and some questions were modified and interviewees added. After about 18 or 19 interviews, it was realised that redundancies had set in and data was saturated as any additional interviews did not add new information.

Data Analysis. All interviews were audio-recorded and transcribed using digital means. Thematic analysis was conducted using Atlas TI to identify key themes.

Results

Qualitative Data Analysis. The coding process involved five stages of coding, including coding by software and manual coding. Initial codes shown by the software were organised, deleted and merged manually to arrive at a final set of 174 codes which were used for data analysis. These were further analysed in view of the research questions. In the final coding achieved, out of the 174 Codes, the Codes that specifically loaded onto the Research Questions are described in Table 2. These Codes were finally organised into 18 Sub-Themes and five Themes (refer to Table 3).

Research Questions/ Themes	No of Codes
Behavioural Complexities & Mindsets	25
Challenges in Growth and Development of Strategic Leadership	32
Effect of Training and Military Experiences	10
Impact of Organisational Culture	31
Military Personalities Traits and Attributes	28
Overcoming Challenges of Strategic Leadership Development	41

Table 2: Themes as per Research Questions

Code Groups	Sub Themes	Themes
174 Codes identified under 7 Groups • Organisational Culture in Military • Effect of Military Training and Grooming	• Conformity & Obedience • Tactical Orientation: Short Term Goals • Zero Error Syndrome: Survival Instincts • Authoritarianism: Hierarchical Command • Combat Oriented Decision Making • Resistance to Change: Status Quoism • Groupthink & Regimental Biases • Traditionalism & Cultural Biases	Characteristics of Org Culture in Military Organisations
• Effect of Military Experiences	• Conformity & Obedience • Critical Thinking & Innovation • Intellectual Growth • Tactical Orientation: Short Term Goals • Behavioural Rigidity: Indoctrination • Zero Error Syndrome: Survival Instincts • Combat Oriented Decision Making • Resistance to Change: Status Quoism • Disciplined & Ordered Mindset	Effect of Military Training, Grooming and Combat Experiences on Military Personalities

Code Groups	Sub Themes	Themes
• Attributes, Competencies & Mindsets of Military Personalities	• Conformity & Obedience • Critical Thinking & Innovation • Tactical Orientation: Short Term Goals • Behavioural Rigidity: Indoctrination • Zero Error Syndrome: Survival Instincts • Authoritarianism: Hierarchical Command • Careerism • Resistance to Change: Status Quoism • Disciplined & Ordered Mindset • Groupthink & Regimental Biases	Traits, Attributes & Mindsets of Military Personalities
• Strategic Leadership Attributes • Challenges to Growth and Development of Strategic Military Leadership	• Government & Bureaucracy Exposure • Critical Thinking & Innovation • Intellectual Growth • Behavioural Rigidity: Indoctrination • Transition & Adaptation • Zero Error Syndrome: Survival Instincts • Careerism • Resistance to Change: Status Quoism • Strategic Leadership Development Programme • Traditionalism & Cultural Biases • Technology Orientation	Challenges to the Growth & Development of Strategic Military Leadership
• Measures to improve Strategic Military Leadership Development	• Government & Bureaucracy Exposure • Critical Thinking & Innovation • Intellectual Growth • Transition & Adaptation • Resistance to Change: Status Quoism • Strategic Leadership Development Programme • Technology Orientation	Measures to ensure effective Growth & Development of Strategic Military Leadership

Table 3: Network & Interconnections- Codes, Sub Themes & Themes

Secondary Data Analysis. The selected literature was sifted to identify only the documents relevant to the current analysis. A total of six previous studies, 11 Research Papers and six books were studied and analysed. These were sorted for identification of specific theories and concepts related to the identified Themes and were further put through an in-depth study and Content Analysis. This analysis yielded new perspectives on leader development and attempted to weave the findings into a new theoretical framework. As part of Desktop Research, case studies on Military Leaders like Manekshaw, Cariappa and a few of the contemporary Generals from the Indian Army were also studied, who, despite their military upbringing and training, had the intellect and self-awareness to be able to rise above the typical military mindset and exhibited behavioural complexity, which is one of the pre-requisites for strategic leaders. These case studies were meant to enrich the overall findings with examples from the Indian Army.

Discussion

Strategic Leadership in a Military Perspective. Strategic leadership firmly connects strategy with organisational action and is responsible for the following:-

- Guides the actions of its members and inspires them to achieve defined objectives.
- Integrates a variety of efforts in the performance of activities.
- Helps solve major disputes and disagreements.
- Encourages members to perform to the best of their abilities.
- Assesses the organisation's performance in light of its objectives, an envisaged future and a set of principles that justify organisational relevance and outcomes (Darko Tipurić, 2022).

- Initiates required structural and organic changes and reforms as necessitated by changes in the external environment and implements these changes.

Strategic military leaders are primarily concerned with winning wars by optimally utilising national resources and ensuring that operational end states give strategic advantages and favourable bargaining chips. They are an important cog in the civil-military wheel who need to translate political directives to achievable military goals and capabilities and also need to be directly involved with national security policies, including inter-ministerial, international and multidisciplinary paradigms (Lt Col Jeff Stouffer and Dr Allister MacIntyre, 2015).

Strategic leadership realises the vision of an organisation by influencing the organisational culture, allocating resources, directing through policy and doctrine, and building consensus within a volatile, uncertain, complex, and ambiguous global environment, which is marked by opportunities and threats. In its limited sense, it is concerned with the art and science of using various elements of national power to achieve national objectives (NA, 1998). In Military parlance, the strategic leader acts as a bridge between national security guidance and military operations. The tactical commander helps to organise and manoeuvre forces to engage the enemy in combat, whereas the operational commander is concerned with the planning and conduct of operations/ campaigns within the overall ambit of and as part of the implementation of military strategy (NA, 1998). However, in the context of organisations in general and as a theoretical concept, the role of strategic leadership can be summarised as conceptualising a new world for the organisation, understanding complex inter-relationships between its various elements and members, communicating the vision and gathering the support for organisational change as Change agents (Serfontein & Hough, 2011; Norzailan et al., 2015).

Context: Strategic Leadership and Organisational Change

Organisations have to evolve and change their strategies based on the developments in the external environment. The organisational change is the precinct of strategic leaders. Over the last 2-3 decades, the rapid change in technology, growth of social media and multitude of communications have led to the fast-forwarding of generational gaps and accelerated societal and civilisational changes. It has been challenging for the strategic leaders to grasp the pace of this change, anticipate the new dimensions and keep pace. More so because, more often than not, strategic leaders are perched at the apex level of organisations comprising Chief Executive Officers (CEOs) in their 50s who are not attuned to sensing the current changes in the external environment. That is the reason we see startups being led by CEOs in their 20s and 30s because they are better wired to sense the change that is happening in the world and well poised to leverage those opportunities.

Military leaders are faced with similar challenges of generational mismatch. The strategic leaders are inbred officers who have reached the top of the hierarchical ladder in their 50s and are actively educated and trained in the 'value systems and competencies' that are seeded two or three generations in the past. The young officers who are wired for the recent technological advancements and societal changes see nothing in common with the senior hierarchy. This dissonance of culture and values between the strategic leaders who are supposed to be change agents and the new generation who are supposed to undertake and sustain change and reforms acts as an impediment to the entire initiative of transformation.

Challenges of Military Strategic Leaders as Agents of Change

Behavioural Phenomenon. It is now well established that Leadership is a set of skills and attitudes that are used in working with people, decision-making and performing collective tasks, rather than a trait possessed by “a select few”. Such leadership traits, skills and abilities can be learnt and honed over time. But it is equally important to understand the psychological underpinnings of leaders' functions and decision-making. The innate human traits and behavioural patterns are a complex set of characteristics that have an overbearing effect on how we respond to situations. The strategic leadership development from a behavioural perspective involves an interplay between three critical components using the Triangle of 'Skill Sets', 'Behavioural Patterns' and 'Innate Traits' (refer Figure 1). Skill Sets represent the specific competencies and knowledge leaders must acquire, while Behavioural Patterns describe the consistent

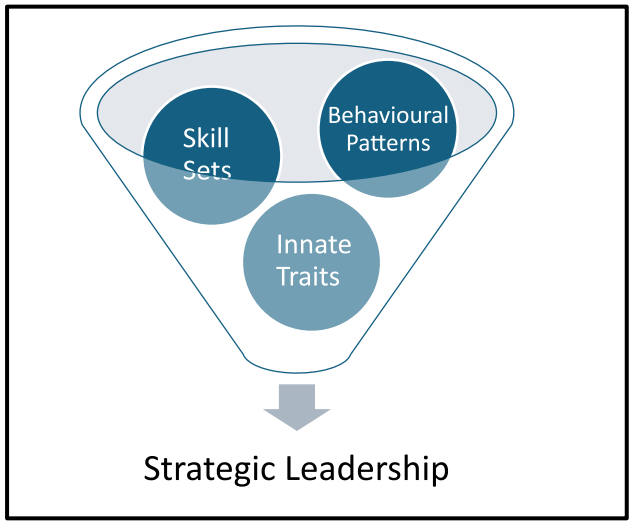

Figure 1: Behavioural Components of Strategic Leadership

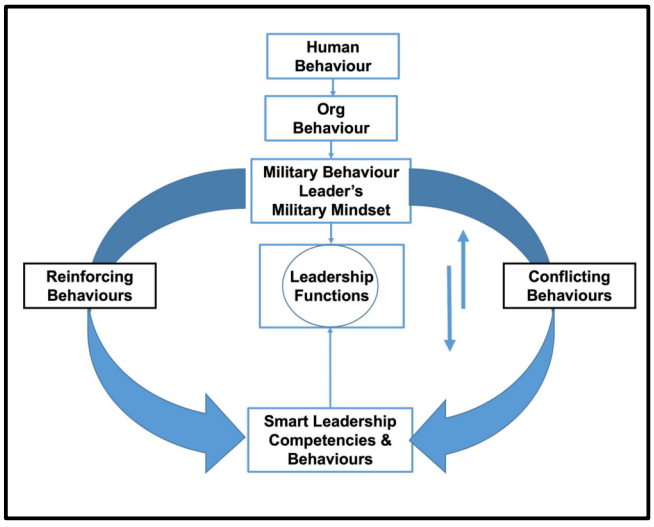

Figure 2: Relation Between Military Behavioural Traits & Leadership Development

actions and reactions leaders exhibit in various situations. Innate Traits refer to the underlying personality characteristics and natural tendencies that shape how leaders engage with their teams and environments. Together, these aspects create a comprehensive framework for effective leadership, emphasising that strategic leaders must blend learned skills, adapt behavioural approaches, and leverage their innate qualities to navigate complex organisational challenges successfully. The strategic leaders will do well to have multiple avenues of communication from various domains to understand the operational environment and use collaborative efforts of all levels of organisation. This would not only negate the psychological predispositions of senior leaders but also help achieve more enriched and holistic solutions. Leadership behaviour can be learned and internalised through experience, quest for knowledge and a series of adaptive learning processes over one's career span.

Military Paradox of Strategic Leadership. Wars and the Warrior culture were a prevalent cultural norm in the olden days when society was imbued with the requirements of producing and creating soldiers to fight their wars. The armies were populated by peasantry, commanded in the field by officers either selected from the same stock as the soldiers or from the royalty, and the Generals were of the breed of the royalty and noblemen. In the modern era, with the advent of technology and urban lifestyles, the profession of soldiering has been restricted to the few enrolled and recruited citizenry as part of the state machinery. The modern democratic armies recruit officers and men from the same socio-economic stock with different educational levels. The senior ranks and the Generals are further picked up and promoted from the same stock of young officers based on their performance, aptitudes, attitudes and skills exhibited over their career (Col Jessie O. Farrington, 2007).

In the peculiar context of the military, the traits and the skills required of a soldier, a young commander in the field, a middle-level officer or a general are neither mutually exhaustive nor completely distinct. The overlap and the conflicting requirements of skills/ behavioural traits/ personality traits/ competencies/ aptitudes/ attitudes at different levels of military hierarchy are conflicting and require a fair amount of learning, unlearning, relearning, and dedicated training at various leadership echelons (Stanley McChrystal, 2015) (refer Figure 2). The same officers, as they progress through the organisational hierarchy, are expected to think and act in manners far detached from their initial training and grooming. The application of behavioural sciences to early training, grooming and mental conditioning of young military leaders and their transition through the middle levels would give a deep insight into the impact of such training on their growth and development as Strategic/ Visionary Leaders.

Tactical Bias of Military Leadership Development. The development of strategic leaders is a larger issue of national security and policy-making with wider ramifications beyond the military. Since the military leaders are primarily concerned with administration and management of



warfare and combat operations, most of their training, education and assignment opportunities focus on building competencies related to fighting at tactical and operational levels. These competencies are paramount in the growth and development of a military leader. Therefore, when military leaders cross over to the strategic leadership roles in their career growth trajectory, the officer needs to shed part of their combat military competencies and relearn new ones at a later stage in their career. The transition of a senior military officer from being a tactical and operational commander to a strategic leader is a very critical phase in the officer's career. Appropriate training, education, and psychological conditioning by way of institutional development processes and cross-domain exposure are important to ensure that the military leaders become effective strategic leaders. There would be a need for them to shed some of their beliefs, skills, and competencies in favour of a more nuanced understanding of their roles as strategic leaders (Col Jessie O. Farrington, 2007). In a steep pyramidal career progression, while it may be challenging to identify early in their careers, the officers who are likely to rise to strategic roles, it will be fatal not to start training such officers for strategic roles much earlier in their careers (Lt Col James H. Schwitters, 1996).

The Psychology of Change Managers. The most challenging part of the Change is not Systems and Processes in an organisation, but individual character, personality and leadership behaviour. In fact, management of human nature is the wildcard of change management. Strategic leadership relies on the ability to work with others to initiate changes that will create a viable future for the organisation (R. D. Ireland and M. I. Hitt, 2005). A strategic leader wanting to effect organisational change needs to be adept at understanding the elements and character of their own organisation, external environment, competing and supporting organisations, as well as the psychology of the people of various generations in these organisations. It is a major psychological challenge to establish harmony between different generations of people, their psychological underpinnings and cultural biases. Strategic leaders must be able to anticipate critical success factors, develop a vision, build and align the organisation around this vision, and lastly mobilise the whole organisation to meet the strategic goals. Achieving the future strategic vision requires leadership behaviours that are flexible, innovative, collaborative, and continuously learning, which are not intrinsic to military training and behaviour.

Key Imperatives for Change Leaders

Change Leaders of the 21st Century. The warfare in the 21st century is characterised by the application of high-end technology, intense information operations, a merger of the tactical, operational and strategic levels of war and the need for the strategic leaders to interact with diverse populations and to embrace complexity. Such an environment calls for rapid changes in organisational cultures and structures, whereas military organisations are rooted in deep traditionalism and culture, which is slow to evolve (Paul Eduardo Vera Delzo, 2022). The officers leading the armies must manage the fluid operational environment and manage a multi-dimensional application of national power. A leader should be able to have a vision of the future of warfare and be able to effect the required organisational changes to be future-ready. The military culture and training curriculum do not prepare its leaders to succeed in a strategy arena where non-military elements of national power and information operations play a greater role than the application of forces and high-tech equipment. The leader development systems in the military must promote creative and strategic thinking much earlier along the career path of officers. The development of strategic military leaders capable of effecting organisational change in complex adaptive environments and steering national policy decisions, besides winning wars for the nation, requires a three-pronged approach (Maj James M. Hardaway, 2008):-

- The ability of the Military Training and Professional Military Education to impart critical thinking and intellectual abilities, which are required to succeed in strategic roles in the modern security environment.
- The ability of the Officer Annual Confidential Reports (ACRs) System to measure different attributes/ competencies at different levels of their career, for example, up to Colonels in command, the existing set of parameters may be adequate; however, after command, it may have different parameters to assess creative skills, intellectual abilities, multi-dimensional ability, etc.
- The ability of the officers' promotion system to

distinguish between and delink requirements for tactical levels and higher-level promotions.

Anatomy of Change in Military Organisations. The key question is how the leaders in military organisations balance the need for change and reform while still perpetuating the fundamental military values, principles and culture? The change in military organisations cannot be as rapid and revolutionary as the corporate world. The tenets of organisational change in the military can be captured by the acronym C4UTP as under:-

- Culture
- Courage
- Communication
- Civilisational Continuum
- U- the Leader
- Transforming while Preserving

Organisational Culture. The Indian Army is a typical hierarchical organisation with strict protocols and command structures. So how does it adapt to the dynamic changes in the operational environment? Is it top-driven? The answer is 'No', in fact, it is bottom-driven. It is the all-permeating organisational culture, the ethos and spirit of leadership that runs in the veins of its personnel, which imbues them to adapt to a changing operational environment. The tactical leaders are the sense agents of the operational requirements and respond in the most professional way as the situation demands. The strategic level takes cue from such actions at tactical level and initiates the change in strategic direction. This is a unique example of how organisational change can also be bottom-driven. During the US Army deployment in Afghanistan in 2004, the organisation's structures buckled under an entirely new set of circumstances presented to it (Stanley McChrystal, 2015). But the Indian Army never faced any such setbacks when operating in CI operations in J&K or the North East in an entirely hitherto unknown scenario. It is because of the resilient tactical commanders who have a way of achieving strategic outcomes (Lt Col James H. Schwitters, 1996). It's possible because of the deep-seated organisational culture, ethos and spirit in the organisation, which can be embedded and reinforced by leaders in the following ways:-

- What leaders pay attention to, measure, and control is noticed and carried forward.
- Leader responses to critical incidents and organisational crises help shape the culture for crisis management and dealing with challenges.
- Deliberate role modelling, teaching, and coaching by leaders shapes leadership development.
- Criteria for allocation of rewards and status directly affect the motivation orientation and help shape culture.
- Criteria for recruitment, selection, promotion, and excommunication to ensure the correct orientation of leaders at the helm.

Civilisational Continuum. Organisations fail because they fail to evolve and change with the times. Change is permanent. “Today's problems cannot be solved with yesterday's mindset”. And that is the paradox of strategic leaders of our times. The change agents, the strategic leaders at the apex, are in their 50s, two generations detached from the middle-level officers and four generations detached from the young officers. The lot of the younger generation is changing faster than strategic leaders are able to adapt and evolve. So is the case with technology, which is growing exponentially and disruptively outpacing the cognitive domain of senior military leaders. Therefore, military organisations have to find innovative ways to infuse our organisation's leadership with Vit G, the New Generation. The senior military leaders must hold wider consultations from within and outside, to get correct perspectives in order to effect organisational change. They must learn how to deal with the Volatile-Uncertain-Complex-Ambiguous (VUCA) world, which would need the new age skills and competencies. If not, the status quo would always appear the best course of action and the laurels and values of the past would always lull us into complacency.

Strategic Communication. There are two facets of strategic communication: within the organisation and outside the organisation. A leadership communication takes various forms like language, written communication, personality, behaviour, slogans, actions, psycho-social aspects, etc. Leaders have to innovate communication for a collective response from subordinates and for a desired response from external agents and stakeholders. Communication is the lifeblood of an organisation, and strategic leaders can ill afford to ignore it. The



millennials understand a different form of communication from Gen Z. You need perspectives to understand it, and you need to be involved with them to really know how to communicate with them. In this regard, Simon Sinek's Why-How-What paradigm of communication appears to be a panacea for developing thought leaders in the military. For today's generation, 'Whys' are important. It's more fulfilling to know the 'why' of 'what' one is supposed to be doing. The military planning, for example, starts with the Commander's intent first (Why), followed by the Concept, Procedures and Plans (How) and then Execution (what). However, it is rarely used in strategic communication by senior leaders.

Courage. Courage is not some innate quality an individual has. It is, at best, a capability to overcome fear in the simplest terms. It's a combination of accepting realities, accepting risks and making decisions from a hope of success (Brene Brown, 2018), and strategic leaders dealing with the uncertainties of organisational change management need it the most. Brene Brown's recipe for courage in her book 'Dare to Lead', which has described courage as a behaviour involving 'Rambling with Vulnerability, Living into your values, Braving Trust and Learning to Rise', needs to be adapted by leaders.

Courage is an essential change agent in a VUCA world. In fact, Combat leadership always operates in a VUCA kind of situation. It demands that leaders make immediate decisions in a fog of war. No plans survive the first contact. Ironically, the Army is 'ordered' and disciplined but expected to work efficiently in chaos. In fact, Chaos and Order both go hand in hand in a leader's scheme of things. The senior military leadership must embrace uncertainty and chaos to be able to effect change. Zero error Syndrome, which emanates from the need to have foolproof operational plans, rehearsals and avoiding casualties, which is a second nature of combat leaders, is an antithesis of organisational change.

Transforming while Preserving. The traditionalism and deep-seated value systems of the military and the generational gaps continuum lead to severe cognitive dissonance at various echelons of the organisation due to their different value systems and regimentation (Lt Col James H. Schwitters, 1996). Under such circumstances, the only panacea to organisational change is Transformational Leadership, which emphasises maintaining and preserving the cultural lineage of the organisation while effecting change. It is characterised by the authenticity and motivational capacity of the leader to inspire willing and enthusiastic followership to perform the tasks and jobs in the collective interest, focusing on shared goals, vision and values. It is catalysed by a distinct vision accompanied by the leader's personal values and strong character (RS Bangar, 2014). This is a process in which, as noted by Burns, 'leaders and followers help one another reach a higher degree of morale and motivation' (James MacGregor Burns, 1978). Leaders create an environment that brings followers together with higher levels of employee engagement, satisfaction, and organisational performance, as it fosters a sense of purpose, motivation, commitment and reinforces the individual's identification with the leader and the organisation (Peggy Combs, 2007).

The Military Change leaders must create a culture of risk-taking, learning, relearning, thinking independently and be creative in finding new and novel solutions beyond textbook learning. Key imperatives for military strategic leaders to be change agents can be summarised as follows: -

- The leader has to successfully motivate members of the collective and influence their growth and development.
- The work culture should reinforce ethical standards in overcoming dilemmas in Strategic Leadership.
- Clear delineation of values, priorities and standards to be achieved.
- Nurture a culture of collective goals and common interests.
- The leader must act as mentor and coach and delegate decision-making powers to lower echelons.
- Authenticity, cooperation, openness of communication and empathy where individual or team contribution is valued and appreciated.
- The military hierarchy must be able to integrate charisma, inspiration and intellectual stimulation with individualised consideration towards increasing enthusiasm and achieving satisfaction in effecting organisational change.

In Summary: The Penguin Story

The single most relevant and effective story for Change Management from a military perspective can be learnt from the story of two penguins who defer acting on an impending crisis till the time the inevitable change that has been foisted upon them. It is a story of 'denial, fear, resistance to change, penguin-led activism, and finally, acceptance and transformation'. 'Our Iceberg is Melting' is also a parable that can effectively be applied to organisational change and change management in military organisations. Eight Key Lessons from the Penguin Fable have been concluded by distilling these lessons for strategic leadership and change management (John Kotter, Holger Rathgeber, 2013):-

- Create a Sense of Urgency to bring the focus on the impending need for change.
- Establish a core guiding team to act as change agents.
- Develop a Change Vision through modelling and leadership analysis.
- Communicate the Vision to the organisation through strategic communication.
- Monitor change and empower those who agree to the authority to act towards the goal of Change.
- Acknowledge, review and reinforce Short-Term Wins.
- Maintain Momentum through persistent communication and motivation.
- Embed the New Culture through SOPs, Concepts, Doctrines and test bed exercises.

The penguin story is a powerful narrative which provides a framework to enable both individuals and organisations to 'identify icebergs, encourage creativity, avoid stagnation, control change in a structured and deliberate manner, reduce stress, anxiety and confusion about change, clearly understand risks and opportunities, work smarter, by restructuring who does what and how, increase productivity by reducing waste, stripping out inefficiency, and increasing quality. It can be well adapted as a panacea for bringing about an attitudinal shift in the Indian Military towards welcoming change beyond the rigid, long-held and deep-rooted outdated beliefs, processes and procedures, in its year of reforms.

Recommendations for Indian Military: Growth & Development of Strategic/ Change Leaders

The emerging dominant position of India in the global security architecture, particularly in the Indo-Pacific region, further necessitates the need for a paradigm shift in the manner in which India looks at its National and Military Security. Growth and development of its strategic military leaders and change agents will be one of the foremost requirements in this direction. Some of the recommendations in this regard are enumerated in the succeeding paragraphs.

Civil-Military Relations. The nature of the civil-military relations and the character of its Higher Defence Organisation need a more integrated and synergistic civil-military domain. It should promote dialogue, jointly formulate strategic security policies and devolve some latitude and expectations from the military leaders in decision-making in national Security and Military Security matters. Indian Military leadership cannot be expected to grow in strategic leadership skills and as catalysts of Change and transformation unless it is expected to perform those roles for real.

National Military Consciousness. The National Security and Military Security cannot be nurtured in the absence of academic discourse and consciousness on such subjects. Such an environment cannot be created by a few seasoned 'jack of all bureaucrats' and a few sponsored think tanks doing all the talking and leading the discourse on National Security matters. India needs to promote wider academic research in military and security matters. It needs to open a dedicated University like the National Defence University to lead such discourses and promote research and strategic culture. This ecosystem will help in the growth and development of strategic leaders who can drive Change and Transformation.

Leadership Doctrine. The Indian Military is yet to issue a doctrine outlining its leadership development philosophy. In today's scenario, Leadership, even by militaries, cannot be taken for granted. It must formulate a Leadership Doctrine with a clear articulation of the levels of leadership and how it plans its growth and development. The Doctrine should envision the growth and development of strategic military leaders who can

lead the national discourse on Reforms, Transformation and Change in security and military matters and form part of the decision-making bodies in the National Security architecture.

Professional Military Education (PME). The Indian Army comprises overtrained officers with a primary orientation towards operations. As the career progresses, the organisation should focus more on PME and rationalise the content of Training. The current curricula lay adequate emphasis on military training to meet the operational requirements of the armed forces. However, the PME domain needs to have a broad-based curriculum with clear content at various levels of the career path of military officers towards the achievement of clearly articulated strategic leadership development goals, which would flow from the Leadership doctrine.

Early Exposure to Non-Military Disciplines. Officers beyond the first ten years of service (Staff College onwards) should be exposed to more domains of PME/ Multi Domain Expertise through content like Data Analysis, Organisation Behaviour, Policy Formulation, Research Methodology, Psychology, AI, Economics, Political Science and Defence Industry, etc. After the command of Units (HC/ HDMC levels onwards), the PME curriculum should take a common format for all three services officers, with options for Elective and Domain expertise subjects.

HR Reforms. It clearly emerges that the career progression curve acts as an impediment towards the development of strategic leadership. The Indian Military has a monolithic, integrated cadre with non-differentiated aspiration, competence and growth perspective. It suited the 'Jack of All' kind of a requirement of leadership, which, in today's scenario, is bound to fail. There is an urgent need for cadre restructuring with differentiated entry, exit and aspirational levels. In this regard, the following steps will help in reducing stagnation in ranks and help in providing more avenues for growth and development of strategic leaders: -

- Reduce the number of ranks and delink ranks from appointments.
- Lateral entry to officer rank through recruitment at NCO/ JCO levels.
- All Non-UPSC entries to be short service in addition to the SSC entry.
- Reducing the levels of command by subsuming Brigade HQs into IBGs and aligning rank structures accordingly.
- Avenues for creating specialists by bifurcation of Command and Staff streams at Col levels after command of a Unit.

Lateral Exposure. The prospective three-star officers should be given exposure to other organs of the government, at the level of Colonels, to get a hands-on understanding of bureaucracy, other ministries, and other organs of the government. Likewise, the bureaucrats must be exposed to the military through field exposures and working in the DMA, DoD, DRDO, DDP and Service HQs at the level of Directors. This should be one of the prerequisites for posting to the MoD at the JS level and above. The civilians working in the MoD should be given exposure to courses in Military Security, National Security and Civil-Military Relations.

Psychological Orientation/ Conditioning. There is a definite need for senior military officers, aspiring for roles in the national strategic landscape, to shed part of the military dogmas and truisms they have been so intensely trained for and exposed to. The HC/ HDMC & NDC and such other courses are an ideal opportunity to make them aware of their psychological predispositions, which have served them well within the military and some of which need to be shed in favour of a new set of skills and competencies required to shape their growth here on as strategic leaders. They need to be exposed to Government Policy Making, Ministerial Functioning, Technology and Industry development and National Economy much earlier in their careers.

Officers' Performance Appraisal System. The performance appraisal serves as the most important input towards the career progression of an officer. It should be based on a two-level appraisal. Part one should deal with the officers' performance in the current assignment for which they are being assessed. The second part should be an evolutionary criterion which appraises an officer's personality profile, intellect, behavioural complexity and creative potential required for future growth as a strategic leader by identifying their dominant traits, expertise, mindsets and skill sets. The two may not necessarily be in sync with each other. The former objective criteria should act as a quantitative input for promotions to the next rank, the latter could act as a subjective cum objective input on an officer's

future potential to grow as a strategic leader. It may be used as an input for deciding the command or staff stream. The staff stream should be based on creating a pool of specialists, and the command stream should be based on identifying strategic leaders who can function effectively in command and in roles requiring an interface with the government and bureaucracy.

Conclusion

Inertia to change is ingrained in basic human nature, and therefore, there is a need for strategic leaders who can act as change agents for their organisations. The military organisations are more averse to change due to the very nature of their operational training and organisational culture. The strategic military leaders need to consciously educate themselves towards the need for organisational change. Having prepared themselves for Change, they need to create an environment for change by acting on the minds of the people in the organisation. It needs a synthesis and synchronisation of diverse value systems, mindsets and traditions, spread over multiple generations working together to effect an organisational change. The strategic military leaders must act as catalysts of change by absorbing diverse perspectives and yet being able to guide the organisation towards adapting to changes in the external environment, and embrace a future that they have yet to experience.

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About the Author

Brigadier DK Singh, VSM, was commissioned in the 3 Kumaon Rifles in the year 2000. The officer is an alumnus of the National Defence Academy, Khadakwasla, Defence Services Staff College, Wellington and the College of Defence Management, Secunderabad. He holds an MSc (Defence & Strategic Studies) from Madras University and a Master's in Management Studies from Osmania University. He is currently pursuing PhD from Rashtriya Raksha University.



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RESEARCH ARTICLE

Strategic Autonomy Through AI: Re-Imagining Indian Air Power

Air Commodore Mukhvinder Pal Singh Virk

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"AI is the new electricity." – Andrew Ng, Co-founder of Google Brain

Abstract

Artificial Intelligence (AI) is transforming military aviation worldwide, reshaping how air forces plan, fight and sustain air power. For India, the question is no longer whether AI should be integrated into the Indian Air Force (IAF), but how it can be adopted in a safe, assured and strategically meaningful manner. Strategic autonomy in the context of AI use in air power is India's ability to make sovereign decisions, operate independently and reduce technological dependence. It will increasingly hinge on mastering AI-enabled air power. AI will lead to autonomous operations in various facets of airpower usage and will even impact other sister services. However, the use of AI to enhance autonomy in combat operations in defence services will have to be progressed in a phased manner, as software developments and certification frameworks in this domain are still evolving.

The United States (US) has adopted a test-driven approach through initiatives such as Air Combat Evolution (ACE) and Skyborg programme, which involve AI models as combat aircraft through simulations. Europe's Future Combat Air System (FCAS) incorporates networked manned and unmanned platforms along with AI assistants. Meanwhile, China has concentrated on developing low-cost swarm drones to saturate defences, and they are incorporating AI for speedy coordination. All these programmes are adopting AI to ultimately reach to fully autonomous operation. India will have to adapt these lessons to its unique operational requirements.

This paper examines global trends in AI adoption, analyses lessons from leading air forces and identifies India-specific gaps in testing, certification and doctrine. Using interviews with subject-matter experts and thematic analysis, the study proposes a phased roadmap for the IAF covering data architecture, combat cloud development, manned–unmanned teaming between unmanned aerial systems (UAS) and fighter aircraft, certification mechanisms and talent creation. The findings show that strategic autonomy through AI requires structured testing, open architectures in software development (instead of licensed versions from foreign vendors) for mission computers, indigenous data pipelines and a strong ecosystem for safe and ethical adoption. The paper concludes with practical recommendations to help India progress from isolated AI applications to a fully networked, AI-enabled force.

Keywords: AI; MUM-T; digital twins; predictive maintenance; combat cloud.

Introduction

Air power has undergone a dramatic change. Early aircraft depended on manual controls and basic instrumentation. Today's systems can integrate many sensors, automate tactical tasks and even predict equipment failures. AI-enabled avionics, autonomous drones and simulation ecosystems have led to realistic Virtual and live training known as Live-Virtual-Constructive (LVC) training. Further, AI is accelerating decision cycles and increasing operational tempo in modern combat (Scharre, 2018; Allen, 2017).

In the Indian context, strategic autonomy refers to the nation's ability to make sovereign military and political decisions without being constrained by external technological dependencies or supply-chain vulnerabilities. AI contributes directly to this autonomy by enabling indigenous decision-support

systems and data-cloud networks for use in combat (combat cloud) that reduce reliance on foreign algorithms. By developing and certifying its own AI-enabled air-power ecosystem, the IAF can strengthen its operational independence rather than being reliant on imported technologies or opaque proprietary systems and software.

For the IAF, the challenge is twofold. First, global air powers are rapidly adopting AI-driven capabilities such as UAS working as unmanned companions alongside fighter aircraft as wingmen, algorithms to assist pilots as AI or electronic pilots, AI-enabled swarm drones and predictive maintenance systems with the incorporation of AI. Second, the geopolitical environment of India demands technological self-reliance, which ensures freedom of action and reduces dependence on foreign systems. (Sachdev, 2021)

This study focuses on bridging the gap between global advancements and India's requirements. It uses expert interviews and studies international programmes to propose an Indian roadmap for AI adoption that is phased, test-driven and conforms to ethics. (Prakash, 2022).

Research Problem

Global air forces are integrating AI in operations, but India's adoption is still at a nascent stage. The challenge is to determine how the IAF can integrate AI responsibly and systematically. Thus, strengthening operational effectiveness without compromising safety or creating technological dependencies.

Aim

To analyse international models of AI-enabled air powers and propose a phased integration plan suiting to India's operational context, safety requirements and objectives.

Research Questions

The following questions were identified, answers to which would provide a solution to the Research Problem: -

- Which global AI programmes provide relevant lessons for India?
- Which AI use cases yield the highest operational advantage for the IAF in the short and long term?
- What frameworks are required for testing, certification, ethics and governance?
- How does AI adoption contribute to India's broader pursuit of strategic autonomy?
- The Rich Picture: India's AI-Air Power Context

India's air-power environment is marked by:

- An increasingly contested neighbourhood
- Rapid Chinese and Western advances in autonomous aviation
- Ageing fleets that require improved sustainment
- A growing indigenous aviation ecosystem
- The need for faster decision-making across a multi-domain battlespace.

Thus "rich picture" in the Figure 1 underscores why the IAF must adopt AI: to protect sovereign decision-making, reduce foreign reliance, enhance survivability and maintain parity with technologically advanced adversaries. The concepts in the rich picture are elaborated in subsequent sections of the paper.

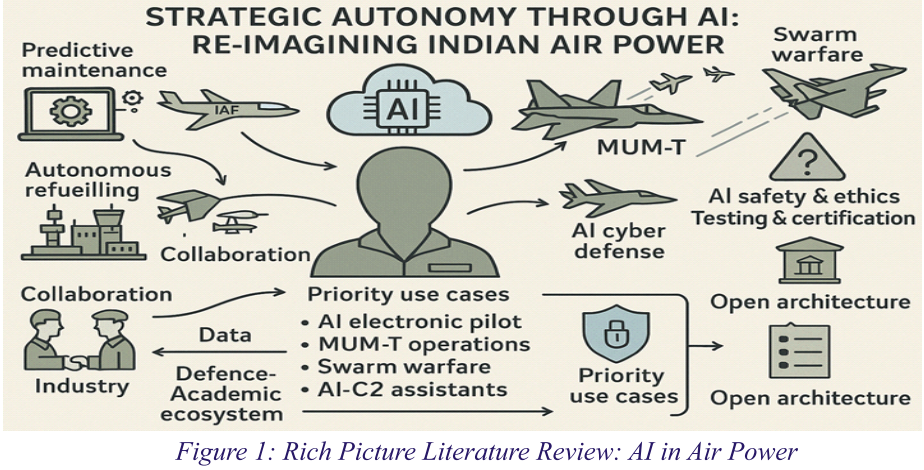

Figure 1: Rich Picture Literature Review: AI in Air Power

Review of Literature

Scope. The literature review highlights three major themes relevant to India: global trajectories, the AI–UAV revolution and emerging use cases. Each theme concludes with a "so-what" assessment for India.

The literature review looked at the available literature on the adoption of AI by major Air Powers and their relevance to India's unique requirements. These aspects were studied under three pivotal focus areas.

Focus Area 1: Global Trajectories and Lessons

United States. U.S. initiatives, including the Defense Advanced Research Projects Agency's (DARPA) Air Combat Evaluation (ACE) and the Air Force Research Laboratory's (AFRL) Skyborg program, reflect a step-by-step approach to autonomy, where new capabilities are tested and confirmed before scaling. Wingman prototypes have already flown alongside manned fighters, and Live–Virtual–Constructive (LVC) training incorporates AI-driven adversaries (DARPA, 2021; Air Force Research Laboratory, 2020). What India can do is adopt a similar test-driven approach, introducing AI gradually with clear safety gates and doctrinal validation. (Scharre, P, 2018).

Australia. Australia's Boeing Airpower Teaming System shows cost-effective wingmen designed for surveillance and electronic warfare. Australia's Airpower Teaming System (ATS) demonstrates low-cost, modular wingmen designed alongside industry partners (Kainikara, 2019). India can replicate this collaborative model by involving private industry and start-ups in projects such as HAL's CATS Warrior and DRDO's Ghatak to design affordable, unmanned aerial vehicles (UAVs) that reduce risk to pilots.

Europe. In Europe, the Future Combat Air System (FCAS) programme uses open architecture software and a shared combat cloud linking sensors and platforms (European Defence Agency, 2020). India must adopt interoperable standards so that Tejas, Su-30 MKI, AWACS, SAM systems and UAVs can exchange data seamlessly into a unified battlespace to maximise the potential of existing assets.

China. China has been using swarm drones, which are capable of both reconnaissance, surveillance and strike missions. This reflects its emphasis on using mass/low-cost systems rather than individual platforms (Kania, 2017). Its approach relies on achieving saturation and overwhelming enemy defences with numbers. For India, this highlights investing in affordable swarm drone technologies and counter-swarm drone capabilities to maintain operational readiness and deterrence.

India. The IAF's doctrine (IAP 2000–22) emphasises digitisation, information warfare and network-centric operations, but lacks explicit frameworks for autonomous systems (IAF 2022). While automation has not yet emerged as a separate doctrinal focus, it is part of the IAF's modernisation priorities. This includes integrated command and control systems, automation of logistics and decision-support tools to enhance operational efficiency (Yadav, 2024).

Focus Area 2: Unfolding the AI–UAV Revolution.

Globally, UAV programs highlight common trends including collaborative systems, modular architectures, and rigorous testing. Figure 2 reflects the comparative paths of AI integration in air power. The U.S. Skyborg and ACE programs, Europe's FCAS and China's swarming experiments confirm that rapid simulation, flight trials and open architectures are essential for trust in AI-enabled systems and scalability (Deptula, D, 2020; Voke, 2019). For India, these lessons point toward wingmen such as the DRDO's Ghatak, Hindustan Aeronautics Limited's (HAL) Combat Air Teaming System (CATS) Warrior and the Future Weapons & Defence Agency's (FWDA) Kaalbhairav; first integrated with Tejas, Su-30 and other IAF fleets (Raska, M, 2021; Prakash, B, 2022). Further, they should be followed with swarming drones for suppression of enemy air defences, AI-driven fusion of radar and sensor data, predictive maintenance with digital twins and adaptive LVC training against AI adversaries (Raska, M, 2021; Prakash, B, 2022).

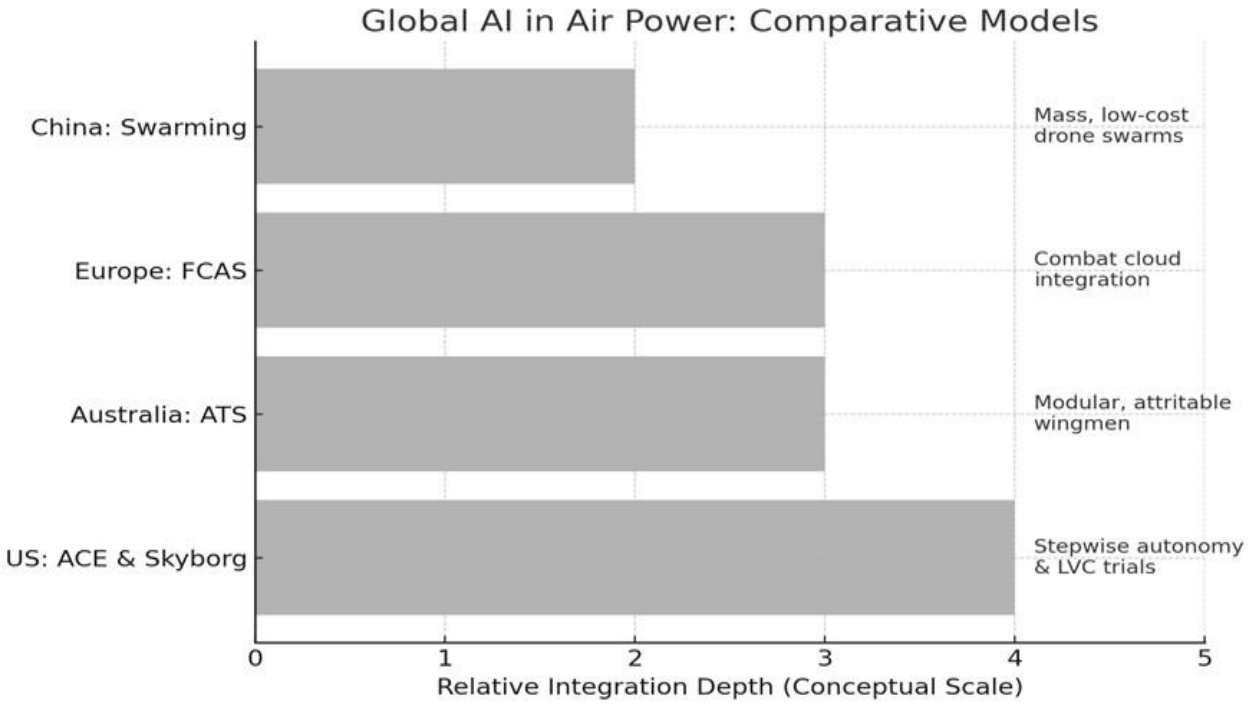

Figure 2: Comparative Paths of AI Integration in Air Power

("Adapted from multiple sources, including DARPA ACE, EDA FCAS, and the official IAF doctrine")

Focus Area 3: Emerging Additional Global Use Cases.

Major air powers are also moving towards many other AI integrations. A few important use cases are AI Mission Planning and Debrief with Adaptive flight route Optimisation (Lockheed Martin, 2024), Autonomous Refuelling and Boom/ drogue AI alignment (Gertler, 2020),
Cognitive Workload Management as Neuro-ergonomic assistants (Parasuraman, 2010),
AI-Logistics & tech Optimisation with Digital twin-based sustainment (Allen, 2017),
Cyber Defence Agents for Intrusion and spoofing detection (Cummings, 2021) and
AI-Wargaming with Adaptive simulation for doctrine evolution (Voke, 2019; USAF, 2023).

So, what are the lessons and use cases for India?
India needs a tailored AI doctrine, certification systems and a national testing infrastructure. In India, a Task Force for Implementation of AI was set up in 2019. The Defence Artificial Intelligence Council (DAIC) and Defence AI Project Agency (DAIPA) were set up as per its recommendations. DAIC is responsible for guiding and providing structural support, while the DAIPA has been established to facilitate AI-based processes across defence organisations. However, certification responsibility with respect to AI in the aviation domain is not exclusively mentioned as a task in the open domain.

Research Gap. The review of literature revealed a significant research gap in understanding the specific strategic needs and implementation modalities for the incorporation of AI capabilities in India. The literature reveals four key gaps for India:

- Lack of defence-specific AI test and evaluation ranges.
- No certification standards for adaptive AI models for air power usage. (FAA, 2024).
- Limited integration of AI ethics and autonomy levels in doctrine.
- Fragmented indigenous data pipelines are slowing indigenous model development.
- India requires a Defence AI Assurance Framework linking performance, safety and policy.



Methodology

Research Strategy. A qualitative comparative analysis was chosen due to the exploratory nature of defence technology integration and limited quantitative datasets. Primary Sources were interviews of experts from Aeronautical Development Agency, Aeronautical Development Establishment (ADA), Centre for AI and Robotics (CAIR), Hindustan Aeronautical Limited (HAL), Centre for Military Airworthiness and Certification (CEMILAC) and Aeronautical Society of India (AeSI). Secondary sources included Doctrinal papers, programme briefs (DARPA, DRDO, AFRL, EDA), and peer-reviewed literature

Sample Selection & Data Collection. Perception of the environment was captured through interviews/ interactions with the Subject Matter Expert (SMEs) selected through non-probabilistic, judgmental sampling, on the subject and their applicability in the Indian context.

Data Analysis. Thematic analysis enabled the identification of common themes embedded in the interview transcripts, which were deciphered from meaningful phrases gleaned from SME interview transcripts.

Approach. Cross-case comparison to identify patterns relevant to the IAF. To arrive at a Phased AI integration model aligned to IAF operational risk tiers.

Findings

Detailed review of various aspects leads to reaching to priority & additional use cases for IAF and also Gaps in AI certification in the domain of Air Power, especially in India. The same are brought out as subsequent findings. These findings directly lead to the phased AI integration roadmap presented in the following section.

Use Cases for IAF. Priority Use Cases for the Indian Air Force are given in following paragraphs.

- **Electronic Pilot**. Modern 5th- and 6th-generation fighters like the F-35, Su-57 and India's AMCA use AI-driven "electronic pilots" that fuse multi-sensor data to reduce pilot workload and enable semi-autonomous missions. For India, the lesson is that future air combat will rely as much on AI-enabled avionics and pilot–machine teaming as on stealth and agility; hence, the AMCA project must prioritise these capabilities to match 5th-generation benchmarks (Gady, 2023; Pubby, 2023; Lockheed Martin, n.d.; United Aircraft Corporation, n.d.)
- **Manned–Unmanned Teaming (MUMT)**. India can adapt a phased model for its Tejas Mk1A/2, AMCA and Su30MKI fighters to deploy AI-enabled wingmen for roles such as intelligence, surveillance and reconnaissance (ISR), electronic warfare and target designation. A phased model means starting with very basic, rule-based automation and then gradually increasing the level of autonomy only after each stage is tested and proven safe. These checkpoints, called "trust gates", ensure that pilots gain confidence in how the machine behaves before giving it more responsibility. (Deptula, D, 2020).
- **Swarm Enabled Unmanned Aircraft Systems (UAS)**. Small, expendable UAV swarms could conduct suppression of enemy air defences (SEAD), disrupt runways or deploy electronic jammers. Over time, air-launched effects (ALE) from fighters and helicopters could form a layered wall of sensors and electronic warfare payloads.
- **AI-Driven Sensing, Fusion and Prioritisation.** By combining active electronically scanned array (AESA) radar sweeps, electro-optical feeds and electronic support measures through AI, the IAF can generate near-real-time threat prioritisation, enabling faster and more exact engagement decisions (Raska, M, 2021).
- **Predictive Maintenance and Fleet Readiness.** By employing digital twins and predictive AI analytics, the IAF can predict system failures in advance, streamline spare parts management and sustain higher fleet readiness. Proactive maintenance reduces costs and improves readiness across fighter, transport and rotary platforms (Prakash, B, 2022).

- **Live–Virtual–Constructive (LVC) Training**. Future training ranges will mix live pilots, VR/AR systems and AI-driven adversaries that adapt in real time. This allows pilots to rehearse against evolving threats, sharpening decision-making cycles before real combat (United States Air Force, 2020).

Additional Use Cases for the Indian Air Force. Beyond teaming drones and predictive maintenance, several emerging AI applications are becoming relevant. However, adopting them will depend upon technological maturity, data availability, certification hurdles, cost & timeline pressures and readiness of the industry. These use cases offer operational value, but only if pursued selectively and phased appropriately. These use cases are not presented as a wish list, but as realistic possibilities in future.

- **AI-Driven Command and Control Assistants**. Smart dashboards that not only display sensor feeds but flag anomalies, recommend deconfliction paths, and dynamically reprioritise missions as the battlespace shifts (Voke, 2019; Raska, M, 2021).
- **Autonomous Aerial Refuelling Coordination**. AI agents that plan best tank-up points, watch boom alignment in real time and adjust for weather or counter-air threats; reducing pilot workload and extending sortie endurance (Deptula, D, 2020; Gertler, J, 2020).
- **Cyber & Physical Threat Detection**. Machine learning defences embedded in ground stations and aircraft links, spotting intrusion patterns, spoofing attempts or deepfakes before they corrupt mission data (Cummings, M, 2021; Parasuraman, R, 2010).
- **Logistics and Supply Chain Optimisation**. Predictive models that optimise spares inventories, forecast part degradation across dispersed bases and suggest leaner, just-in-time resupply routes under contested communications (Allen, G, 2017; Prakash, B, 2022).
- **Health and Fatigue Monitoring for Aircrew**. Wearable sensors paired with AI to track pilot vitals, recognise early signs of cognitive fatigue or spatial disorientation and recommend mission pacing or recovery periods (Parasuraman, R, 2010; Sachdev, A, 2021).
- **Cognitive Workload Balancing**. Adaptive interfaces that shift routine tasks, like target annotation or radio calls, to AI assistants when the pilot's stress spikes, then hand back control when the situation steadies (Allen, G, 2017; Scharre, P, 2018).
- **Autonomous Electronic Warfare Suites**. Onboard AI that detects, classifies and counteracts jamming or radar threats mid mission, tuning emitters and decoys in milliseconds (European Defence Agency, 2020; Kania, E, 2017).
- **AI Enhanced Wargaming and Doctrine Simulation**. Virtual exercises where AI adversaries evolve tactics continuously, helping planners stress-test new operational concepts before hardware ever flies (Voke, 2019).

Challenges in Adoption. Key challenges to adopt the above emerging AI technologies in air power in IAF include limited datasets, integration constraints with legacy platforms and the need for strict safety certification, especially for functions like autonomous refuelling or electronic warfare. A phased strategy is recommended.

- **Near-term**: AI C2 assistants, logistics optimisation, fatigue monitoring, low risk and immediate payoff.
- **Mid-term:** Cyber threat detection, cognitive workload aids, and aerial refuelling algorithms, requiring moderate testing.
- **Long-term**: Autonomous EW suites and AI wargaming, high complexity requiring robust combat cloud and certification frameworks.

A proposed AI Operational Capability Roadmap from 2025 to 2047 is given in Table 1.



Use Case	Application	Operational Impact	Key References
AI Electronic Pilot	Sensor fusion, threat Prioritisation, flight Optimisation	Reduces pilot load; improves decision latency < 1 sec	Lockheed Martin (2024); Parasuraman (2010)
MUM-T Operations	Collaborative UAV ISR and strike support for Tejas Mk2 / AMCA	Extends reach; increases survivability by 40 %	Deptula (2020); Kainikara (2019)
Predictive Maintenance	AI digital twins for fleet health and spare-part forecasting	25–30 % higher availability	Prakash (2022); Allen (2017)
Swarm Warfare	AI flocks for SEAD, ISR, EW deception	Saturation attacks; area denial	Kania (2017); Raska (2021)
AI-C2 Assistants	Mission re-tasking, data correlation	Faster response and lower fratricide risk	USAF (2023); Voke (2019)
Cognitive Automation	Adaptive cockpit and neuro interfaces	Improves trust and situational awareness	Parasuraman (2010)
AI Wargaming Simulators	Live–Virtual–Constructive training	Continuous doctrine evolution	USAF (2023)
AI Cyber Defence	Intrusion and spoofing detection for data links	Enhances combat-cloud resilience	Cummings (2021)
Autonomous Refueling	AI guidance for rendezvous and boom control	Extended endurance for AMCA	Gertler (2020)

Table 1: AI Operational Capability Roadmap 2025–2047

Gaps in Certification. The envisaged gaps in certification are discussed in following paragraphs.

- **AI certification**. At present, India faces significant gaps in AI certification. Existing global standards, such as DO-178C and ARP 4754A, were designed for conventional software and do not address adaptive AI, leaving a regulatory vacuum (FAA, 2024; EUROCAE, 2024). AI models also lack transparency, complicating safety cases where regulators require traceable decision logic (Bello, H, 2024). While these use cases highlight potential, certification challenges remain the most significant barrier to operational adoption.
- **Defence-specific challenges**. These further amplify the problem: datasets are often classified, fragmented and insufficient for rare but critical events, making reproducible assurance difficult (IISS, 2024). Moreover, civil frameworks rarely account for adversarial robustness, an essential factor in combat environments, and India has a shortage of specialists trained in both aviation safety and AI assurance (DDP/MoD, 2023).
- **Way Forward on Defence-Specific and Certification Challenges**. While the paper identifies key challenges such as fragmented datasets, limited test infrastructure, and the absence of AI-specific certification standards, it is equally important to outline a practical way forward. The IAF should begin by establishing a dedicated Defence AI Certification Framework with the help of CEMILAC that adapts global norms to India's operational environment, supported by specialised test ranges and simulation libraries for AI validation. Parallel efforts must focus on improving data discipline across platforms, enabling secure data-sharing mechanisms and creating tri-service repositories for AI training. Efforts need to be put into building a skilled

workforce to integrate AI systematically. These steps will scale AI from support functions to mission-critical roles.

Analysis

Before examining architecture, data frameworks and capability development pillars, it is essential to place them within the thematic analysis derived from expert interviews. The analysis revealed three main areas: (1) the need for purified and high-quality data, (2) the importance of interoperable datalinks & modular software architectures, and (3) the requirement for structured testing and governance. These themes reflect concerns about reliability, scalability and safety in AI-enabled air power. They directly inform the subsequent sections on combat cloud design, open architecture adoption and the phased integration of autonomy. Presenting these themes upfront provides a clear analytical bridge, showing how expert insights translate into actionable capability pillars for the IAF. Lessons learnt emphasise that AI will evolve as does the Air power and other defence services. The study empowers us to interpret and draw relevant lessons for the integration of AI in Indian Air Power, as brought out in following paragraphs.

Capability Development Roadmap for India. Establishing a reliable combat cloud backbone linking fighters, UAVs, AEW&C aircraft, SAM systems and ground command posts enables secure, real-time data flow with AI workloads at the edge (Cummings, M, 2021). Data lifecycle discipline treating data as a strategic asset with traceability and governance underpins this architecture (Parasuraman, R, 2010).

- **Architecture and Data**. Architecture, Data, Platforms and Autonomy have been merged under the unified heading 'Capability Development Pillars' for concise presentation.
  - **Combat Cloud Backbone**. Establish a reliable and interoperable network linking fighters, UAVs, airborne early warning and control (AEW&C) aircraft, surface-to-air missile (SAM) systems and ground command and control (C2) posts. This "brain mesh" enables secure, real-time data flow while allowing each node, whether pilot or drone, to run AI workloads at the edge (Cummings, M, 2021). The networking needs to cater for unique needs of Indian defence forces to integrate both legacy and modern systems seamlessly across the three services.
  - **Data Lifecycle Discipline**. Treat data as a strategic asset. From collection to labelling to model governance, every data point should have traceability and quality checks. Build sanitised, shareable datasets for academia and startups under strict security protocols (Parasuraman, R, 2010).
- **Platforms and Autonomy.**
  - **UAVs**. Air combat is shifting toward expendable and collaborative wingmen, modular Air Launched Effects (ALEs) and AI-driven aircraft design to enhance flexibility and future readiness (Air Force Research Laboratory, 2020; Deptula, D, 2020; Prakash, B, 2022). A few use cases for India are discussed as follows.
  - Advanced Medium Combat Aircraft (AMCA) and LCA MK 2 by design integrate AI, Multi-Sensor Data Fusion (MSDF), ensure growth margins, Integrated Vehicle Health Monitors (IVHM) and open mission system frameworks into the next generation stealth fighter from the outset (Prakash, B, 2022).
- **Open Architecture Software Frame - works.** The Indian Air Force (IAF) is rapidly modernising under its 2047 capability roadmap, with a focus on indigenisation and seamless integration of new technologies (Kumar, 2025). Legacy aircraft are being upgraded with indigenous sensors, mission computers, secure data links and Software-Defined Radios (SDRs) to enhance connectivity and interoperability (Astra Microwave / IAF, 2023). To avoid dependency on a single vendor and reduce integration timelines, adopting open architecture software and standard Application Programming Interfaces (APIs) with plug-in capabilities is required by India (Tokar, 2017).
- **Test, Safety and Certification.** AI can transform air power, but requires well established testing and certification setup. Developing AI test and evaluation (T&E) ranges with thousands of simulated

scenarios allows autonomy to be validated before operational use (United States Air Force, 2020). Clear trust gates, including explainability audits and human-in-the-loop checks, act as safeguards to prevent operational failures (Cummings, M, 2021).

- **Defence AI Assurance Framework.** A dedicated Defence AI Assurance Framework is needed to adapt global safety standards while adding AI-specific requirements, such as dataset documentation, adversarial testing and explainability reporting (EUROCAE, 2024; Bello, H, 2024). Establishing red-team laboratories for adversarial and degraded-environment testing would provide robust certification evidence, while controlled-disclosure protocols could balance the need for secrecy with the requirement for transparency (IISS, 2024).
- **Defence AI Certification Office.** Finally, a Defence AI Certification Office under CEMILAC should be established to coordinate across the services, regulators, and industry. This office would oversee T&E ranges, define safety cases, and institutionalise trust gates for the progressive use of AI autonomy, from support tools to mission-critical operations (Cummings, M, 2021). India should first deploy AI in lower-risk domains such as predictive maintenance and mission planning, then gradually progress to mission-critical applications (FAA, 2024).

- **Talent and Industry Ecosystem.**
  - **Joint Fellowships.** Fund IAF–university programs in reinforcement learning, computer vision, verification & validation and human factors. Train manpower in defence forces who can handle digital twins and AI models (Allen, G, 2017).
  - **Start Up Fast Lane.** Encourage startups to adopt open APIs and software development kits (SDKs) for faster integration of capabilities, instead of the process being followed at present by the defence public sector undertakings (DPSUs) of using application-specific software. This will ensure DPSUs will not be the only vendors for IAF, and for any upgrades, they are not the only option. Encourage startups to use edge AI hardware and software (Voke, 2019).

- **Policy, Law and Ethics.**
  - **Meaningful Human Control.** Potential advancements in AI could have profound implications for how countries research and develop weapons systems and how militaries deploy those systems on the battlefield. (Scharre, P, 2018). So, till maturity of systems to fully become autonomous, human-in-the-loop control will be required.
  - **Assurance Frameworks.** To ensure ethical use of AI in military systems, embed ethics from design to deployment. This involves human oversight, adherence to International Humanitarian Law (IHL) and transparent accountability mechanisms. Independent ethics review boards and bias-auditing protocols should verify compliance, while continuous testing, validation, and standards must guarantee that AI operates within legally and morally acceptable boundaries throughout its lifecycle. (Sachdev, A, 2021).

- **Risks, Ethics and Governance.**
  - **Operational Risks.** The operational risks of AI in the military are the deployment of inadequately tested AI systems. This could endanger both soldiers, civilians and critical equipment. Further, a gap in R&D may result in unsafe or inferior military AI systems. This will pose significant risks to reliability and oversight. (Cummings, M, 2021).
  - **Ethical Risks.** Ethical risks include increased harm to users from complacency and automation bias due to over-reliance on imperfect systems. They raise accountability and responsibility problems; who's to blame when an autonomous system causes errors? Finally, they undermine human judgment, because training or instructions alone don't reliably prevent these failures by AI (Parasuraman, R, 2010).
  - **Strategic Risks.** The strategic risks are

that air forces failing to adapt to AI's rapid evolution may lose their operational relevance and strategic advantage. Nations that delay integrating AI into air power risk falling irreversibly behind technologically advanced adversaries, undermining their national security and deterrence posture (Kania, E, 2017; Raska, M, 2021).

Phased AI Integration Roadmap for the Indian Air Force (IAF)

The Phased Integration Roadmap for the IAF is shown in Figure 3. The Phased AI Integration Roadmap for the Indian Air Force outlines a progression in phases that matches the maturity in technology. Phase 1 (0–3 years) focuses on basic capabilities such as predictive maintenance, data standardisation, AI-assisted mission planning and the introduction of basic LVC training with AI. Phase 2 (3–5 years) builds on this by integrating autonomous wingman prototypes, improving AI-enabled sensor data fusion, starting swarm drone trials and establishing the architecture for a data cloud for combat use. Phase 3 (5–8 years) moves to operational deployment, with MUMT squadrons, autonomous electronic-warfare pods, AI-enabled cyber defence agents and an expanded LVC ecosystem. Phase 4 (8–10+ years) leads to full-spectrum autonomy, including autonomous collaborative combat aircraft, a fully AI-enabled combat cloud and AI-supported command-and-control architectures with assured human oversight.

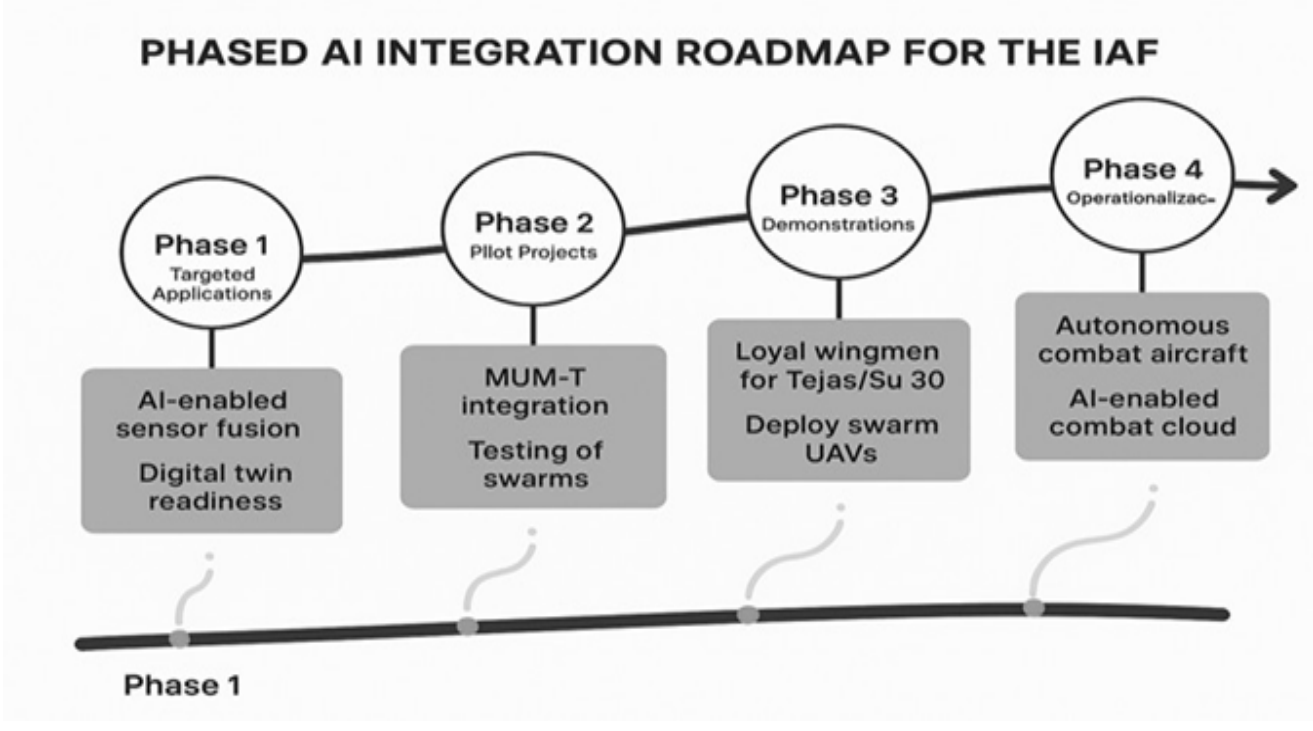

Figure 3: Timelines for Induction of AI-MUMT in Air Power

Recommendations for India

Start with practical, high-impact adoption. India's first step in defence modernisation should focus on areas where digital tools can make an immediate difference. These are predictive maintenance, system health monitoring and decision-support systems. These technologies can result in cutting costs, enhancing aircraft availability and building confidence among personnel in the use of AI-enabled systems.

Strengthen networked operations and wingman initiatives. The Indian Air Force should give priority to developing an indigenous combat cloud that connects fighters, UAVs, radars, Air Defence systems and command centres from all three services in real time through interoperable data links. Parallelly, HAL's CATS Warrior, DRDO's Ghatak, and similar projects from private industry need to be accelerated to expand the radius of operation and improve pilot safety through advanced manned–unmanned teaming.

Establish a Defence Certification Office under CEMILAC. A dedicated Defence Certification Office should be created to develop and enforce performance and safety benchmarks for new



defence technologies that involve AI. It would manage testing, validation and certification processes across the armed services, regulators and industry partners.

Invest in talent and partnerships. A strong defence-technology base depends on skilled professionals and close collaboration between start-ups, research organisations and established firms. Procurement models should promote open, competitive structures that encourage innovation, prevent vendor dependence and strengthen India's path toward technological self-reliance in AI and new technologies.

Uphold ethics and maintain human oversight. Although modern AI-enabled systems are evolving, they will take time to mature; human judgment must remain at the core of mission-critical decisions. Technology should support human decision-making. Clear protocols and training frameworks will help personnel gain confidence in employing AI systems responsibly and effectively.

Conclusion

The Indian Air Force stands at a defining moment. Emerging technologies are going to reshape how it fights and sustains air power in conflicts. New technologies can transform maintenance processes, how mission planning is done, making training AI-enabled and ultimately their use in combat itself. However, real progress lies not in incorporating technology but in the ethical use of AI, along with confidence that it will not lead to unwarranted situations.

The IAF must integrate these capabilities into every layer of its force structure. That is in aircraft/systems, networks and command and control (C2). A test-driven approach should guide AI projects. Building reliable data systems and skilled professionals will result in real operational strength. It must be dedicatedly pursued with vision, discipline and responsibility. This will enable the IAF to ensure strategic balance and AI-enabled air power, one that not only deters adversaries but also reflects India's values of restraint and resilience.

In conclusion, the study fulfils its aim of proposing a phased, test-driven AI integration roadmap in air power, aligned to India's strategic autonomy goals.

Future Scope. The paper has analysed the use of AI in Air Power, and use cases have been accordingly arrived at. However, lessons will apply to the Indian Army and the Indian Navy too. The limitations, especially in respect of certification of AI models, training of manpower, ethical use, interoperability between various systems and developing a combat cloud, will apply to all arms of defence forces. Hence, these can be studied as a future scope with respect to AI in the defence forces.

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About the Author

Air Commodore Mukhvinder Pal Singh Virk was commissioned into the Aeronautical Engineering Branch of the Indian Air Force in 1996. An alumnus of IIT Madras, he has attended professional courses at Air Force Technical College and College of Defence Management, Secunderabad. He is a permanent member of the Aeronautical Society of India and is presently pursuing a doctorate in Defence and Strategic Studies at Savitribai Phule Pune University.

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RESEARCH ARTICLE

From Concept to Capability: Applying Design Thinking to Accelerate Technology Absorption in the Indian Army

Col Gagan Singh

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"If we have to succeed in the 21st century, we must be the masters of technology, not its servants."

— Dr. A.P.J. Abdul Kalam

Abstract

Enhancing the effectiveness of the technology absorption process in the Indian Army is crucial for defence modernisation and operational readiness. This article covers the qualitative research to apply a design thinking framework for studying challenges and recommending measures to enhance the effectiveness of technology absorption in the Indian Army. It explores the gap between policy goals and implementation realities in the process, bringing out the issues that range from procedural bottlenecks, HR issues, procurement mindset for R&D and recommends pragmatic acceptable solutions to enhance the effectiveness of the entire process.

This article was authored by the officer as part of his dissertation topic, 'A Qualitative Study on Design Thinking Models for Prescribing Measures to Enhance the Effectiveness of the Technology Absorption Process in Army Design Bureau', undertaken in CDM Secunderabad between June and December 2024.

Key Words. Design Thinking; Soft Systems Methodology; Application; Effectiveness; Technology Absorption.

Introduction

The Indian Army had announced the year 2024 as the Year of Technology Absorption as part of the overall Army's 'Decade of Transformation'. Army Design Bureau is spearheading the effort towards technology absorption in the Indian Army. The current processes as being followed by the Army Design Bureau are complex and cumbersome, with multiple stakeholders and limited resources. Design thinking, with its emphasis on human-centred problem-solving and iterative learning, offers a promising framework for addressing such complex organisational challenges (Simon, 1969; Brown, 2009). This study cross-pollinates design thinking methodologies into the military context. By identifying the actual constraints in the system, this research aimed to generate a policy framework that is closer to ground reality, thereby leading to the establishment of a more flexible ecosystem for technology absorption in the Indian Army (Agarwal, 2024).

Problem Statement. The slow process of technology absorption is adversely affecting the operational effectiveness of the Indian Army. Application of Design Thinking Models to find a pragmatic and acceptable solution to a problem can greatly enhance the effectiveness of technology absorption in the Indian Army (Simon, 1969; Ganapathi, 2024).

Aim of the Study

The aim of the study is to:-

- Examine existing processes for gaps in the technology absorption process.
- Assess the suitability of the Design Thinking Model for bridging gaps in processes.
- Suggest/ facilitate a policy framework through tangible recommendations.

Review of Literature

While a large number of articles and research studies related to design thinking and military

design thinking were perused during the literature survey, it is pertinent to focus the literature review on only those publications that align with the research questions. Accordingly, publications related to the following themes were reviewed for analysis:-

- Existing design thinking models.
- Design Thinking applications in militaries across the world.
- Design Thinking applications in the Indian Army.

Existing Design Thinking Models. Design Thinking has been at the centre of human-centred problem-solving in the corporate world since the 1960s, with Herbert Simon's foundational work laying the intellectual groundwork for modern design methodologies (Simon, 1969). There exist several Design Thinking Models to include IDEO's 3I model, Google's Design Sprint, IBM's Enterprise Design Thinking, AIGA's Head-Heart-Hand Design, Frog's Collective Action Toolkit, LUMA Institute's System of Innovation, Double Diamond Process by the British Design Council, Herbert Simon's 7-Stage Process and so on (Brown, 2009; Grefe, 2012; UK Design Council, 2024; Google, 2024; IBM, 2024). While each model has been designed for specific areas of application and user requirements, Stanford's Design Thinking Model (Agarwal, 2024) is the widely accepted model that can be applied across varied disciplines. The five-phases under this methodology are empathise, define, ideate, prototype and test.

Design Thinking Applications in the Military. Military Design thinking owes its origins to Systemic Operational Design (SOD), pioneered by Israeli Brigadier General Shimon Naveh back in the 1990s, for solving complex military problems. His contributions helped shift the focus away from prescriptive, linear planning to comprehensive and iterative methodologies, which later influenced the development of the Army Design Methodology of the US Army. This so-called paradigm shift was stated by Jackson (2019) in A Brief History of Military Design Thinking and exposed points of friction between traditional ground approaches and new design-based methods (Agarwal, 2024; Jackson, 2019). The U.S. and NATO militaries employ methodologies such as Army Design Methodology and operational design to deal with the conundrum posed by modern war dynamics (Mitchell, 2018; Rauch & Tackett, 2021; Zweibelson, 2016).

Identification of the Research Gap and Its Significance. A large number of articles and publications exist on design thinking application in military contexts such as strategic decision-making, training and innovation management (Jackson, 2021; Wrigley et al., 2021). However, there is no study available on design thinking applications within the Indian Army and especially in the domain of technology absorption.

Methodology

Research Design. A qualitative research strategy was chosen due to the subjective and complex nature of the research problem. The emphasis was on obtaining comprehensive narratives to comprehend the difficulties in the technology absorption process within the Indian Army and how design thinking models might mitigate them. The research employed an inductive methodology, underpinned by philosophical frameworks of constructionism (ontology) and interpretivism (epistemology). The research was guided by a series of well-defined research questions addressing existing design thinking models, organisational structures, stakeholder perspectives and the application of design thinking principles to overcome systemic barriers.

Data Collection. Data collection combined primary and secondary sources.

- **Primary Data.** A total of 17 interviews were conducted with stakeholders from the Army Design Bureau, Line Directorates, nodal officers at Cat A Establishments and Startup representatives.
- **Secondary Data.** Books on Design Thinking, Journals, Research Papers and online materials on Design Thinking by various design thinking schools worldwide. For the technology absorption process, the data includes SOPs, procedures and FAQs from the ADB Website.

Data Analysis & Interpretation. The data analysis followed a structured approach to derive meaningful insights from both primary and secondary data sources. The analysis employed thematic analysis, where recurring patterns, themes and sub-themes were identified manually and validated through NVivo Analytics Pro software.



Also, the themes and sub-themes were tabulated, and the Power BI module was used to draw insights.

Findings

Suitability of Design Thinking for Technology Absorption Challenges. Design thinking models with their user-centric and iterative frameworks offer a robust methodology for addressing the complex problem of leapfrogging of galloping technology advancements and sluggish absorption. The Stanford design model (Empathise, Define, Ideate, Prototype & Test) with its structured yet adaptable phases is particularly suited for this context by fostering empathy, collaboration and continuous refinement (Hasso Plattner et al., 2012; University, Hasso-Plattner Institute, 2024). The results and inferences of this holistic approach are outlined in the succeeding paragraphs.

Data Collection. The qualitative approach aligns with design thinking's emphasis on empathy-driven inquiry and problem reframing (Brown, 2009; Jackson, 2021). Unstructured interviews with rich narration were conducted with all stakeholders to identify gaps and perspectives with respect to the problem at hand, and proposed solutions were discussed with them.

Challenges in the Technology Absorption Process. Post unstructured interviews, gaps were identified by various stakeholders. The same are enumerated below:-

- **HR Issues.** Procurement officers in Line Directorates deal with both R&D and procurement cases. The focus primarily remains on progressing procurement cases rather than R&D cases. Officers in these appointments sometimes don't have the technical knowledge to properly review R&D projects, leading to rejections or delays. Limited tenures and frequent turnover of officers, absence of institutional memory, non-availability or incomplete documentation of projects and tenure-centric focus cause delays because the new officers start afresh with a certain time penalty to catch up with the pace of ongoing projects.
- **Procedural Bottlenecks**. There is no accountability for delays caused by procedural bottlenecks. Not knowing enough about technology and hesitation, owing to faltering in monetary decisions, slows down approvals. Inefficiency is caused by multiple stakeholders not working together in complementary roles, but rather having overlapping roles in the process.
- **Procurement Mindset for R&D.** Current procurement-driven models hinder the iterative and exploratory characteristics of R&D projects, resulting in delays. ADB doesn't have the financial autonomy to directly buy or test promising technologies, which results in a loss of opportunities. Integrated Financial Advisors (IFAs) use discretion without comprehension of the necessity for R&D, thereby impeding new ideas from coming up.
- **DGQA Standards and Testing Standards**. Strict DGQA testing criteria are redundant and often go beyond what is needed for operations, which slows down the acceptance of new concepts. Poor testing facilities and inconsistent standards make it cumbersome to finish projects in time.
- **R&D Focus**. Indigenisation efforts are set by the focus on ready-made solutions instead of basic research. Long-term innovation is held back by the fact that operational needs and foundational research don't always match up. Unrealistic QRs make it hard for new businesses to commit to production.
- **Collaborative Support to Startups.** Startups need funds and expertise to scale up production. DPSUs are reluctant to handhold startups because they are seen as competitors.
- **Startup Challenges**. Startups have limited financial resources, leading to issues in continued operations and talent retention. They also lack expertise in processing documentation for complex R&D projects. These challenges get amplified by bureaucratic delays and unrealistic expectations from users.

A fishbone diagram (Figure 1) collating the challenges under themes and sub-themes was prepared to fully comprehend the issues plaguing the technology absorption process (Dam, 2020).

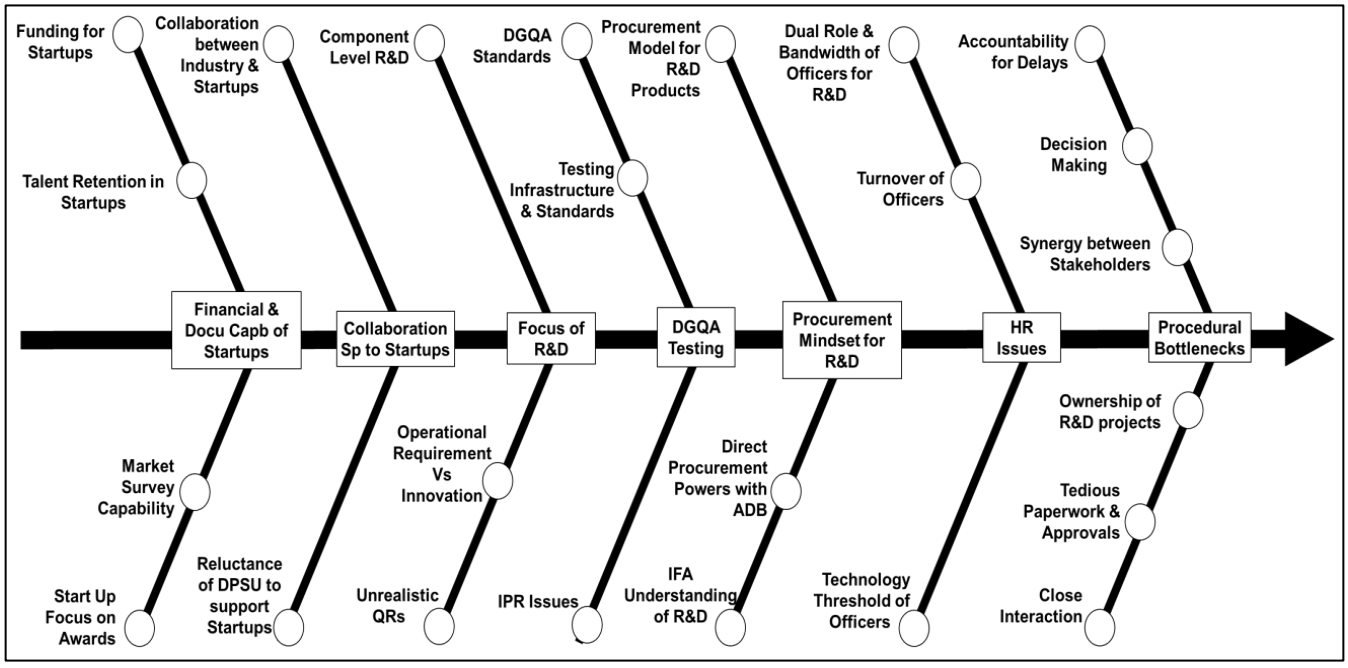

Figure 1: Fish Bone Diagram of Challenges in R&D Procedures

Based on thematic analysis of interviews carried out, the themes were mapped to each category of stakeholder, i.e. Army Design Bureau, Line Directorates, Nodal Officers at Cat A establishments and Startups. The data was analysed using the Power BI module to understand the perspective of each stakeholder. The details are given in succeeding paragraphs.

Challenges for ADB. HR issues and procedural bottlenecks were the highly recurring issues brought out during the interview with ADB Officers, with 36 references. DGQA Testing Standards & Testing Infrastructure, with 16 references, highlights the gap in quality assurance and infrastructure adequacy. Balance issues are moderate to lower mentions in the interviews. HR issues and procedural bottlenecks are the most highlighted constraints for ADB preventing it to progress the projects in an earlier timeframe towards a logical conclusion. These are shown in Figure 2.

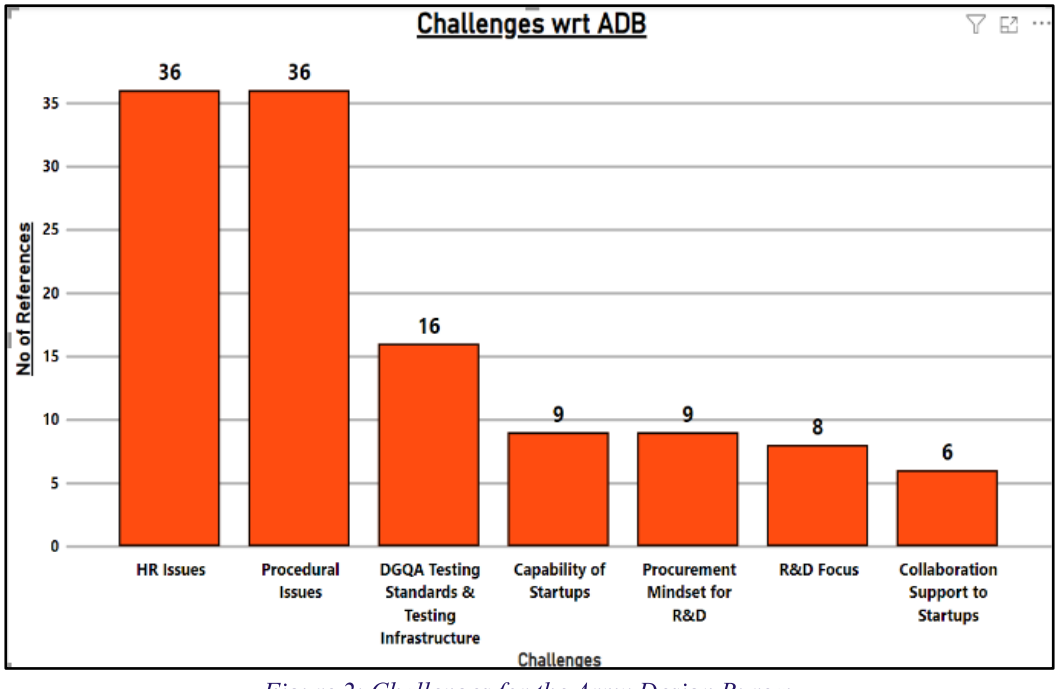

Figure 2: Challenges for the Army Design Bureau

Challenges for Line Directorates. Line Directorates have the highest references to procedural bottlenecks, indicating systemic inefficiencies. HR Issues and a lack of R&D Focus are also mentioned. The capabilities of Startups has minimal attention. Line Directorates perceive procedural bottlenecks as the biggest challenge, followed by HR issues and R&D focus. These are shown in Figure 3.

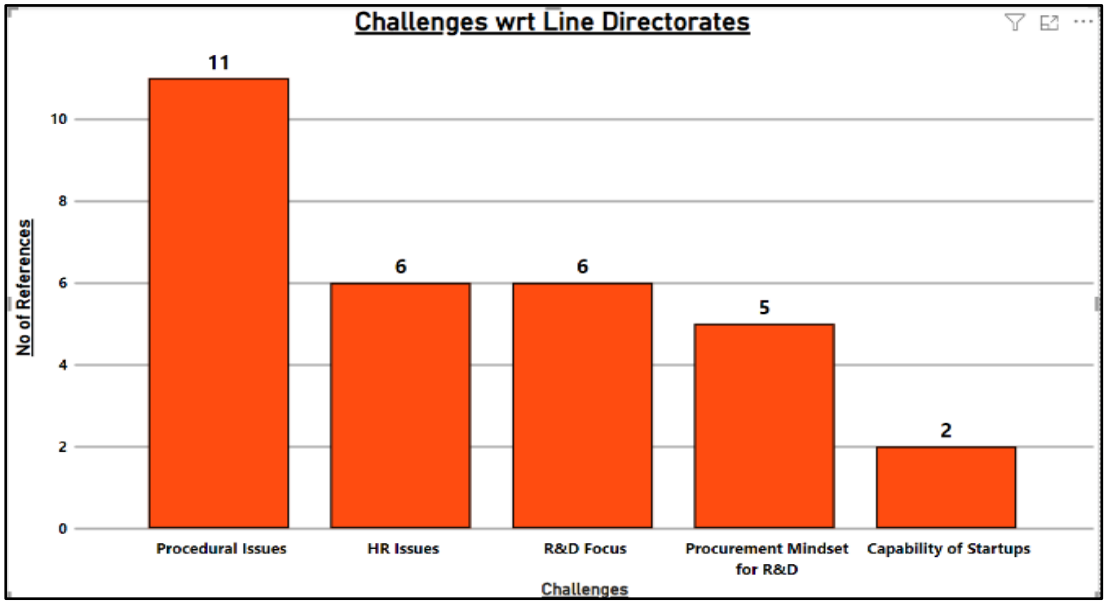

Figure 3: Challenges for Line Directorates

Challenges for Nodal Officers. Nodal Officers also highlight procedural bottlenecks as the biggest challenge in progressing the R&D projects. Concerns of dual workload derailment or technical know-how highlight HR management issues. These are shown in Figure 4.

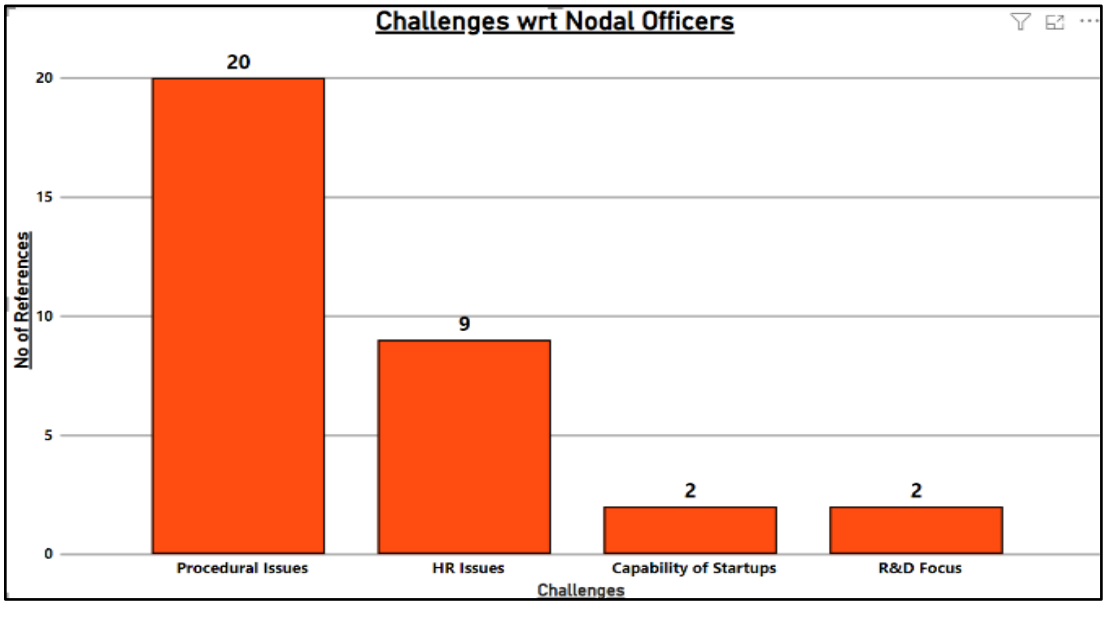

Figure 4: Challenges for Nodal officers at Cat A Establishments

Challenges for Startups. Startups have highlighted complex bureaucratic procedures as the biggest challenge, overshadowing other categories. Focus on turnkey projects in R&D is also a concern, wherein startups lack the capability to develop fully functional equipment and a proof of concept. DGQA Testing Standards, Testing Infrastructure and HR management issues were also highlighted during interviews with startups. These are shown in Figure 5.

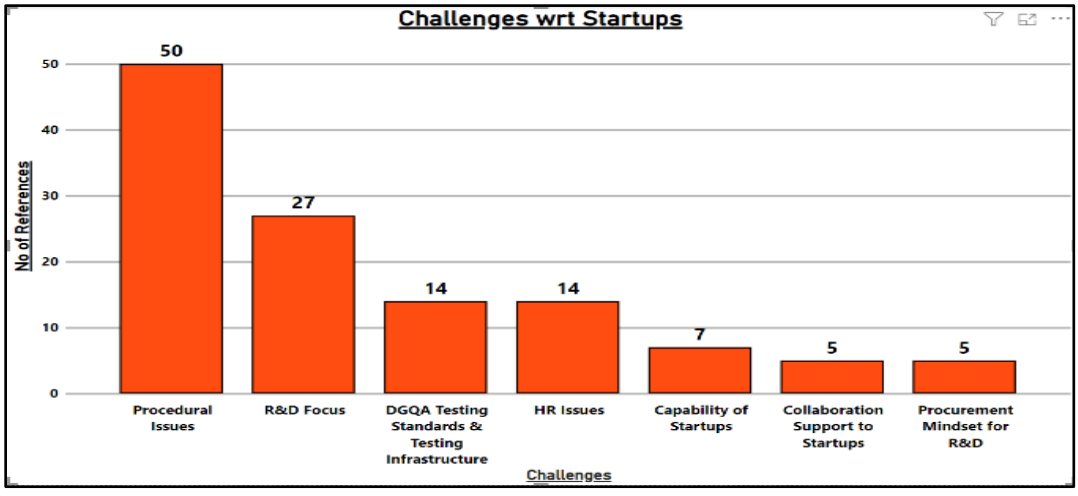

Figure 5: Challenges for Startups

Across all stakeholders, the major challenges centre on procedural delays and HR constraints. ADB also struggles with testing standards and a lack of calibration labs and testing infrastructure. Fixing procedural bottlenecks in technology absorption can greatly enhance the efficiency of the entire process.

Application of the Design Thinking Process to Technology Absorption Challenges

ADB and its challenge of technology absorption involve people, ideas and systems working together in a complex setting. Using Soft Systems Methodology (SSM) within a Design Thinking framework helps identify these complexities. SSM helps understand different viewpoints and real-world challenges, while Design Thinking encourages empathy, creativity and experimentation. Together, they create a practical, people-centred way for the Indian Army to absorb and adopt new technologies effectively (Brown, 2009; Agarwal, 2024). In an attempt to give tangible recommendations for the problem solving, SSM Tools within the design thinking framework were utilised.

Empathise. The Empathise stage focuses on identifying constraints and gaps as perceived by the stakeholders. Towards this effort, unstructured interviews were conducted with all stakeholders and the challenges faced by them were recorded. These have been summarised in findings and depicted as fish bone diagram in Figure 1 above. Insights were synthesised using thematic analysis, and the same is represented using a Rich Picture (Figure 6), capturing systemic challenges in the entire process (Ganapathi, 2024; Dam, 2020).

While each challenge identified during the "Empathise Phase" has been deliberated through the design thinking process, for the purpose of this article, only details of HR Management Issues are enumerated for clear understanding and brevity.

Define. In the Define stage, insights from the Empathise phase were translated into actionable problem statements using Root Definitions and the CATWOE (Customers, Actors, Transformation Process, Worldview, Owner, Environmental Constraints) framework. This clarified systemic challenges such as HR issues, procedural inefficiencies, procurement rigidity and testing gaps (Checkland, as cited in Simon, 1969). CATWOE analysis for HR issues is given below:-

- **Customers.** Startups, MSMEs, ADB, Line Directorates, Nodal Officers and Army units relying on R&D.
- **Actors**. Officers in R&D, discharging procurement duties, and the MS branch for officer selection.
- **Transformation Process**. Allocate officers with relevant technical expertise and ensure focus on R&D through specialised training and streamlined roles.
- **Worldview.** R&D is essential for technological self-reliance but is perceived as secondary to procurement.
- **Owners**. Army Headquarters.
- **Environmental Constraints**. Limited officers, dual responsibilities, career progression and HR management challenges of the MS Branch.

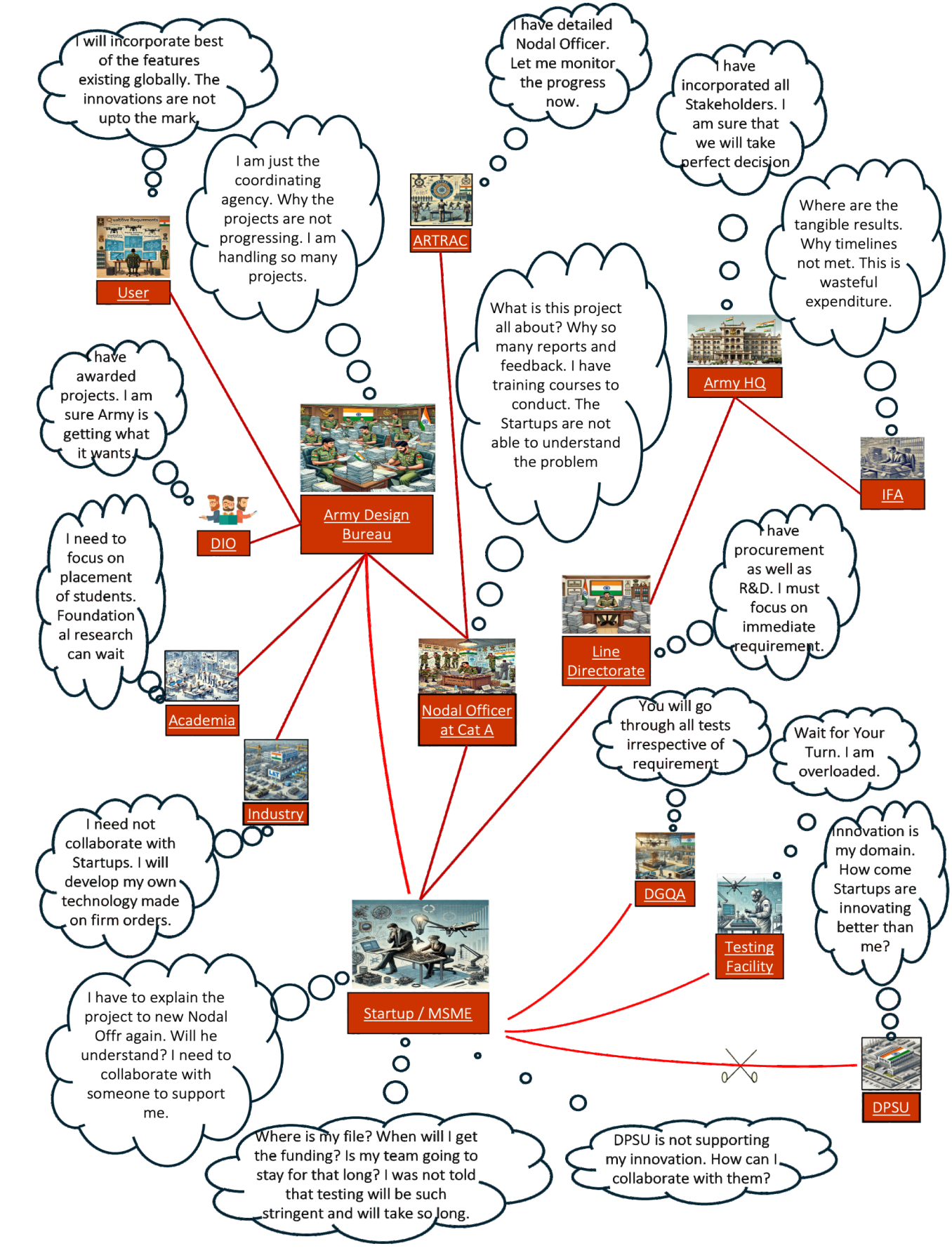

Figure 6: Rich Picture of Technology Absorption Process through ADB

- **Root Definition**. A system owned by Army Headquarters (O) and operated by ADB, Line Directorates and the MS Branch (A) to allocate officers with appropriate technical expertise, provide specialised training and delineate roles (T), in order to support startups, MSMEs and Army units reliant on R&D outputs (C), based on the worldview that technological self-reliance necessitates treating R&D as a core operational function rather than a secondary procurement activity (W), while operating within limitations of officer availability, dual-role responsibilities, career progression requirements, and prevailing HR policies (E).

Ideate. The Ideate stage emphasised brainstorming sessions with stakeholders to generate innovative solutions. Divergent thinking produced multiple ideas, while convergent thinking refined them based on feasibility, desirability and viability (Brown, 2009; IBM, 2024).

- Conceptual models were developed, prioritising solutions such as digital file systems, realistic QR frameworks, technical expertise enhancement and streamlined collaboration platforms. A conceptual model for HR issues is given below in Figure 7.

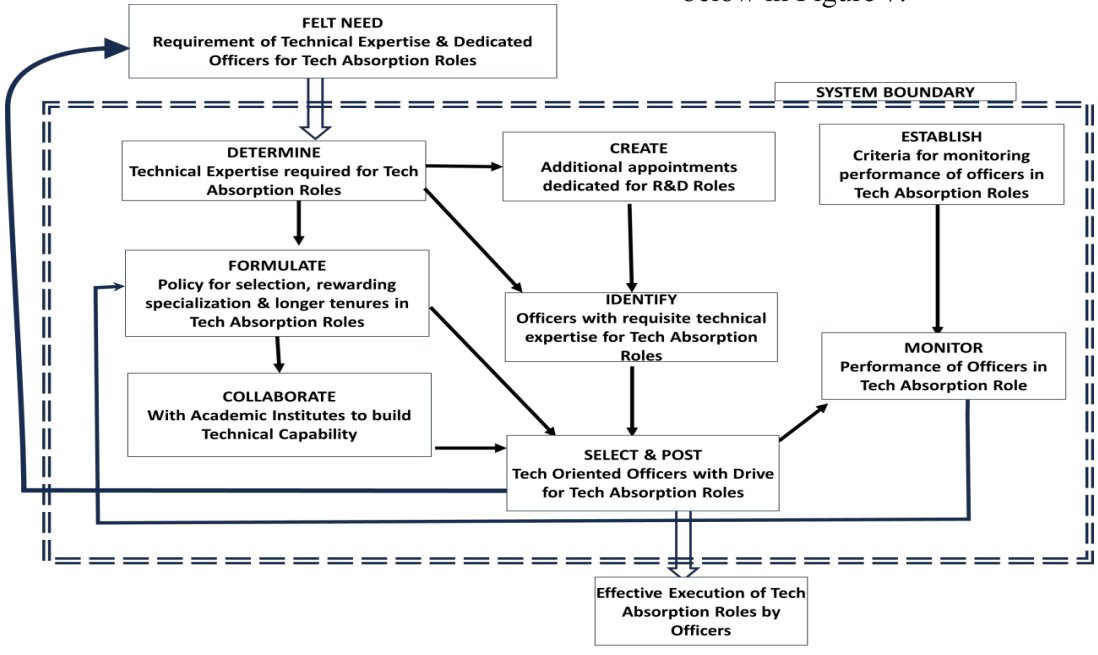

Figure 7: Conceptual Model for HR Issues

- In the convergent phase of ideation, ideas are tested solutions based on cost, impact and consistency with user needs, thereby allowing teams to choose the most viable and scientific ideas to prototype and test. In the convergent stage ideation phase of design thinking, ideas were assessed on the following important criteria: -
  - **Feasibility.** Does it utilise the available resources, within reasonable bounds, given constraints of technical, financial or organisational setups?
  - **Desirability.** Does this idea effectively meet user needs, preferences and is acceptable to all stakeholders?
  - **Viability.** Does the idea lend itself to sustainability in terms of cost, resources and long-term benefit?
- **Prototype.** In the Prototype stage, selected ideas were transformed into tangible, low-fidelity solutions to address key challenges. User journey maps visualised interactions across R&D stages, highlighting constraints and opportunities. Prototypes included file tracking systems, revised testing standards and mentorship frameworks. Although direct user feedback was constrained, the stage produced actionable, user-centred solutions aligned with operational needs (Dam, 2020; Google, 2024). Journey Map for officers assigned to R&D roles is given in Table 1.



Journey Stage	Action	Experience	Pain Point	Opportunity
Assignment	Officer is selected based on technical expertise.	Frustration due to lack of streamlined selection criteria.	Mismatch between skill sets and role requirements.	Dashboard for matching expertise with R&D roles.
Training	Officer undergoes technical training at partnered institutes.	Learning curve due to unfamiliar domains.	Limited access to advanced training resources.	Collaborate with academic institutions for domain-specific training.
Tenure	Officer engages in R&D projects for an extended tenure.	Satisfaction with long-term alignment.	Insufficient support during role transition.	Overlap periods to ensure smooth handovers.

Table 1: Journey Map for Officers in R&D Roles

Test. Testing of the prototype checks its implementation feasibility for a larger-scale rollout. Issues identified during testing are refined by a reiterative process, going back to the first stage to learn more about the user. Iterative feedback mechanisms were incorporated to allow reframing of problem definitions where required, reflecting the cyclical nature of design thinking (Brown, 2009). Such iterative testing is essential for validating design-based interventions within complex organisational systems (Hasso Plattner et al., 2012). It implies that not only was the solution wrong, but the whole problem was missing some essential part which require reframing. In this context, the solutions arrived can be put to the test by ADB or Army HQ to check their effectiveness, as it is not feasible for the researcher to put them to the test on his own. However, a testing framework for HR issues is given below:-

- **Objective.** Post a few technically qualified officers in technology absorption roles and seek feedback on their effectiveness in their respective projects.
- **Metrics.** Skill improvement, project completion rates, proof of concept and officer satisfaction.
- **Methods.**
  - Pilot testing of officers sent on specialised courses from academic institutes like IITs and IISc.
  - Check the effect of new policy changes for R&D roles form MS Branch.
  - Surveys and interviews with officers to seek satisfaction with new tenures.

Discussions

This study attempts to extend the Stanford Design Thinking approach to the problem of technology absorption in the Indian Army, characterised by process bottlenecks, heterogeneous stakeholders and rigid systems. This study utilised soft systems methodology tools of rich picture to empathise, CATWOE analysis to define, and a conceptual model to ideate as part of Stanford's Design Thinking Methodology (Jackson, 2019; Wrigley et al., 2021). Key outcomes included streamlined R&D processes, revised QA frameworks, flexible procurement models, enhanced collaboration of industry with startups and focused HR management policies. Solutions were tested and validated with respect to feasibility, desirability and viability, ensuring that practical and acceptable solutions are deployed.

Prescriptions to Enhance the Effectiveness of Technology Absorption in the Indian Army. A total of seven themes were identified as challenges being faced by stakeholders in progressing the technology absorption process. These prescriptions, comprising the seven thematic challenges, align with best practices in design-led innovation and military adaptation (Mitchell, 2018; Martin, 2014). The prescriptions arrived post-application of the

design thinking process are as follows:-

- **HR Management Issues.** The challenges related to the dual role and bandwidth of officers in R&D roles can be addressed by deconflicting responsibilities between procurement and R&D tasks and posting additional officers based on project requirements. To enhance the technical proficiency of officers, certain technological areas must be identified, and officers with technical proficiency and aptitude must be employed. Collaborations with academic institutions for specialised training, such as M.Tech programs, along with incentives through service policies, would significantly augment capability. Extending tenures to align with project timeframes and implementing a more prolonged, planned handover period, incorporating direct interaction with startups, would facilitate continuity and enhance transitions and institutional memory in essential R&D projects.
- **Procedural Bottlenecks.** R&D project procedure can be streamlined through digital file management system, single-window clearances and delegating authority to a single agency for approvals. Clear accountability, centralised project visibility on a dashboard and regular monitoring mechanisms will go a long way in identifying and addressing the bottlenecks. Training of startups in hand holding mode and assistance in documentation for R&D procedures may also be undertaken to facilitate timely progress.
- **Procurement Mindset for R&D.** R&D projects require a dedicated and flexible procurement model rather than a procurement-aligned process. Army Design Bureau (ADB) needs to be empowered with adequate procurement powers for prototype testing and field trials. Simplifying the financial approval process and embedding of Integrated Financial Advisors (IFAs) in the R&D project process are prerequisites to aligning financial workflows with the iterative nature of R&D dynamics.
- **DGQA Standards and Testing.** Rigid and redundant DGQA standards are very difficult to achieve by startups. DGQA needs to formulate revised methodologies to balance quality assurance with innovation facilitation. New centralised testing facilities and approving private labs and academic institutions for evaluations will also catalyse the testing procedure. Clear and consistent testing parameters aligned with operational requirements are the need of the hour. IT and software testing frameworks adhering to global standards and certification processes are essential for efficient and timely testing of prototypes.
- **R&D Focus.** Most R&D projects are a turnkey model involving large-scale development and integration, which is beyond the capability of startups. There exists a need to transcend from turnkey solutions to component-level innovation. There is a need to formulate a framework for bringing component-level innovators and system integrators onto one common platform with a common certification protocol. Balancing immediate operational needs with long-term R&D goals is essential for sustainable technological advancement and self-reliance.
- **Collaborative Support to Startups.** Startups on their own lack the capacity to scale up production. There is a requirement for formal mechanisms and interactive platforms to provide support to startups through DPSUs and the reputed private industry with capacity. DPSUs may be incentivised through financial and policy rewards to mentor startups, thereby facilitating the scaling of innovative products. Similarly, industry partners can also be encouraged to enhance collaboration through policy interventions for fostering a robust and synergised innovation ecosystem.
- **Startup Capability.** Startups have limited financial and procedural capability to see the project through the long process. This also results in difficulty in talent retention due to lack of funds. There is a requirement to establish a flexible, long-term funding model tied to progress and accountability towards fruition. The concept of angel investors in private industry may be explored. Mentorship programs for startups to enhance their capability in market survey and financial management skills can be employed to

strengthen the growth of startups in the defence innovation ecosystem.

Contribution to the Subject under Study. The findings contribute to a better understanding of the challenges in the Indian Army's R&D process. The hierarchical structures and norms inhibit progressive research and development, where failure is an intrinsic part of the process. This study stresses the importance of using a human-centric iterative technique, such as design methodology, to solve the difficult issue of technology absorption, allowing for the development of practical solutions that are widely accepted through stakeholder involvement.

Contribution to the Methodology of Design Thinking. While design thinking is a broad framework, Soft Systems Methodology (SSM) tools were employed as part of the design methodology process. The rich picture and root definitions aided in enhanced understanding of user requirements. CATWOE analysis was employed to define actionable problem statements, ensuring that solutions were relevant and practical. Conceptual models were used to design prototypes developed from ideas explored with users. This combination of design thinking and soft systems methodology can be a useful tool for future development in the field of design thinking.

Participatory Design Processes. The research was able to identify the bottlenecks in the technology absorption process through empathising with all stakeholders. The research showcases how participatory design processes can improve the entire process of technology absorption with enhanced user involvement. The solutions arrived after the application of design thinking methodologies are more effective. They are acceptable to maximum users, thereby enhancing the effectiveness of the technology absorption process as per the research objective.

Limitations of the Study. While an attempt has been made to apply design thinking methodology in addressing the complex problem of technology absorption in the Indian Army, the study has not been able to implement the methodology fully owing to time constraints and access to system owners (Army HQ and Ministry of Defence) who are to implement the solutions. Design thinking is an iterative process with continuous feedback from the users and the system owners in arriving at effective, practical and acceptable solutions. During research, interviews were conducted with the stakeholders on one occasion only, empathising with challenges and brainstorming solutions. Ideally, the research should have involved multiple interactions with the stakeholders and the system owners after each phase, which is intrinsic to design thinking (Simon, 1969; Agarwal, 2024), thus optimising the solutions. The study's framework and reform suggestions are specific to the Indian Army and thus have limited scope in other services, barring analogous structures and operational environments.

Conclusion

The findings contribute to understanding the challenges plaguing the technology absorption process through the Army Design Bureau and suggest the design thinking approach to such complex problems involving multiple stakeholders. The study highlights the human-centric iterative approach of design thinking to hierarchical structures and processes of the Army to arrive at solutions that are practical and have wide acceptance due to user involvement, thereby ensuring success in achieving its desired outcome.

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About the Author

Col Gagan Singh was commissioned into the Corps of Engineers in 2003. The officer is an alumnus of Cadets Training Wing, College of Military Engineering, Pune, Defence Services Staff College, Wellington and the College of Defence Management, Secunderabad. He holds an MSc (Defence and Strategic Studies) from Madras University and a Master's in Management Studies from Osmania University. He is presently pursuing a PhD from the National Forensic Science University, Gandhinagar.



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PERSPECTIVE

From Assessment to Assurance: The Evolution of Defence Technology Evaluation in India

Group Captain B Janarthan

"Self-reliance in defence is not merely a matter of pride; it is a strategic necessity."
- Dr APJ Abdul Kalam

Abstract

DRDO is the primary agency that is vested with the responsibility of developing critical military technology for the Indian Armed Forces and undertake project/ programs for Defence. Towards this, Technology Evaluation has been a crucial factor in managing all R&D Projects, which enables us to achieve strategic alignment, avoid technological surprise, identify opportunities & breakthroughs, enable informed decision making, ensure resource & risk management, formulate technological road mapping, exploit dual-use potential and establish a collaborative ecosystem. In recent years, the defence R&D and production infrastructure has changed from a public sector-dominated system of the 1990s to a diversified manufacturing ecosystem involving private industry in 2025. Therefore, the need for standardisation of technology evaluation across the industry has come into the limelight, and the introduction of these metrics is likely to form part of the procurement procedures of defence equipment. Therefore, the understanding of these technology evaluation metrics by the services has gained more importance than before.

Keywords. Defence Technology Evaluation; Systems Analysis Approach; DRDO; Defence R&D Management; Defence Acquisition Procedures.

Introduction

Let us begin with a fundamental question, as to what is a Project / Program? A Project or Program are made of well-defined objectives which are planned to be achieved within given time and cost constraints. By objective, Projects or Programs are divided into three types, namely, Strategic, Operational and Compliance. Going by this categorisation, all R&D projects fall under the category of Strategic Projects. The primary defence R&D organisation of India, which handles Defence R&D projects, is DRDO, which encompasses a number of specialised labs working towards self-reliance in critical defence technologies. DRDO dominated the R&D ecosystem in the country to achieve self-reliance in Defence Technology since its establishment in 1958. However, in the last 5-10 years, the dominance is being decentralised with Defence R&D opportunities being extended to DPSUs & Private industries to overcome delays, reduce import dependency and accelerate innovation. Thus, the likelihood of the R&D ecosystem in India moving away from a monolithic model to a collaborative model for defence technologies has gained momentum more than ever. In the present context, DRDO remains India's principal agency responsible for developing critical military technologies for the Armed Forces and for executing project-based technology evaluation in the defence domain.

Scientific Methods for Technology Evaluation

What is Technology Evaluation? Technology Evaluation has been a crucial factor in managing all R&D Projects, which enables us to achieve strategic alignment, avoid technological surprise, identify opportunities & breakthroughs, enable informed decision making, ensure resource & risk management, formulate technological road mapping, exploit dual-use potential and establish a collaborative ecosystem. Evaluation also enables us to forecast technology requirements for R&D. Technology forecasting may be defined as the prediction of the invention, characteristics,

dimensions or performance of a machine serving some useful purpose (Emamul, Somi & Abid, 2013). Technology Evaluation is a powerful scientific method that helps in making strategic forecasting decisions. Technology Foresight encompasses a variety of application and most often, it requires national-level participation to achieve desired results.

MCDM Framework for Technology Evaluation. Some of the well-known operational research tools used for technology evaluation under the category of Multi-Criteria Decision Making (MCDM) are Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Simple Additive Weighting (SAW) and hybrid methods like Fuzzy AHP. The choice of the right tool is governed by the complexity of the problem, data type involved, interdependencies among different criteria and the desired decision goals.

Technology Evaluation and Categorisation Procedure (Pre-2020)

In the early 2000s, DRDO project planning and critical technology identification were based on the Services' Long Term Integrated Perspective Plan (LTIPP) and technology forecasting was based on global developments (Nabanita 2009). Based on this, DRDO formulates the five-year Project Plan and is subjected to technology evaluation for the realisation of the project (refer to Figure 1).

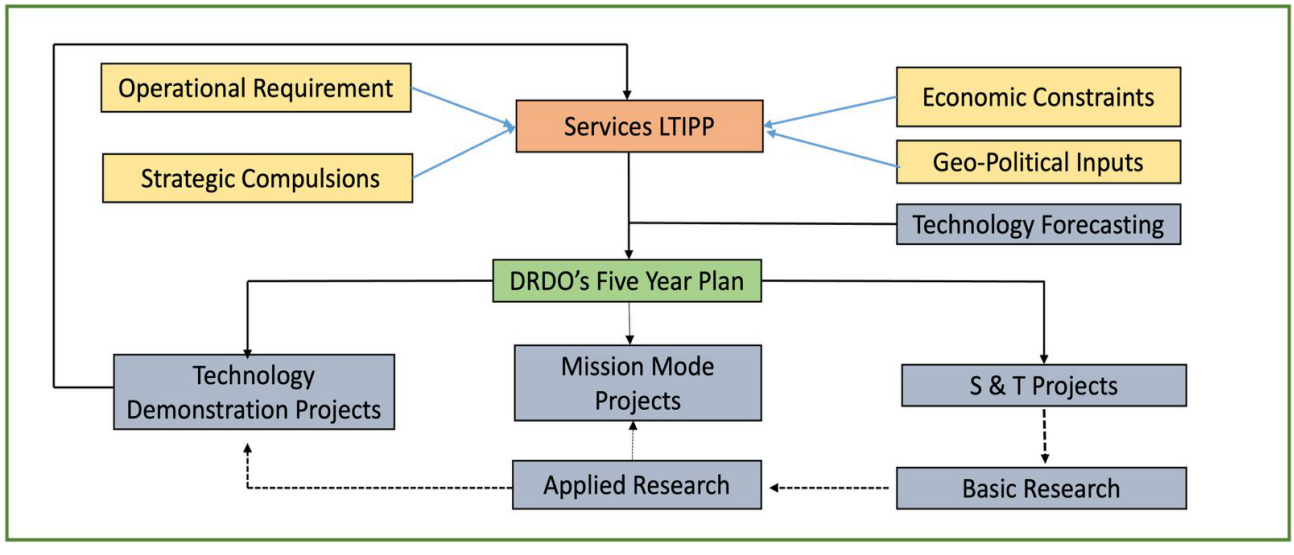

Figure 1: Erstwhile DRDO project planning process (pre-2020)

Methodology of Technology Evaluation (Pre-2020)

DATE. Decision Aid for Technology Evaluation (DATE) is a decision support tool for technology evaluation developed by DRDO based on the MCDM framework to understand Technology Maturity Assessment against the level of expertise and infrastructure in the country. DATE uses National Resource Index (a composite Parameter) internally to bring out the level of expertise and infrastructure available in the country (DATE Ref Manual, 2001). Under this scheme, different engineering disciplines relevant to DRDO are grouped as per technology, which is further divided into core technologies and finally, into sub-technologies. The National Resource Index of the country for a particular technology is used to identify the viability of a project and also to identify the technology gaps.

System Analysis Approach. DRDO employes reductionist approach while undertaking technology evaluation and project formulation. In the process of technology evaluation for the development of a system, the system is broken down into major subsystems. The significance of the sub-system and allied technologies is assessed, following which the viability of development is calculated. The core technologies are further subdivided into sub-technologies and, in turn, into sub-sub-technologies. During system realisation assessment, certain allied technologies required for a project under a technology group, but not belonging to its core technologies, are also mapped during the evaluation process. Figure 2 indicates a sample decomposition of a core group under a technology group, namely, Aronautics.

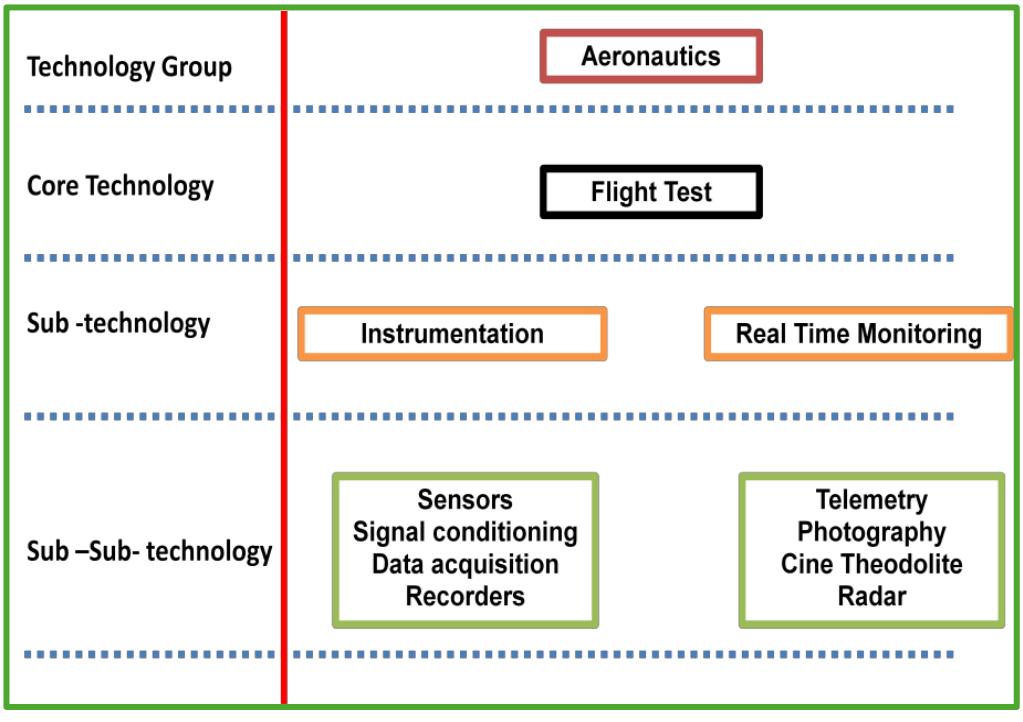

Figure 2: Decomposition of technologies in Aeronautics

Factors and Indices. In the technology evaluation process, a range of factors and indices are used for weighting various detrimental parameters. Factors are assigned an integer between 0 and 10 by various representatives of DRDO undertaking the evaluation. The interpretation of the assigned values of 10 stands as very important, while 0 stands for inconsequential for a project's success. Figure 3 shows the entire technology evaluation process by DATE, in assessing feasibility of a project and also identifies the technology gap.

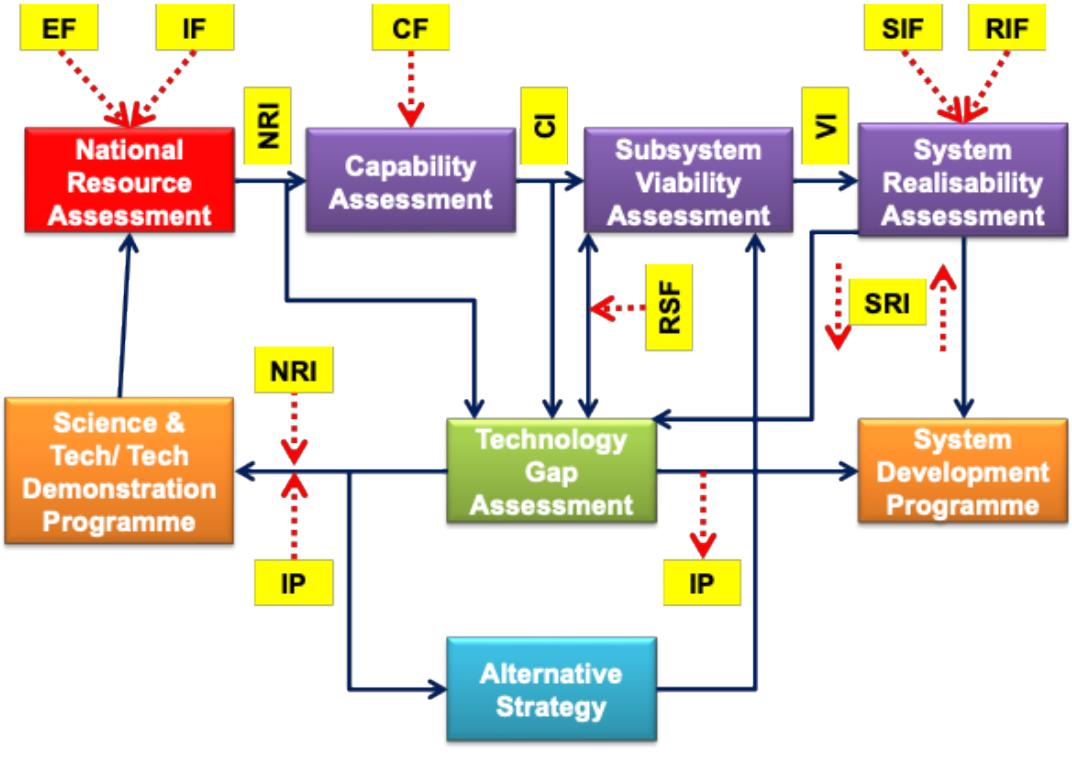

Figure 3: Technology evaluation process

Identification of Technology Gap.
Identification of the technology gap to assess the feasibility of a project is undertaken by assessing the following aspects through different metrics/factors normalised to a scale of 10: -

- **National Resource Assessment.**
  National Resource Assessment is undertaken by the computation of the National Resource Index (NRI). NRI is a composite factor obtained by using the Expertise Factor (EF), which indicates the level of expertise available and the Infrastructure Factor (IF), which indicates the level of infrastructure available in various labs of DRDO and also elsewhere in the country in a specific technology. The average of the NRI values of sub-technologies gives the NRI value for each core technology. A similar method is followed to obtain the NRI value for sub-technologies from sub-sub-technologies. Technology with a low NRI value indicates a technology gap.
- **Capability Assessment by DRDO Team.**
  Capability Assessment of a project team to undertake a technology development project is undertaken by computing the Capability Index (CI). The CI indicates the ability of a project team to synergise the national resources in a specific technology area and the confidence it has in exploiting the same (Nabanita 2009). Confidence Factor (CF) reflects the confidence level of the team to execute the project irrespective of the NRI value, considering the job commitment already being progressed or on an alternative strategy. CI for an allied technology is evaluated as the average of the CI for the relevant core technologies in the allied technology group. Technology with a low CI value indicates a technology gap.
- **Sub System Viability Assessment.**
  Viability to develop subsystems to realise the complete system is assessed by evaluating the Viability Index (VI). VI is calculated as the ratio of Corrected Relative Significance Factor (RSF) (wrt CI) to assessed RSF, considering all applicable technologies in realising the sub-system. RSF indicates the relative importance of a particular technology in the design and development of a specific subsystem under consideration (DATE Ref Manual 2001). Subsystems with VI above 0.5 are considered reasonably viable, 0.7 are most likely proven subsystems, and those below 0.3 need analysis to identify the technology that needs special attention.
- **System Realisability Assessment.**
  Certain subsystems would be more important than other subsystems as they enhance the performance or versatility of the system. Thus, relative importance is assessed using the Relative Importance Factor (RIF). One of the major phases in assessing the feasibility of a project is system integration, which may bring about unique problems. Thus, the experience and expertise of individuals are put to use to evaluate the System Integration Factor (SIF), which brings out the project team's ability to integrate the system effectively. System Realisability Index (SRI) indicates the feasibility of successful completion of the system development project within the given timeframe and resources as a summation of all the subsystems involved in it. Projects yielding an SRI above 8 are assumed to have no R&D requirement, between 4 and 8 would imply a reasonable chance of success to complete the project from a technology point of view and below 4 would suggest that it needs further analysis to determine technology gaps that need to be plugged to ensure project success.
- The identified technology gap is iteratively evaluated based on alternate strategies (like Simulations/Digital twins, import substitution, JVs, phased build up etc) to improve the Subsystem Viability Index and the System Realisability Index by reducing the technology gap.

Assessment of Project Feasibility. Low CI gives out the possible lack of expertise/ infrastructure in the country or a lack of confidence to harness the scattered resources. Thus, the technology gap is defined in terms of 'Inadequacy Parameter' (IP). DRDO is to mount Science & Technology (S&T) or Technology Demonstration (TD) projects, in case the average of the IP reported for a particular technology is significantly high. Though it is not declared as a critical technology, it is considered a technology of greater significance in developing a

system as required by the Armed Forces, the ultimate user. Thus, the process is a system requirement-driven procedure and technology evaluation is done in order to assess the feasibility of developing a complete system.

System-of-Systems. This process is extended to system-to-system development, too. In this, the entire product is divided into various systems, and then SRI is calculated for each component system. The System Viability Index (SVI) of the component system is obtained. Thereafter, each component system is assigned a System Relative Importance Factor (SRIF). Finally, the System-of-Systems Integration Factor (SSIF) is then assigned to calculate the System-of-Systems Realisability Index. Based on this, DRDO labs decides three types of projects, namely,

- Science and Technology (S&T) projects (loosely aligned to future technology needs) to plug the identified technology gaps and enable the development of futuristic system prototypes.
- Technology Demonstrator (TD) projects (involve limited user inputs, develop technologies for the future, involve academia/ industry for design and analysis) to extend the developed prototypes into operational systems through the Mission Mode Project.
- Mission Mode Projects (involve user initiative, time-bound and technology already available in India or abroad for access) to develop operational systems to meet the operational needs of services.

Critical Analysis of DATE and its Shortcomings

Importance of NRI in Technology Evaluation. NRI directly affects the Capability assessment to realise the project, which indirectly affects the Sub-System viability and System Realisability. Therefore, if a technology gap is revealed by NRI, it is going to inflate the remaining three assessment criteria, magnifying the technology gap. Therefore, assessment of correct NRI is critical. NRI was assessed by specialists in the field and reviewed once every two years by DRDO. However, NRI, not being a national endeavour was marred by inaccuracy, leading to high inadequacy.

Impact in Large System Evaluation. IP is not only dependent on NRI and CF but also on the RSF of different subsystems. Thus, high NRI and CF can be subdued by the RSF values of the large number of subsystems involved in a system. Therefore, the development of highly complex systems with multiple subsystems results in unrealistic project timelines.

Subjectivity in Evaluation. Confidence Factor and System Integration Factor are two factors that are purely reliant on the knowledge, experience, expertise and confidence of the project team, which have a direct effect on system realisation and project timelines. This is one of the reasons the project is mandatorily subjected to deliberation by an oversight committee at the Detailed Project Review (DPR) stage. In spite of it, most project sub-systems end up as TD projects, increasing the timeline of a development project by 4-5 years till operationalisation.

Non-Standard Evaluation Tool. DATE is a custom tool developed by DRDO for technology evaluation and project formulation. This tool is not compliant with any standard evaluation tool existing in the industry across the world. Therefore, the application of the tool was suitable only till the R&D efforts remained within DRDO labs, and limited intervention of private industry was solicited by DRDO. However, leading into the 21st Century, with the migration of the growing private industry into R&D, DRDO, who was not able to exploit the tool when dealing with international players through Transfer of Technology or Joint Ventures.

New Method of Technology Evaluation (Post-2020)

Failed Improvements. Extensive studies were conducted by the Institute for Systems Studies and Analysis (ISSA) of DRDO to improve the accuracy of the DATE, but all improvements were on the existing DATE framework, which was already affected by the lack of national-level effort towards NRI assessment. The different factors considered for technology evaluation are, in actuality, subjective and imprecise in nature (Defence Journal, 2008). Many of the factors contributing towards the success of an R&D project, as discussed, are imprecise in nature, and the imprecision may come from a variety of sources, such as unquantifiable information, incomplete information, and non-obtainable information (Pramod and Debasis, 2007).

CAG Audits. ERP systems developed for project planning using decision aids like PERT, CPM, DATE, etc., could not be exploited to the fullest extent due to inconsistent assessment of indices. CAG audit report brought out implementation of an ERP system for project planning and evaluation was utilised sub optimally. Out of 23 projects, details of six projects were available on the ERP system, and the data with respect of remaining 17 projects were not maintained or partially maintained in the ERP system (CAG Audit Report No. 44 of 2015).

Formation of Clusters in DRDO. A committee under the chairmanship of Dr P. Rama Rao was constituted in 2007 to conduct a comprehensive review of DRDO to improve collaboration across multiple labs under DRDO. This review brought in the formation of Seven technology clusters headed by a Director General, namely, Aeronautical Systems, Missiles & Strategic Systems, Naval Systems & Materials, Micro Electronic Devices, Computational Systems & Cyber Security, Armament & Combat Engineering Systems, Electronics & Communication Systems and Soldier Support Systems. Along with the formation of clusters, migration of Technology Evaluation based on National Resource Index to Technology Readiness Level (TRL) Index came into practice and was documented in Directives for Project Formulation and Management in DRDO (DPFM-2021).

Technology Readiness Level (TRL). TRL is a technology maturity metric that came into being way back in 1970 and is used by NASA even today for technology evaluation during project formulation. TRL is now being extensively used by the EU since the 2000s and has been canonised into an ISO publication as ISO 16290:2013 standard. The metric is much simpler than the NRI, and it is a 9-point scale that categorises technology maturity. Figure 4 shows the interpretation of various TRLs into technology maturity as per the global standards.

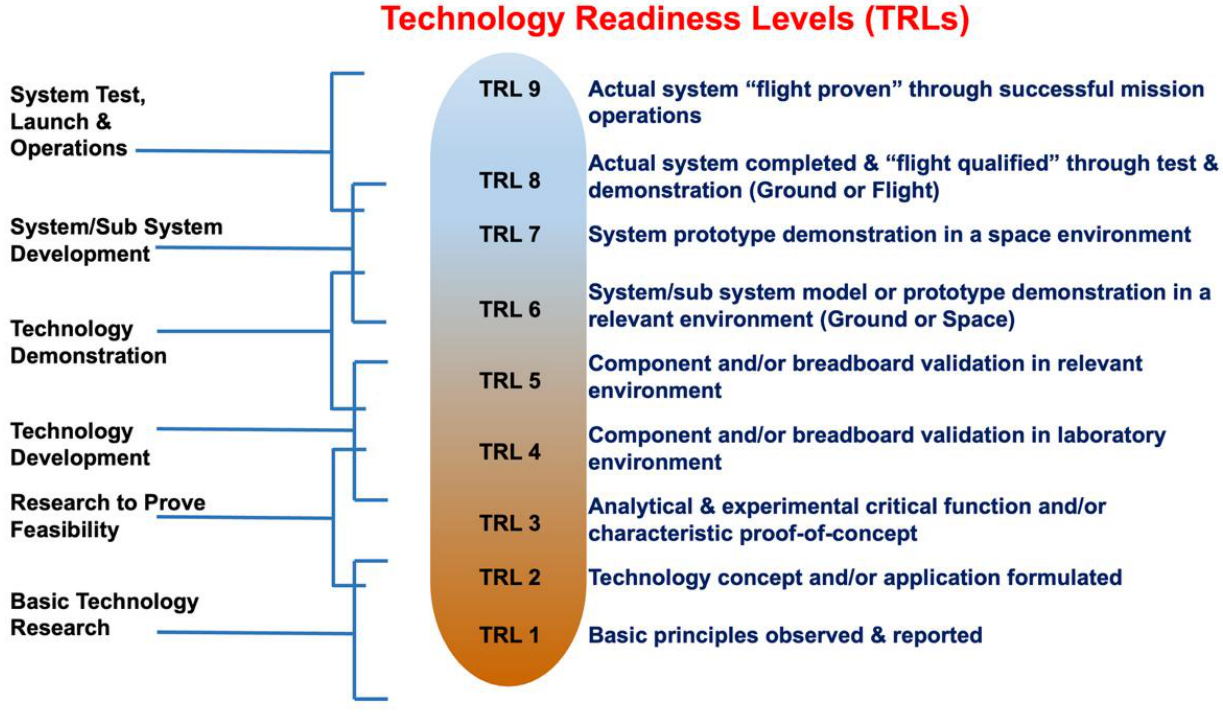

Figure 4: Global standards based on TRL (EESA, TRL Handbook, 2009)



Difference between NRI & TRL. Unlike NRI, which measures a nation's broad capacity and ecosystem to utilise resources, TRL is used to assess a specific Technology Maturity. The key differences between NRI and TRL are listed in Table 1.

S No	TRL	NRI
1	Assess a specific Technology	Assess Nation's overall Environment & Capacity
2	Project Level or Technology level	National Level or Regional Level
3	Assess Technical maturity and Risk to take R&D Decisions	Holistic readiness for a specific technology development and effect policy change
4	Measured on test demonstration and validation in lab, simulated or operational environment	Based on survey and KPIs/data from different sectors in the county
5	Objective	Mostly Subjective

Table 1: Differences between NRI & TRL

Implementation of TRL in DRDO. In the context of DRDO, the TRL is measured on a scale of 1-10, with 10 being the highest. The definition for a TRL index, as per the predefined qualifiers and supporting documents as adopted by DRDO, is shown in Table 2.

TRL Index	Definition
1	Basic Principle & Research
2	Basic technologies assessed and technical concept formulated
3	Experimental proof of concept and preliminary design
4	Technology validated in lab environment
5	Technology validated in simulated environment
6	System/sub-system model or prototype demonstration in simulated environment
7	System prototype demonstration in relevant simulated environment
8	Actual system completion and qualified through PSQR validation trials for performance requirements against trial directive
9	Actual system operated over the full range of operational conditions as per PSQR parameters against trial directive
10	System in production / COTS

Table 2: TRL index defined in the context of DRDO (DPFM 2021)

Project Readiness Indices. TRL indices are assigned for sub-systems/ components/ technologies as per the definition based on the qualifiers defined for each index, confirmed by the specified supporting documents. The lowest of the TRLs of sub-systems/ components/ technologies envisaged under a project will be considered as the Project Readiness Index (PRI). Based on the PRI, projects are categorised into six types as shown in Table 3.

Project Category	Minium PRI for initiating a Project	Minimum desirable PRI at Project Completion
Basic S&T	1	2
Applied S&T	1	2 to 3
Technology Level Demonstration	2	6
Systems Level Technology Demonstration	3	7
Mission mode (MM)	6	8 to 9
User Trial	7	9

Table 3: Project Categorisation by DRDO as per TRL (DPFM 2021)

Progressive Technology Readiness Assessment. Throughout the execution of the project, TRL enhancement is continuously monitored till the closure of the specific type of project in order to initiate the next level of the project for the said technology. The project category has been extended to six types in comparison to the earlier categorisation of three types.

Critical Analysis of TRL and Its Shortcomings in R&D Projects of DRDO

Though the use of TRL-based technology evaluation has commenced in DRDO recently, the standardised method of technology maturity assessment using TRL as a metric has been prevalent in NASA and many European countries for over 25 years. Some of the critical aspects regarding major shortcomings that have come into the limelight and have been addressed by researchers across the globe, meriting attention of all the stakeholders in the country (dealing with Defence R&D & induction of operational indigenous systems into defence services), are discussed in the following paragraphs.

TRL excludes Industry Readiness. Unlike NRI, in TRL-based evaluation, the manufacturing readiness is completely removed by limiting the scope to technical maturity only. TRL assessment by DRDO is purely dependent on the supporting documentary evidence of completed indigenous projects within DRDO, as per the description in Table 2, as seen earlier. Therefore, the adoption of TRL by DRDO is part of the project management process, which is only useful for DRDO. This will only give a measure of the probability of success of a development project for the armed forces and not the overall technology readiness in the country.

Effect of TRL-based Project Categorisation on Timelines. TRL-based technology evaluation is being promoted as an objective method since each TRL Index has a definition that is qualified by supporting documents in comparison to NRI, which was deemed subjective due to the non-availability of a clear definition for each level of the index. However, the TRL assessment can be manipulated by concealment of supporting documents, which is why it is purely based on individual perspective (in the present context, it is the Project Director), which may lead to conservative or inflated readiness levels, which may directly affect the project's success and introduce false confidence of timely induction of required capability into the Armed Forces. Development of EW Suite for LCA Mk II was contested by IAF as DRDO initiated it as a TD project, followed by a MM project for operationalisation, in spite of a successful development and induction of internal Jammer system for MiG-29 ac by DRDO (similar to what was envisaged in LCA Mk II ac). Assigning a TRL level below 6 for the subsystems. The timeline difference between a TD and MM project is three to four years, which is likely to punch a hole into the operational readiness of IAF while inducting LCA Mk II ac.

TRL is not Holistic. TRL-based technology evaluation is also a reductionist approach; as TRL assessments do not cover common failure points that emerge during the integration of multiple technologies into a complex system. This could be a serious limitation in a networked environment, which is going to be the future battlefield, as envisaged by the Services. The Universal Data Generation and Analysis system was a combined module of EW messaging and data analysis system being developed by DRDO for IAF. The project progressed as an MM project; however, integration of the system into the IAF AFNET backbone and integration with the AI model of the EW analysis system of IAF pushed the project back due to low TRLs which were not assessed when the system was assessed independently.

Risk Assessment is not part of TRL-based Evaluation. TRL-based project initiation enables linear progression of technology development through projects/programs as per technology maturity. However, it does not factor in risk management aspects for handling setbacks that emerge during development. Critical safety issues, manufacturing limitations, and integration issues with other systems/sub-systems are likely to emerge in later stages of development, which was closing-in towards a high level of technology maturity. In general, gauging the maturity of technology and systems provides decision support with respect to advancing from one phase of the acquisition life-cycle to the next; the difficulty of maturity advancement is also of high value to decision makers (Nazanin, Shahram, Thomas, 2009). One of the main reasons for the inability to induct LCA Mk 1A for operations is due to the delay/inability to integrate various weapon systems in the platform, despite the readiness of a flyworthy airframe, which is a classic example of a project with high TRL falling back by years due to poor risk assessment, which is not part of the TRL-based project evaluation.

Migration to TRL-based Defence Procurement Categorisation

The effectiveness of this method in the Indian R&D context will come into the limelight in the near future since the implementation of TRL-based technology evaluation has become part of project formulation in DRDO, recently (in the last 5 years). However, the Project Management Team (PMT) of IAF, being embedded into different clusters of DRDO are already seeing the red flags that are likely to impact the Make in India Project timelines assigned to DRDO/industries through Service Headquarters following the TRL-based technology evaluation during project formulation.

TRL based Categorisation in Defence

Acquisition. The Government Accountability Office of the US DoD claimed that "maturing new technology before it is included in a product is perhaps the most determinant of the success of the eventual product or weapon system" (Nazannin 2009). Therefore, DoD in the US also adopted the Technology Readiness Level (TRL) metric for defence acquisition in later part of 2000s. In similar lines, the MoD in India is also contemplating the use of TRL as a metric for technology assessment to decide whether to go with Indigenous programs or adopt a Buy Global approach for capability development in the next revision of DAP. This move will have a telling impact on the procurement categorisation itself, which was otherwise affecting only indigenous development projects that were already categorised as Make in India.

Pitfall likely to emerge. During the AON stage, acquisition categorisation is likely to be undertaken based on TRL as per the new DAP, which is under revision. Researchers argue that the TRL index is an insufficient metric because they do not take into account many of the system development needs, such as manufacturing, integration, transition, difficulty of advancing maturity and more (Nazannin 2009). Therefore, reliance on TRL alone for categorisation of acquisition into the IDDM category is likely to induce false confidence, and stakeholders may overestimate readiness, leading to poor investment or procurement decisions. Having seen the shortfalls in TRL-based assessment and the likelihood of these shortcomings amplifying and affecting the operational readiness of armed forces; it is only to increase in the near future.

Recommendations

Need for National Endeavour. The effectiveness of every methodology depends on the accuracy of

the evaluated metrics. DATE was a good tool, but the shortcomings were primarily due to the lack of a national-level endeavour to measure NRI. Unless an appropriate agency is earmarked and tasked as a primary function to evaluate metrics like TRL and another important matrix ie., Manufacturing Readiness Level (MRL), any amount of new methodology will fail to achieve the intended goal and ensure successful indigenous programs. This can be used by HQ DRDO/DDP during the categorisation phase of defence procurement to decide Make or Buy Global. A department under MoSPI should be assigned the said responsibility of evaluating TRL & MRL.

Comprehensive Readiness Level Assessment. In recent years, high interest has been taken in metrics such as the TRL, System Readiness Level (SRL), Manufacturing Readiness Level (MRL), Integration Readiness Level (IRL) and other metrics as avenues to measure the maturity and readiness of systems and technologies (Tetlay and John, 2009). The following is recommended to be introduced in DAP as part of the readiness level assessment during the categorisation stage of acquisition: -

- Bring about a framework using the following metrics to answer key questions of development: -
  - TRL answers: Does the technology work?
  - IRL answers: Can components work together?
  - MRL answers: Can we build its reliability at scale?
  - SRL answers: Is the whole system mission-ready?
- System Readiness Level (SRL) assessment provides an overall system maturity index quantitatively.
- According to this approach, TRL and IRL are used to compute SRL with MRL as a risk modifier.
- First, TRL is assessed for each sub-systems and IRL is calculated between the different subsystem combinations, using which the SRL is computed.
- Finally, the SRL is adjusted using MRL, which acts as a confidence factor. This assessment is recommended to be done by DDP & HQ DRDO and is recommended to be reviewed by an oversight committee involving Users (Services) to avoid conservative/expansive assessment of IRL by DDP/HQ DRDO to arrive at SRL, which could lead to unrealistic expectations ultimately, affecting operational readiness of Services.
- At the beginning of categorisation, TRL will be dominant, IRL will be low, and MRL will be minimal. This can be used to confirm if the project is to be categorised as a Make category or otherwise, and will act as a baseline.
- Services as users, will get a quantitative project monitoring criterion from development to deployment, post categorisation of the procurement case in the following manner: -
  - During the development phase, as TRL, IRL and MRL will be increasing in comparison to the baseline during categorisation.
  - During the production phase, MRL will be dominant, TRL will be maxing, and IRL will get stabilised.
  - At the deployment phase, the SRL will approach full readiness.

Role of Services in TRL-based Assessment. Though TRL-based technology evaluation outclassed the shortcomings of DATE, it has brought in some other shortcoming which were the strength of DATE. DATE was more comprehensive in assessing the overall national capability, but it could not achieve the intended result because the evaluation of NRI was a local endeavour of DRDO rather than that of it being a national endeavour. Till now, TRL-based assessment was an internal affair of DRDO, and services were turning a blind eye to the shortcomings of the assessment method. Many consider the delays in projects by DRDO due to the shortcomings in TRL-based project formulation to be a legit reason for migrating to the Buy Global category after a considerable amount of delay in the



estimated capability development of the services.

However, now that TRL-based assessment is becoming part of the categorisation of acquisition, it is imperative that the Services understand the importance of TRL-based evaluation to protect their own interest in the long run. A setback in a technology development after years of investment will actually push back the defence capability against an adversary by years, especially with no timely fall back having been envisaged to maintain technology superiority or parity.

Conclusion

The defence R&D and production infrastructure has changed from a public sector-dominated system in the 1990s to a diversified manufacturing ecosystem involving private players in 2020s. Therefore, it is imperative to standardise metrices for informed decisions on technology development that would enable easy transition from a single agency dominated R&D culture to a decentralised system where the emerging private industries are also included without losing strategic focus while ensuring operational readiness of the Indian Armed Forces. Understanding of technology evaluation metrics by the Services is more important than ever, in the present fast-evolving context, especially when inclusion of the same in the upcoming revision of DAP is being contemplated to make procurement decisions for the Indian Armed Forces' capability to fight future wars.

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About the Author

Group Captain B Janarthan joined the Technical Branch of the Indian Air Force in the year 2002. The officer is an alumnus of IIT, Bombay, and the College of Defence Management, Secunderabad. He holds a Master's in Management Studies from Osmania University and has acquired niche specialisation in Non-Destructive Testing, Quality Management and Project Management.

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PERSPECTIVE

India's Defence Modernisation: The Procurement - Acquisition Interplay

Group Captain Rishi Raj Mohindru

'Aatmanirbharta' does not mean working in isolation.
-Shri Rajnath Singh

Abstract

The preamble of Defence Acquisition Procedure 2020 opens with the statement - 'DAP is based on the concept of Womb to Tomb'. This translates to the fact that a military capability needs to be acquired and owned in its entirety- i.e complete ownership over design, development, manufacturing and upgradation. In the context of India's defence capabilities, DAP 2020 promotes 'Acquisition' over 'Procurement'. Currently, there are capabilities that India possesses, but does not have control over their design, development and upgradation, wherein dependence on other Nations is inescapable. While it is ideal to have zero dependency on foreign countries, it in no way diminishes the significance of possessing these capabilities through 'procurement'. Procurement' is usually the quicker way of filling capability gaps by buying equipment, while 'Acquisition' is the longer process of developing indigenous capability. (America's Seed Fund for Innovation, 2025) Procurement is considered to be the easier route and is, at times, seen in a poor light, especially in the 'Atmanirbharta' narrative. This paper argues that such discrimination is harsh. In practice, India has almost always relied on both at the same time, which has had its benefits. Foreign procurement has often helped the Indian industry learn new technologies and standards, while indigenous programmes have depended on selective imports to remain viable (Bhatta NMK, 2024). By examining India's defence experience from independence to recent reforms under the Defence Acquisition Procedure (DAP), this paper shows that procurement and acquisition are more than just alternatives to each other. They are not mutually exclusive. The analysis highlights both progress and limitations and emphasises that in the current times that are marked by supply-chain volatility, geopolitical uncertainty, unpredictable global trade frameworks and brittle international partnerships, India's defence capability growth and export potential will depend on a calibrated balance that reduces structural dependence without pursuing impractical notions of absolute autonomy.

Keywords. Defence Acquisition Procedure (DAP); Procurement & Acquisition; Atmanirbharta in Defence; Capability Development; Defence Industrial Base; Technology Dependence; Supply Chain Resilience.

Procurement and Acquisition - Distinction and Overlap

In defence planning, 'Procurement' means buying equipment ready or almost ready for use in operations. This includes buying ready-made items or making them under licence. It is driven by urgent needs and time-sensitive deadlines. It is a given that the importing country would receive only those technologies that are in the latter stage of their Maturation cycle. The exporting country would seldom part with a technology in its embryonic or growth stages. 'Acquisition', on the other hand, is a long-term effort to build capability. It includes local

SU-30MKI - From Russian License to Indian Upgrades

design, system integration, production, ongoing support, and control over key technologies. This difference, though useful for binary analysis, actually hides how things work. Countries facing threats, technology gaps, and budget limits rarely get to pick one way. Instead, they use both at the same time.

Procurement gives access to abilities that the local industry cannot yet make, even if those abilities use older technology. The acquisition framework then takes in, adapts, and improves on that base. Procurement, in fact, is the entry door to new technology. For example, India's licence production of over 270 Su-30MKI fighters at Hindustan Aeronautics Limited (HAL), starting in the early 2000s under a Russian technology transfer deal, created aircraft-building skills, assembly know-how, and supply networks . This set the stage for local upgrades and the addition of Indian-made avionics and radars.

It is extremely difficult to conceive and execute a major 'acquisition project' with zero dependency on foreign countries. In the case of complex platforms, dependence to a certain extent on parts like engines, sensors, avionics, and special materials becomes unavoidable to keep the progress going and lower the risk of the project stalling. In the Tejas Light Combat Aircraft, designed and built by HAL, the GF404 engines are imported from the US, AESA Radars from Israel, whilst the airframe and systems have local content. The project continues to progress, allowing for the Indian defence ecosystems to catch up, working towards indigenisation of engine and radar technologies. One may argue about the time being taken, but then we might not have had even this if not for going ahead with 'Procurement' of certain capabilities, as against rigidly insisting on 'Acquisition' at all costs!

Arjun Main Battle Tank: India's first indigenous MBT

There cannot be a linear, direct path that takes us from imports to self-reliance in one quick sweep. Instead, the route evolves over changes that are shaped by various factors, viz., war, foreign sanctions, limitation of budget, and the evolution of the defence manufacturing ecosystem itself. India's defence modernisation journey has traversed along a continuum, with Imports and self-reliance making up for the two ends. The idea of a continuum between procurement and acquisition is a conceptual picture of how a military power is built when both money and time are short. Our progress has been uneven and mixed, but it has built up over the years.

Post-Independence Defence Planning: Weak Industry Base (1947-1962)

In 1947, India took over a military that was built for colonial needs. The forces were designed for internal control. Post partition, most of the fighting troops became part of the Indian Army, but many of the industries and the supply bases went to the soon to be western adversary. India's share was weak and unevenly distributed. Most of the fighting capabilities- in the form of Aircraft, Tanks, and Warships were of foreign origin. In the initial years of Independence, the integration of princely states, partition riots, and the Kashmir conflict required urgent response as opposed to that of capability building for the military forces. The imminent nature of challenges meant that the government had no option but to undertake off-the-shelf buying of military equipment to secure both internal and external situations. Also, the early years of the economic situation meant that the industrial base was thin. None of the key technologies was home-grown. The process of procuring military equipment was a forced choice, which, though a short-term fix, was vital for the survival of the newly freed nation. This clash of meeting the short-term needs at the cost of long-term goals marked the initial years of independent India's military modernisation. An incremental improvement in the situation was marred by what was again an unwanted military conflict of 1962.

1962 War: Shift in Defence Procurement Approach

The 1962 Indian War brought forth India's weaknesses in its defence setup. India's non-aligned policy and the forced choice of buying from multiple suppliers had worked just as well until

then. The 1962 war exposed the risks. The Kennedy administration, under pressure from the Cuban missile crisis, did not want to get directly involved against China and refused to supply fighter aircraft to India. It is interesting that in 1961, the US had already supplied F-104 Fighters to Pakistan!

Following the 1962 war, India responded by turning to the Soviet Union. This decision fructified in the form of the MiG-21 Fighters, Tanks, artillery guns and support systems that were procured off the shelf and enabled military strength to be rebuilt at a fast pace. What followed was the licensed production of fighters at HAL along with local assembly, transfer of technology, specialist tools, training of workers, and building of institutional and industrial knowledge over the years. Thus, these decisions led India to handle upgrades and sustainment in the long run. This shows that the initial procurement served as a basis for a later acquisition of capabilities. These capabilities, though limited and only tied to certain military platforms, mattered most in the next war that India was forced into.

What can be inferred is that procurement does not hurt self-reliance; in fact, it aids long-term capability growth. And history also shows that acquisition pursued in isolation, without timely procurement support for critical subsystems, can constrain even sound indigenous efforts, as illustrated by India's experience with the HF-24 Marut fighter aircraft.

Critical Subsystems: The HF-24 Marut Experience

India's first major attempt to develop an indigenous combat aircraft was the HF-24 Marut. The programme began in the late 1950s, with the aircraft making its first flight in 1961. Led by the German designer Kurt Tank, the project demonstrated that India could design a modern fighter. The airframe was well-engineered, with effective aerodynamics and structural design.

The programme's primary limitation was the lack of a suitable engine. The Marut was intended as a supersonic fighter capable of reaching speeds of Mach-2. The original design depended on a new afterburner engine, which was then under development in Britain. In the early 1960s, the British government withdrew funding for that engine project, and alternative Western options were not made available. No engine with the required thrust and afterburner capability could be

This photo shows - Marut's streamlined, aerodynamically clean pencil fuselage with its side air in-takes for the twin power plants; thin wing designed for supersonic flight; wide track under carriage to support landings on rough airfields; the bubble canopy for good visibility. Photo Copyright: Kurt Tank

obtained. As a result, the aircraft entered service with the Bristol Siddeley Orpheus 703 engine, which produced significantly lower thrust, thus restricting Marut's top speed to only Mach 0.93, which was well below the planned Mach 2 performance. Efforts to integrate a more powerful engine proved unsuccessful due to systemic shortfalls. Although the aircraft airframe was sound, the propulsion constraints meant that only a small number of the aircraft were built, and the aircraft was prematurely phased out of service. The programme faltered because acquisition was pursued without the enabling support of selective and timely procurement of a critical subsystem.

Procurement-Led Capability: 1971 War and Naval Shipbuilding

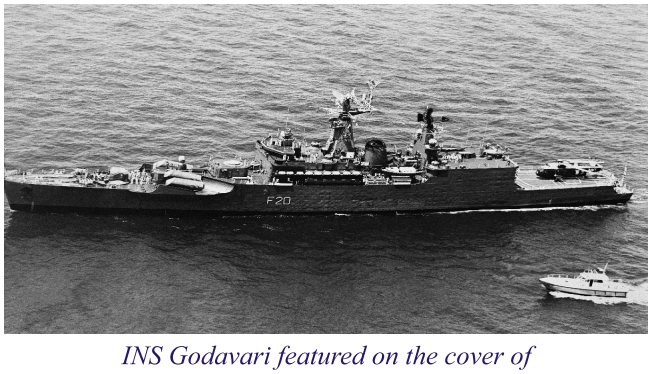
Critical technologies take decades to mature, while military capability is required immediately. Procurement bridges that gap. The 1971 war showed the practical benefits of India's mixed approach to procurement and acquisition. Soviet-supplied platforms formed the backbone of combat strength in all three services. The Indian Air Force depended on MiG-21 fighters for air defence and ground attack. On land, Soviet tanks and artillery delivered mobility and firepower. At sea, missile boats and other warships allowed India to move from defence to offence, especially in operations off the western coast. The reasons for the stellar performance of military platforms in 1971 war, were not limited to mere external procurement of critical war-fighting equipment. The underlying reasons for India's military triumph included the licensed production and local assembly in the country, which led to an enhanced maintainability and serviceability state of the aircraft fleet.

Post 1971 War, capability acquisition saw a rise in the domain of Naval ship building. India began licensed construction of Nilgiri-class frigates with British technical help, thus moving the Indian shipyards from traditional repair and overhaul work to builders of modern frontline warships. The British assistance in design details and system integration proved essential in honing this capability. This naval warship building capability thus acquired transitioned to become the basis for Godavari class warships/frigates, which were fully designed in India and commissioned in mid 1980s. The Godavari class frigates still had imported engines, sensors and weapons. However, they clearly demonstrated a shift from 'licensed building' to 'local designing', an important upgrade in defence modernisation. This was not an easy acquisition of capability and came only from repeated production, steady orders from the Indian Navy and persistent institutional experience instead of just an abrupt technology induction.

Capability building in other areas was slow to come. The Indian economy in 70s and 80s could not support the overall pace of defence modernisation, and the budgetary constraints slowed down the process. However, what was important was the continued building up of institutional knowledge, weapons and platforms designing skills, project management and industrial capacity, at least in selected fields. India did not reach full technological independence by the 1980s. However, it gained a more practical and proven method of gradual capability growth, where military procurements provided the impetus for capability acquisitions through sustained efforts. This realisation became the basis for future defence acquisition reforms.

Indigenous Capability in Key Domains

India also worked on building local capability in a few selected areas. These projects stayed away from day-to-day operational demands and had longer timelines. The most important was missile development led by the Defence Research and Development Organisation. From the early 1980s, the Integrated Guided Missile Development Programme (IGMDP) gave steady attention to propulsion, guidance, control systems, materials, and systems integration. This programme was centred on mastering subsystems through repeated testing. This was a departure from the philosophy in previous platform-focused projects. The programme built a credible leap in indigenous technologies that simple procurement processes could not provide. Although one might argue that the timelines were still long, problems were common, and induction into service was very slow.



INS Godavari featured on the cover of Time Magazine's Apr 1989 issue, titled 'Super India'.

The IGMDP proved that indigenous development was possible when the objectives were well defined, and the vision at the apex remained consistent across government changes. It was acknowledged that success depended more on control of core technologies than merely building complete platforms. By the late 1980s, India had two separate paths. One used procurement and licensed production to meet urgent operational needs. The other pursued local development in strategic fields where independence mattered most. These paths ran side by side yet followed different rules, timelines, and decision processes. The lack of a shared framework to link them would become clearer as the economic reforms and new operational needs led to the revamping of the old approaches in the coming years.

Liberalisation, Kargil, and Formal Acquisition Processes (1991–2002)

The economic reforms of 1991 changed the broader industrial base. The private companies grew faster in automotive electronics, precision, engineering materials and software development. Although these reforms did not open defence production to private players, their impact on the indigenisation process was immense. By the mid-1990s, these sectors had built skills that could later support defence supply chains, mainly as part suppliers, subcontractors, and service providers. Direct effects on frontline platforms remained small during this time, but the foundation for future local acquisition grew wider.

The Kargil conflict in 1999 brought out the flaws in the existing procurement system. Deficiencies,

especially the lack of modern artillery, became clear during intense operations. Urgent needs had to be met through fast imports while the battles continued. Israel supplied Searcher unmanned aerial vehicles in shortened time frames to fill critical surveillance gaps in high-altitude areas.

The Kargil aftermath saw the Defence Acquisition Council (DAC) set up in 2001 to streamline the capital purchase decisions. The first Defence Procurement Procedure (DPP) laid out clear steps for the signing of contracts. Importantly, emergency procurement was included as part of DPP. These reforms were a marked shift from the earlier ad-hoc experience-based practices.

From Procedure to Ecosystem: DPP to DAP

The structural changes in capital procurement were ushered in by the Defence Procurement Policy 2002 (DPP-2002). The Kargil experience, as well as the post 1991 liberalisation of the Indian economy, influenced these changes. There were to be 6 more versions of the DPP in the ensuing 15 years (Figure 1). Each subsequent DPP brought in additions and improvements. The salient improvements are given in Table 1.

DPP	Significant Additions / Improvements
2005	Offset policy introduced in Defence Procurement Procedure.
2006	'Make' Category Introduced.
2008	Buy and Make (Indian) *category introduced/expanded.*
2011	Integrity Pact provisions strengthened; Offset Guidelines revised.
2013	Offset policy provisions further tightened.
2016	*Buy (Indian–IDDM)* category introduced

Table 1: Salient Improvements in DPP

The Defence Acquisition Procedure (DAP) 2020, which succeeded DPP 2016, marked not only a semantic shift in the words - replacing Procurement with Acquisition- it also pushed for indigenisation by fostering manufacturing capability, thus contributing to driving the defence industrial ecosystem in India. The crucial facet of Life Cycle Support (LCS) was also introduced in this version. Indigenisation being the primary focus, it emphasised Indian design, development and production over imports. There was an increase in the requirement of having local content, up to 50% or higher.

DAP 2020 formalised what had existed implicitly in the early DPPs- that procurement is not just a transactional activity, but it's a lever that shapes technology ownership and enables ecosystems that sustain the capabilities. The emphasis on higher local content thresholds and life cycle support was a conscious effort to ensure that purchases contributed to the increased ability to sustain the capability in the long run.

With all these changes, has DAP 2020 managed to be the panacea to all our problems? An objective answer is No. The reasons are that acquisition timelines remain a concern. The increased

Figure1: Successive Defence Procurement Policies

indigenous content mandated in DAP 2020 has driven growth in domestic defence industrial capacity; however, end-to-end cycles continue to remain protracted. Field trials, staff evaluations, and commercial negotiations still take a lot of time. These issues are under review and are likely to be addressed in the DAP-2026, which is under formulation.

Institutional Changes and Industry Growth

In addition to the introduction of DAP-2020, the



dissolution of the Ordnance Factory Board and its reconstitution as Defence Public Sector Units (DPSUs) has aimed at greater competitiveness in the defence sector. The Positive Indigenisation Lists, which mandated an embargo on imports for specific equipment has given a fillip to the defence industry ecosystem. A measurable impact is evident. The defence industry's turnover of 1.51 Lakh crores in 24-25, of which 23% was by the private sector, is an encouraging sign. Defence exports for the same period were ₹23,622 crores, the highest ever. Between the DPSUs and the private sector, the latter led the effort in the export front. The target is to achieve defence manufacturing worth ₹3 lakh crore and defence exports of ₹50,000 crores by 2029. These targets would not only contribute to economic growth but would also place India as a global defence manufacturing hub.

These production and export numbers (Figure 2) do indicate expansion, but what continues to be a concern is the subsystem dependence. A major portion of licensed production by the Indian DPSUs is still dependent on critical imported subsystems. Dependence in critical areas like engines, radars and sensors, advanced electronics, etc., indicates that just scale and volume in defence manufacturing does not automatically convert into technological ownership. It is a reflection of a crucial aspect that the pace of complete technological control is slow. This slow pace of indigenisation and control of critical technology at the core subsystem level is attributable to entrenched technological barriers and extended development cycles. Inconsistent or zero follow-on demands have not helped matters. Demand predictability is a key enabler for subsystem indigenisation. Industry is wary of investing in specialised facilities without confidence in follow-on orders.

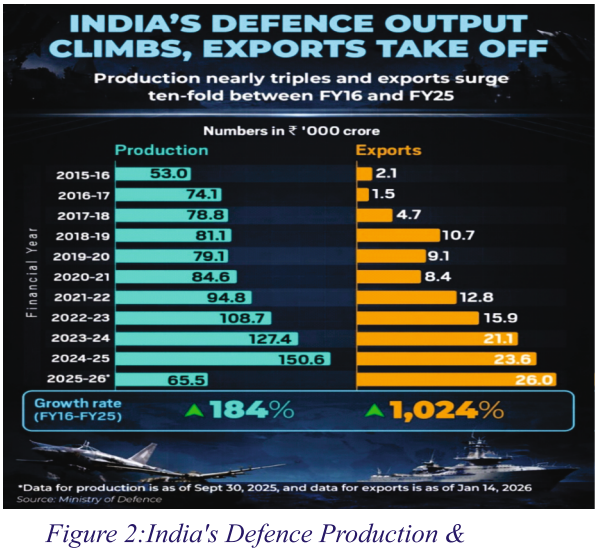


Figure 2:India's Defence Production & Export Numbers (Graphic Courtesy NDTV)

Procurement as an Enabling Instrument

It will be harsh to label the slow pace of Indigenisation as a failure of the acquisition framework. In essence, it rightly reflects the mismatch between the time required to master core technologies and the immediacy of operational needs. It is this gap that procurement has addressed by functioning as an enabling component. Procurement has allowed platforms to enter service while subsystem capability continues to evolve in parallel. Licensed production, phased induction, and selective imports have sustained operational readiness and provided the industry with exposure to integration, maintenance, and life-cycle responsibilities. In this sense, procurement has not delayed Indigenisation but has absorbed risk during the period in which acquisition efforts mature. By allowing capability to be fielded without waiting for full technological ownership, procurement has preserved continuity in force modernisation. The relationship between the two has therefore been reinforcing, not substitutive.

India has inducted platforms while subsystem capability has continued to evolve in parallel. Attempting to align full technological ownership with initial induction in many cases would have delayed or denied capability altogether. Procurement has thus operated as a stabilising instrument within the acquisition process. Emergency and fast-track procurements continue to occur in response to immediate threats. It is crucial to ensure that they do not become self-contained solutions.

Recommendations

India's experience has established that the challenge is not choosing between Procurement and Acquisition but balancing the interplay between the two. The way forward lies in curating procurement that serves and enables acquisition outcomes by acknowledging the realities of global interdependence. The following measures are recommended: -

- **Treating Procurement as a Time-Bound Link, Not an End-State.** Every major import or licensed production case should be accompanied by a clear acquisition absorption

roadmap that identifies subsystems, materials, or processes that must transition to domestic control within defined timeframes and tranches. Procurement contracts should explicitly state what knowledge remains external and for how long. This makes procurement a risk buffer that is manageable rather than a permanent solution.

- **Prioritising Subsystem Ownership over Platform Indigenisation.** When we attempt full platform indigenisation at induction, it often delays the capability. A different approach that can be adopted is to focus on the acquisition of subsystems like propulsion elements, seekers, avionics, control software, materials, and manufacturing processes that are likely to become choke points. Procurement can continue to fill gaps at the platform level while acquisition concentrates on building irreversible competence at the subsystem tier.
- **Embedding Acquisition Obligations into Procurement Contracts.** While DAP 2020 has institutionalised this to a large extent, the tangible results have not yet taken root. All Procurement contracts, including Buy (Global), must include clauses that progress towards access to design data and test regimes, rights to upgrade, modify, and integrate subsystems, and domestic control over maintenance, repair, and overhaul. This would ensure that even when procurement is unavoidable in the near term, it would incrementally deepen capability ownership.
- **Rationalising Fast-Track and Emergency Procurements.** Emergency and fast-track procurements are operational necessities, but they must not become self-contained loops. Each case should trigger a post-induction acquisition roadmap, ensuring that urgency does not harden into long-term dependency. Without this discipline, short-term solutions run the risk of eliminating structured indigenous development from the equation.
- **Insulating Capability Planning from Supply-Chain Volatility.** Recent global events reinforce the fragility and risk of over-reliance on external suppliers. The tariff disruptions triggered during the Donald Trump administration illustrate how rapidly political decisions can disrupt established trade flows. Similarly, the Russia-Ukraine war has exposed vulnerabilities in ammunition, spares, and energy-linked defence supply chains, while the China factor continues to complicate assumptions of reliable access during crises. These developments underscore the lesson that strategic autonomy is not about isolation, but about resilience. India must therefore prioritise acquisition in areas where supply denial or coercion would be strategically hurting. It needs to remain pragmatic in other domains.
- **Accepting Managed Interdependence, Rejecting Perpetual Dependence.** Zero dependency is neither practical nor economically efficient in a globally networked defence ecosystem. However, unstructured dependency is a strategic liability. India's post-2022 experience with sustaining mixed-origin inventories during global supply disruptions demonstrated that availability was determined less by platform origin and more by domestic control over spares, ammunition, software updates, and overhaul. Systems supported by indigenous MRO, alternate sourcing, or local manufacture of consumables remained operationally credible, while those dependent on single foreign supply chains faced avoidable constraints. The lesson is unambiguous: strategic autonomy lies not in eliminating imports, but in ensuring that no critical capability can be rendered inoperable by external political or logistical veto.

Conclusion: Aligning Procurement and Acquisition for Capability Ownership

There is no denying the fact that Procurement should not, and cannot, be considered a substitute for Acquisition. If we excessively rely on Procurement, there is a risk of perpetual dependency on foreign suppliers. It is a grim reality that in several procurement cases, the time taken to contract imported systems has equalled, and also exceeded, the timelines of indigenous development. Protracted staff processes, trials, and commercial negotiations have impaired procurement's value and diminished the distinction between Procurement and Acquisition.

Yet India's defence modernisation story is one of steady progress. Over seven decades, we have evolved from total import dependency to domestically anchored defence capabilities, albeit

not in all areas. Progress, though uneven, has been resilient. Capabilities have been inducted, and the industry has accumulated experience through production and life-cycle support.

The key lesson is that defence capability matures when Procurement and Acquisition are aligned. Eliminating procurement is neither feasible nor helpful, given our resource limits and operational realities. The way forward favours consolidation, where procurement bridges gaps and preserves operational continuity whilst acquisition steadily expands control over sustainment, upgrades, and critical subsystems. In the current global order that has supply-chain volatility and geopolitical coercion, a calibrated alignment will determine India's military readiness, the credibility of its defence industrial base and the fructification of its export ambitions. Procurement and acquisition must thus be treated not as competing choices, but as concurrent instruments in the pursuit of durable capability ownership.

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About the Author

Group Captain Rishi Raj Mohindru was commissioned in the Logistics Branch of IAF on 21 Dec 02. He is an alumnus of the DSSC, Wellington, JCSC Bangladesh, and CDM Secunderabad. He is an MBA from Nagarjuna University and also holds an MSc in Defence Studies from Madras University, and Masters in Management Studies from Osmania University.

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REPUBLICATION
Control of Air Littoral by Land Forces A Doctrinal Misstep in the Making: An Indian Perspective

Group Captain Swaim Prakash Singh, PhD

"Future warfare is all about air, space and sub-surface domains. The conventional land and sea domains will restrict to holding territories."
—Author

Abstract

Warfare is an inherently complex and serious business that cannot be conceptualised or executed on the flawed premise of the primacy of a single warfighting arm. The long-standing assertion that 'the nature of warfare remains the same, while its character evolves with time' warrants nuanced deliberation, structured reasoning and a contextually grounded understanding, especially in the light of a few Western narratives being built on the topic of Air Littoral. As expected, like similar concepts, this term has also been picked up by a few land-warfare enthusiasts trying to embed it in the Indian context.

In this regard, the proposition of delineating fixed geographical limits under the construct of Air Littoral and advocating for its control under a land forces-led command structure reflects a myopic view with borrowed and ill-conceived, unprofessional arguments. Such a construct not only risks diluting the core integrated Airspace Management (ASM) but also contravenes the doctrinal imperatives of jointness and integration across Services by diluting the basic tenets of air power.

This approach appears counterproductive and potentially regressive in the context of contemporary and future warfare, especially when the Indian Armed Forces are making concerted efforts to overcome legacy challenges and institutional frictions in pursuit of a genuinely integrated battle management architecture.

Essentially, the stated narratives focus on two distinct issues of defining the term 'Air Littoral' and the concept of its 'Control by the land forces.' This paper aims to highlight the drawbacks in the philosophy behind the control of the air littoral, using source-based, conceptual and contextual arguments. It will also underscore the critical importance of ASM in the Tactical Battle Area (TBA) and why it must continue to remain under the control of the Indian Air Force (IAF) within the integrated battle management framework.

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Air Littoral: A Conceptual Misfit

Militarily, the term 'Maritime Littoral' is broadly defined worldwide as "the portion of land and sea adjacent to the coast that is susceptible to influence or control from the sea and to influence or control the sea from the land." Operationally, this zone demands specialised capabilities such as amphibious operations, coastal defence, mine countermeasures and the integration of naval gunfire and air support with land operations through an integrated tri-services mechanism.

Drawing a simile from this, a few academicians have coined the term Air Littoral, though it does not appear in any doctrinal publications globally. In reality, Air Littoral is an inconsiderate borrowing from Western narratives and lacks conceptual validity.

In the air domain, there is no equivalent physical or geographical feature. Airspace is a continuous, three-dimensional medium defined by altitude, range and threat environment. It is in no case defined by fixed boundaries such as a shoreline. Both Indian and global

air doctrines already classify airspace by altitude bands (very low, low, medium, high, etc.), threat environment (permissive, contested, denied) and mission type (counter air, coordinated operations, Air Defence (AD), etc).

The proposed concept of Air Littoral adds no doctrinal clarity. Rather, it risks creating artificial silos and confusion over command and control (C2) responsibilities. The low-altitude fight is not a distinct 'special zone' requiring separate service ownership as envisaged by land-warfare enthusiasts. It is simply a segment of airspace within the Joint Air Defence System managed through layered AD Systems, counter-Unmanned Aerial Systems (UAS) measures, Close Air Support and Rotary Wing Operations through the Joint Air Defence Centre (JADC) under the centralised command of the Integrated Air Command and Control System (IACCS).

Furthermore, the Indian Armed Forces Joint Doctrine, the IAF Doctrine and the Joint Services Study Group (JSSG) documents make no reference to Air Littoral as an independent operational construct. Likewise, leading air forces such as the United States Air Force (USAF), the Royal Air Force (RAF) and the People's Liberation Army Air Force (PLAAF) do not recognise the term in their doctrinal lexicon. It just remains an academic expression without operational relevance.

Source-Based Arguments

Borrowed Western Narrative: Not Suited for Indian Context

The core argument of Air Littoral is largely based on foreign doctrinal experimentation and recent conflict-specific adaptations (e.g., Ukraine, Israel, USA) from a couple of foreign literatures. These examples emerge from unique geopolitical, technological and command structure environments. Attempting to replicate these foreign constructs, especially regarding the C2 of the air littoral, without contextual adaptation, amounts to simply force-fitting foreign models into India's vastly different strategic, organisational and doctrinal ecosystem.

India's battle management philosophy is shaped by the following realities:

- India is not expeditionary in nature, like the US or the North Atlantic Treaty Organisation (NATO).
- Joint operations are driven by sovereign geographical imperatives, not by global force-projection requirements.

Within this framework:

- India already operates under established joint doctrines and procedures governing air-land cooperation, including the so-called Air Littoral zone in the form of TBA.
- JSSG is the master document that unambiguously brings out the detailed coordination and operating procedures for all aerial platforms in the highly contested and congested TBA.

Reviewing Foreign Literature

Foreign literature on the subject is largely academic or opinion-based and cannot be applied to the Indian context, either selectively or in its entirety, without due consideration of India's doctrinal outlook, geography and capabilities. In most cases, the Indian Joint Doctrine and the IAF's existing capabilities already address the stated vulnerabilities, thereby negating the case for creating a new concept of an 'Air Littoral'.

Various doctrines and documents, such as the Joint Doctrine Indian Armed Forces (2017), IAF Doctrine (2012, 2022), JSSG and the précis of the Staff and War Colleges, categorically negate the validity of this borrowed construct in its entirety. Table 1, however, brings out opposing statements from Western literature itself, thereby validating the inadequacies of these arguments.

Interestingly, the Air Littoral concept mentioned in the aforementioned documents has been notably downplayed by USAF airpower practitioner Lt Col Grant Georgulis in his article “Drone Hype and Airpower Amnesia”, published in Air & Space Forces Magazine on July 25, 2025.

The aforesaid paper presents several arguments that seem to accord considerable emphasis to the perceived impact of drones on land warfare. The bottom line is that the loosely used term 'drones' for UAS, now being projected as a revolution in land warfare, had already evolved within air forces at least two decades ago. Consequently, the Tactics, Techniques, and Procedures (TTPs), including ASM in the TBA, have long been in practice. The devastating effects of such technology were widely witnessed during Operation Sindoor in May 2025.

Serial No.	Imported Quotes for Borrowed Argument (Slide no./Ref./Quote)	Air Power Doctrinal Stand (Ref./Quote)
1	**Ref. Parameters 51(4), U.S. Army War College** "Close battle now includes not only the area in front but also the area above."	**Airpower in Joint Operations: Air Force Doctrine Publication 3-0, Operations:** "The air domain is the atmosphere, beginning at the Earth's surface and extending to the altitude where its effects upon operations become negligible."
2	**Ref. Parameters 51(4), US Army War College** "The Air Space Generally located below 10,000 ft is defined as the area from the Coord Alt to the Earth's surface, which Must be Controlled to Sp Land and Maritime Ops and can be supported and defended from the air and / or the surface."	In the Indian context, there is a defined vertical limit below which JADC controls the air space. Above that defined limit the IACCS exercises complete command and control. A buffer zone is also demarcated for smooth transition. This demarcation resolves all the issues even with the proliferation of small drones.
3	**Ref. War on the Rocks Blog** "Units that lose control over Air Littoral will be vulnerable."	The unit stated here is the C&R C2 centre in TBA. It is not to be confused with Army unit holding firing units."Units that lose control over Air Littoral will be vulnerable."
4	**Ref. USAF Air & Space Power Journal (2016)** "With blue skies, AF becomes less responsive to land forces."	**Airpower in Joint Operations: Air Force Doctrine Publication 3-0, Operations:** Being responsive does not mean to be seen. "Airpower can create effects across multiple targets without occupying terrain or remaining in proximity to areas of operation to create effects upon targets."
5	**Ref. Grieco & Bremer (2021)** "Low-altitude threats doctrinally neglected."	**Airpower in Joint Operations: Air Force Doctrine Publication 3-0, Operations:** "Due to airpower's inherent flexibility, it can seamlessly transition between mission sets, while simultaneously exploiting the principles of mass and maneuver."
6	**Ref. Barry Posen: Command of the Commons** "High-density Air Littoral is an aerial minefield."	A high-density air littoral is not an 'aerial minefield but a dynamic, controllable, and exploitable battle space. The C4ISR networks, joint airspace management, IFF and layered air defence procedures ensure real-time deconfliction between friendly forces, while allowing precision engagement of adversaries.
7	**Ref. AFTTP 3-2.86 (USAF)** "AF must extend Ops Centres to Coy level."	**IACCS Overview, BEL 2019:** "The IACCS links radars, sensors, and shooters from national to unit level, enabling engagement control without duplicating C2 nodes at every echelon."

Table 1: Air Power Doctrinal Stand against Imported Quotes (Source: Compiled by the author from multiple sources.)

In the Indian context, particularly for drones of nuisance value (e.g., swarm drones), a chain of counter-UAS (CUAS) systems with both soft and hard kill capabilities already operates under the centralised command of IACCS with decentralised execution and complete operational freedom, meeting the requirements of the IA, thereby eliminating the need for a separate structure. Further, the wide variety of UAS spread over the flight envelope in terms of height and operating speed makes any separate structure unnecessary. Nevertheless, it requires further strengthening, and it has to be both a joint and an integrated effort.

Notably, NATO's Joint Air Power Strategy of June 26, 2018, effectively negates the foregoing imported quotations. Similarly, the USAF Doctrine Publication 3-0, Operations, published on January 22, 2025, provides a

self-explanatory paragraph on 'Fires' and 'Air Space Control.' An excerpt is mentioned below:

"The fire's function is supported by the airpower tenets of synergistic effects and concentration as airpower masses and manoeuvres to surprise adversaries by creating effects at the times and locations of the JFC's choosing. USAF contributions to fires are primarily captured in AFDP 3-01, Counter Air Operations, AFDP 3-03, Counter Land Operations, AFDP 3-04, Counter Sea Operations, AFDP 3-12, Cyberspace Operations, AFDP 3-14, Air Force Space Support, AFDP 3-70, Strategic Attack, and AFDP 3-72, Nuclear Operations. In addition, for long-range fires considerations, see AFDP 3-52, Airspace Control, and AFDP 3-60, Targeting".

The Fallacy of Drawing Lessons from Ukraine

The literature has also tried to draw inferences from Ukraine as a template for battlefield air control, which is rather problematic.

- OSINT indicates Ukraine operates under a 'weapons-free' environment, characterised by minimal restrictions on engagement within contested zones, primarily because the protracted conflict has not manifested as a classical air war in the conventional sense.
- Indian Rules of Engagement (RsOE) are more controlled, disciplined and politically calibrated. Airspace is a regulated battlespace, especially given proximity to nuclear thresholds, involving both adversarial interaction and escalation management.
- Drawing conclusions from a unique warzone with permissive engagement and applying them to a structured Indian context or TBA is operationally dangerous with a flawed foundation.
- Operation Sindoor has clearly reminded us that joint and integrated warfare is the only key to success in the Indian context.

Conceptual and Contextual Arguments in the Indian Context

Understanding the Tactical Battle Area (TBA). The TBA refers to a geographically defined zone of military operations that is dynamically flexible and horizontally fluid. While land operations form its core, air operations conducted by both manned and unmanned platforms are an integral component of the TBA. These flying platforms vary significantly in speed, ranging from slow movers to high-speed and very high-speed systems, and operate across a wide vertical envelope from terrain-hugging altitudes to high-altitude flight levels, thus making it Multi-Level Multi-Domain (MLMD) warfare.

Given this multi-layered tactical environment, all aerial platforms within the TBA operate under a complex, multi-level threat scenario, often from friendly weapon systems. To prevent fratricide and ensure the optimal employment of the most suitable weapon systems, a designated authority must regulate the use of airspace. This function is known as Airspace Management. This aims to provide freedom of action to all operators through defined and dynamic procedures while avoiding fratricide and simultaneously denying the enemy use of the air medium.

In the Indian context, the responsibility for the country's air defence lies with the Air Force, as mandated by the Union War Book. The Control and Reporting (C&R) element of the IAF, as the designated authority through IACCS, exercises full airspace management 24x7x365, be it during peacetime, wartime and No War No Peace (NWNP) situations.

With the advancement of technology and the availability of longer-range weapon systems, it has become necessary to reassess vertical boundaries within the TBA. As a result, it was revised once in late 2000. However, such reassessment must not infringe upon the operational freedom of other combat elements within the same space in increasing the vertical limits manifold, as envisaged in the said concept. It is to be ensured that C2 continues to be centralised irrespective of the number of users in the TBA.

In light of the narrative proposing a vertical coordinating limit of 3 km (10,000 feet) exclusively for land forces, this is a tall claim, lacking not only operational rationale but also conceptual and contextual grounding.

Conceptual Divergence Vs Conceptual Overreach

The proponent of *Air Littoral*, who claims it to be the so-called *'Conceptual Divergence'* from air forces doctrine, presents not an innovative doctrinal breakthrough but rather a case of *'Conceptual Overreach,'* rooted in a borrowed maritime metaphor that has no intrinsic significance in the air domain.

The contribution of UAS to warfare is substantial and complementary but not transformational. Drones can observe, harass, or even sting, but they cannot control. Air power is characterised by control of the airspace, strategic reach and decisive impact.

In the Indian context, the divergence between the need for land and air forces is already doctrinally resolved in existing joint documents and related SoPs through integrated C2, layered engagement and shared situational awareness via IACCS. By ignoring these established mechanisms and importing a non-doctrinal term like *Air Littoral*, the argument creates an artificial fault line between the Services where joint doctrine already provides the solution.

Therefore, the assertion of *Air Littoral* as a key imperative needs correction in light of established doctrinal considerations. A few of the critical questions that merit introspection by the land forces are mentioned below:

- What is the rationale for setting a vertical limit of 3 km (10,000 feet)? Are only guns, artillery, AD guns, and UAVs intended to operate below this altitude?
- Will the land forces not also be controlling the Short, Medium and Long-Range Surface-to-air Guided Weapons (SAGWs) of Army units deployed in the TBA or in adjacent areas falling within their engagement ranges?
- Will Special Heliborne Operations (SHBO) be restricted to altitudes above 3 km, and would that be tactically and doctrinally viable?
- Will fighter aircraft be permitted to ingress and egress within the TBA only above the 3 km ceiling?
- How will the land forces ensure that fighter aircraft can switch from subsonic to supersonic speeds and change altitudes rapidly during BVR hot/cold patterns, in order to optimise missile performance while remaining outside enemy radar coverage within the 3 km altitude band?
- The IAF inventory of 4.5-generation aircraft achieves optimal engine performance at around 3 km altitude, while deep-penetration aircraft require even lower altitudes for maximum effect. How would the land forces effectively control and coordinate the operations of such aircraft?
- What mechanisms will ensure effective deconfliction of multi-domain operations, particularly in high-threat and high-tempo scenarios?
- Would interdiction missions under coordinated air operations be excluded from TBA or fall under land forces control within it?
- How will air-landed and air-assault operations transition between areas outside and inside the TBA?
- What measures will protect aircraft operating within the TBA from aerial threats and standoff weapons originating outside this envelope?
- What would be the implications for air operations near forward airfields or Advanced Landing Grounds (ALGs), often located within or adjacent to the TBA?
- How will land forces manage airspace across the International Border (IB), Line of Control (LoC), Line of Actual Control (LAC), and the rest of the sectors during peacetime, wartime and in the NWNP scenarios near/ adjacent/ within TBA?

These few questions, out of many, underscore the need for a balanced and integrated approach to airspace control, rather than adopting vertical limitations and seeking command and control that risk operational friction and tactical incoherence, affecting strategic outcomes.

Lack of Doctrinal Merit

In another work, the notion of an *"Air-Surface Littoral"* has been introduced. This reflects a divergence in the understanding of doctrinal nuances related to integrated operations in the TBA. The following arguments indicate that the proposed construct of an *Air Littoral* or *Air-Surface Littoral* does not align with established doctrinal principles.

- A joint document on the subject exists both at the joint level and the service-specific level.
- It clearly defines roles and responsibilities, C2 structures and deconfliction procedures in the TBA.
- There is no doctrinal void per se, only a need for adherence.
- There is a need to trust the process and adhere to the joint document for better interoperability,

strengthening air-ground coordination mechanisms, and avoiding command takeover or Army ownership.

- Elevating a threat perception into an argument for Army-led control of the airspace dilutes the very purpose of jointness, which is meant to synergise, not override, the inter-service roles.
- Unity of Command is essential to ensure optimal employment and freedom of action for all weapon systems (land or air, manned or unmanned, across multiple operational levels) in TBA.
- The fundamental doctrinal tenet of ***Centralised Command, Distributed Control and Decentralised Execution*** remains non-negotiable and sacrosanct for implementing dynamic ASM within TBA.
- The stated joint document stands as one of the most comprehensive operational documents for integrated battle management. However, its utility remains underleveraged due to limited understanding and non-ratification by the land forces.

Air Littoral is not About Control but Efficiency and Safety Issues

Though the term *Air Littoral* is undefined, it is inherently a shared battle space; it is not about one that must be 'controlled' solely by one Service. While the Army is the primary user in the TBA, especially with the advent of drone swarms and loitering munitions, this does not logically lead to the Army 'owning or leading' the air littoral. This remains applicable globally.

Instead, existing and time-tested JADC structures need to be further strengthened by trained manpower and digital communication from land forces, both for voice and data, in the Indian context. The very fact that most of the air domain threats to land forces now emerge from the low-altitude envelope makes it more imperative for the IA to be familiar with the nuances of air power and its utilisation in MLMD warfare. It needs to be internalised that the Air Force retains:

- Generation of an Integrated Air Picture through feeding by Army and Navy networks (Digital/Manual) as well.
- Building up of Recognised Air Situation Picture (RASP) in the indispensable congested airspace through sensor fusion, real-time data links, and air deconfliction.
- Battlefield air strike coordination and execution.
- Control of air traffic, deconfliction and dynamic management of weapon fire areas/zones (WFA).

Instead of displacing the IAF, Army integration can be enhanced through:

- Empowered Ground Liaison Officers (GLOs) and embedded TACs with enhanced operational training.
- Need-based shared access to IAF's ISR and C2 pictures.
- Creating/Strengthening Joint battle planning cells at Corps HQs through effective implementation of procedures in Corps Area Control Centre (CACC).
- Integration with the proposed Drone Airspace Management Cells (DASM) at airbases.
- Immediate operationalisation of Akashteer at the unit level and seamless integration into the IACCS architecture.
- To ensure fratricide-free airspace management, enhance war-footing training of IA operators in C&R digital reporting and in executing orders received from IACCS.
- Participation of IA troops in the realistic tactical and operational exercise/war gaming in TBA.

Trust in the Joint Process is the Real Need

A recurring theme in such arguments is the perceived trust deficit in timely decision-making, execution of orders, responsiveness and communication latency. These concerns, however, can be effectively mitigated if IA acknowledged that *'Unity of Command'* is a non-negotiable principle in the regulation of airspace, especially in an environment where a diverse range of aerial platforms (manned-unmanned, slow-fast and hypersonic) operate simultaneously.

The land forces' apprehensions regarding responsiveness are best addressed by Tactical Air Centres (TACs), Forward Area Controllers (FACs), and enhanced IA-IAF integration at lower echelons, which need to be further institutionalised, not bypassed. Also, the land forces coercing the concept of 'persistent presence' and 'under command' must be examined within the bounds of available technology, capability and survivability, which the Air Force is

best equipped to manage for an effective integrated battle management.

Operation Sindoor: A Contextual Reality Check

Future warfare is increasingly shifting its centre of gravity towards the air, space and sub-surface domains, where speed, precision, stealth and information dominance are decisive. As technology redefines the character of conflict, these domains offer strategic advantages far beyond the physical occupation of land or sea. Air and space provide unparalleled reach, surveillance and rapid strike capabilities while sub-surface operations ensure stealth, survivability and disruption of critical infrastructure.

In contrast, the traditional land and maritime domains are progressively being relegated to roles focused on holding ground and securing strategic chokepoints rather than initiating or shaping the battle. This statement is not an off-the-cuff remark but requires a serious, impartial, and futuristic professional brainstorm that rises above the arguments of structures, notions of victory, etc. The essence of future war lies in mastering the intangibles such as electromagnetic spectrum, cyberspace, orbital dominance and deep-sea superiority, where control equates to deterrence, denial and domination.

Operation Sindoor, with clearly defined conflict termination criteria, has redefined this argument within the Indian context. The punitive impact delivered through the medium of air achieved in less than 30 minutes during each wave of targeting has reaffirmed that contemporary conflicts are increasingly being shaped in the vertical dimensions rather than solely on the ground.

While the primacy of land and maritime domains remains undisputed, it is time to acknowledge a significant shift. The traditional roles are reversing, with air power now taking a decisive lead and surface forces assuming more supportive functions in shaping and concluding conflicts.

Before advocating for the *Control of Air Littorals*, it is important to recall the operational realities witnessed during Op Sindoor. The air operations were orchestrated in a manner that enabled tactical freedom of action for all types of weapon systems (manned, unmanned aircraft and surface weapons) based on real-time threat assessments and the required response. However, classical airspace management, wherein both aircraft and surface-based weapons operate with full freedom, remained limited.

The prevalence of mass unarmed drone saturation, often deployed as a nuisance and harassment wave, necessitated prioritising surface-based weapon engagement in most scenarios. Fighter aircraft were thus employed primarily for offensive missions and maintaining air defence (AD) watch beyond the effective envelope of surface-based weapons. This operational arrangement, dictated by situational constraints, cannot be misconstrued as a precedent for reshaping or rewriting an Air Littoral doctrine under the primacy of the Indian Army.

Op Sindoor demonstrated the IAF's operational acumen and responsiveness to an unprecedented situation. A robust joint AD and CUAS grid was rapidly put in place, utilising existing procedures and coordination arrangements to excellent effect.

The operation was conducted with de novo operating procedures for the first time while dealing with scenarios that already exist in the joint operating mechanism. It is just a matter of how best and timely it is orchestrated. The forward-looking and careful planning facilitated unproblematic utilisation of available platforms, networks and procedures.

The success highlighted the power of jointness, agility and innovation within real-time battlefield scenarios. Notably, the operation also produced valuable lessons and the process of consolidating tactics, techniques and procedures continues to be an ongoing effort to improve future readiness.

In fact, it is to be internalised by the land forces that such smooth conduct of operations could take place only because of Unity of Command with the principle of *Centralised Command, Distributed Control and Decentralised Execution* through IACCS of IAF.

Conclusion

In contemporary and future warfare, technology plays a pivotal role in shaping capabilities, enabling new forms of engagement and offering enhanced situational awareness. However, the formulation of military doctrine must remain a product of strategic foresight, operational logic and historical military wisdom and not of reactionary impulses triggered by emerging technologies under the trap of 'technological panic.'

The discourse advocating for the creation of new C2 structures redefining air domain boundaries ostensibly to accommodate unmanned systems and slow movers' risks, is at the cost of the fundamental principles of



joint warfare.

The proposal to give land forces command over the air littoral is an agenda-based conceptual overreach based on foreign models, false doctrinal gaps and misapplied conflict lessons. Building a narrative of *Control of Air Littoral* is operationally risky and counterproductive, leading to a mass fratricide scenario. Rather than questioning the IAF's primacy in airspace management and gaining control of airspace by the IA, efforts must focus on the following:

- Airspace remains centrally controlled for safety, deconfliction and tactical flexibility for achieving operational and strategic effects.
- Land-Air synergy is achieved through joint training, empowered liaison and procedural reforms, not structural domination.
- Strengthening joint structures for air-ground integration.
- Joint planning and execution of operational fires.
- Avoiding doctrinal fragmentation in pursuit of temporary tactical convenience.
- Operationalisation of Akashteer and enmeshment into IACCS without further delays.
- Army to devise and revise ground tactics in view of emerging technological challenges in a multi-domain scenario.

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About the Author

Group Captain Swaim Prakash Singh, PhD, is a Cat 'A' Master Fighter Controller and AWACS Mission Commander with over 1,000 flying hours. He is currently serving as a Directing Staff member at the College of Air Warfare (CAW), Secunderabad. He holds an MSc, Mphil, and PhD in Defence and Strategic Studies. He has authored the book Indian Air Force and Integration of Armed Forces and edited Indian Air Force in its Centennial Decade, in addition to publishing over 50 articles on aerospace power and national security.

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A Practitioner's Case Study
Leveraging Operations Research for High Altitude Logistics Resilience

Colonel Himanshu Pandey

(DMJ/XXIII/02/2024/08)

"The strength of the Army is measured not just in battle, but in its readiness to endure, every stocked item is a thread in the fabric of victory."
General Upendra Dwivedi, PVSM, AVSM, ADC

Abstract

Traditionally, the distribution of scarce resources in logistical replenishments in a challenging setting, like in High Altitude, is intuitive and based on experience. This practice may have stood the test of time, and yet it may lack efficiency. This practitioner's case study explores a crisis situation in which operational readiness was put at risk due to unforeseen weather disruptions compromising the Advance Winter Stocking of vital stores for Company Operating Bases (COBs) deployed in High Altitude Area (HAA). It is attempted to depict that by applying the Transportation Model from Operations Research (OR), the Operational Logistics functionaries, including Commanders, could optimise allocation of scarce multi-modal transport resources for time-critical stocking/ replenishment and transcend traditional intuition-based planning to informed decision making.

The author also emphasises the role of logistics in moving beyond mere 'efficiency' to 'endurance' and believes that when time, terrain and resources are severely limited, military logistics planning is greatly strengthened by Operations Research tools.

This is the practitioner's version of the Teaching Case Study, titled "Leveraging Operations Research Tools for Optimal Utilisation of Scarce Multimodal Transport Resources for Undertaking Advance Winter Stocking in High Altitude Operational Area", that was originally authored by the officer as part of the HDMC curriculum at CDM, Secunderabad, in 2024-25.

Keywords. Logistical Resilience, Operations Research, Transportation Model, High-Altitude Warfare, Strategic Deterrence, Risk Management, Military Decision-Making.

Introduction

In September 2022, an unexpected early snowfall well ahead of the anticipated date of 15 Nov 2022, rendered Romeo Pass, a critical mountain pass, temporarily impassable, disrupting the ongoing Advance Winter stocking effort for forward Company Operating Bases (COBs) of a Mountain Division sector along the LoC, in a high-altitude operational sector. With winter approaching faster than anticipated, three key COBs remained only partially stocked, particularly for essential non-airliftable supplies like kerosene. Formation Headquarters assessed that reopening of the pass with the efforts of BRO, if at all, would likely occur only for a short and uncertain duration, creating intense pressure on logistics planners. The responsibility therefore shifted to the staff and commanding appointments to rapidly reassess priorities, optimise available transport resources, and prepare to execute stocking of all three bases in a single concentrated effort whenever even a brief operational window became available. The situation demanded immediate decision-making under the challenges of weather, mobility, and limited resources, transforming routine logistical planning into a time-critical operational challenge focused on maximising stocking within one opportunity, yet in an efficient way. This scenario highlights a fundamental reality, 'Logistics in high-altitude environments are the backbone of strategic endurance'. Such turbulence in winter stocking narrows the line of deterrence along disputed boundaries, morale plunges, combat effectiveness diminishes and mistakes that could lead to conflict become possible.



The maintenance of troops deployed in forward areas is not just an exercise in logistics. It is the basis of operational preparedness in harsh high-altitude areas along the Line of Control (LoC), where early snowfalls can turn rocky passes impassable in a matter of hours. It's a challenge for a Staff Officer to optimise the distribution of limited multimodal transport resources, which include Air Fixed/ Rotary Wing, Mechanical Transport ALS (a 5/7.5 Ton Load Carrier)/ 2.5 ton/ Civil Hired Transport (CHT), Animal Transport, Porters & Ponies. It is a task inherently juggling with multiple options, but there are limited viable choices to do it efficiently.

The 'right efficiency' in logistics operations is in moving beyond cost minimisation to operational resilience by presenting it as the ability to maintain forces for extended deterrence. The study demonstrates how an OR model promotes an evidence-based decision-making culture in which quantified insights are used to control uncertainty. The focus of this practitioner's case excludes a detailed technical description of model mechanics and aims at a more conceptual examination of how Operations Research (OR) tools, such as the Transportation Model, facilitate decision-making in military settings, which generally grapples with limited resources.

Case Narrative: The Phenomenon of Logistical Peril in High-Altitude Operations

A Divisional Army Service Corps battalion assigned to provide logistical support for a Mountain Division was at the centre of the crisis. Romeo Pass became impassable due to early snowfall, leaving three crucial COBs with incomplete AWS and stranding a convoy load carriers. In addition to ammunition and rations that cannot be co-transported due to safety regulations, these bases, which are crucial for sustaining forward deployments, needed an immediate resupply of non-airliftable goods that include certain types of ammunition, highly inflammable fuels like Superior Kerosene Oil (SKO). The only other alternative was to arrange for porters to man pack stock, which would be extremely inefficient and require a three-day hike from Road Head to the farthest COBs.

By the last week of Sep 2022, winter stocking of seven COBs had already been completed; however, three critical bases remained partially stocked, particularly for SKO. Compounding the problem, a convoy of 30 vehicles was stranded on the other side of the pass. Intuitive requirement, based on empirical data, highlighted an overall requirement of 119 ALSs load for a single one-way convoy to complete stocking of the remaining three COBs in one go. However, Higher HQs were not in a situation to allocate all vehicles as demanded, facing similar challenges in other sectors of the Corps Zone. Optimisation was the only solution.

- The following simulated quantities, given in Table 1 (fictitious figures given in Metric Tons/ Kilo Litres), were required to be stocked to ensure sustenance till Romeo Pass reopened in the next year's summer.
- **Stocks available at Replenishment Depots.** Stocks available at different logistics replenishment units, like Composite Platoons/ Supply Points/ Amn Points, from where Ration, SKO, Amn and miscellaneous items were to be collected/ loaded in vehicles for undertaking stocking of the aforesaid three Bases is tabulated in Table 2.

Name of the Adm Base that was to be stocked	Items and quantities required to be stocked			
	Amn / Medicines (MT)	SKO (KL)	Ration (MT)	Remarks
Base A	30	50	40	Amn, SKO, Rations cannot be transported in same Vehicle/ ALSs
Base B	40	40	30	
Base C	30	30	20	

Table 1: Adm Bases to be stocked (simulated quantities)

Supply Depot/ Amn Point	Quantum of stocks available		
	Amn (MT)	Rations (MT)	SKO (KL)
Depot X	50	70	80
Depot Y	60	60	90

Table 2: Stocks available at various Depots (simulated quantities)

Challenges

The organisational context involved coordination between Formation Headquarters, Supply Depots, Transport units, Border Roads Organisation (BRO) and Combat Engineers. Factors that made the situation even more challenging were:

- **Limited availability of load carriers (ALSs).** As other Sectors in the Corps Zone concurrently were facing a similar challenge of early snowfall and partial stocking.
- **Restricted convoy movement days.** Due to the CI/CT situation in the valley, Sundays & Friday were NO MOVEMENT days as no Road Opening Party was deployed in the Corps Zone.
- **Load-carrying limitations of ALS in HAA.** The environmental conditions in HAA and the road load bearing classification necessitated a greater number of vehicles than classical planning templates, owing to reduced loads in ALS. Refer to Figure 1, Depot X was located on a Class 12, One Way Single Fairweather Road, with a gradient that reduced the vehicle load carrying capacity to 3 tons/ALS than classical capacity of 5 Tons /ALS, thus adversely impacting the supplies from Depot X.
- **Inability to airlift.** Non-applicability of air transportation for certain commodities (SKO) due to Hazard Classification and safety regulations denied the stocking of COBs using Fixed and Rotary Wing Transport Assets of the IAF.
- **Narrow and Uncertain weather windows.** Availability of a brief window after initial snowfall was based on inputs from the Meteorological Department, SASE & past years' weather records, as also BRO, assured that they will be able to open the Pass for a brief period of a day or two for convoy movement. Since, the weather is unpredictable, there was requirement to plan and execute the stocking in an efficient way.

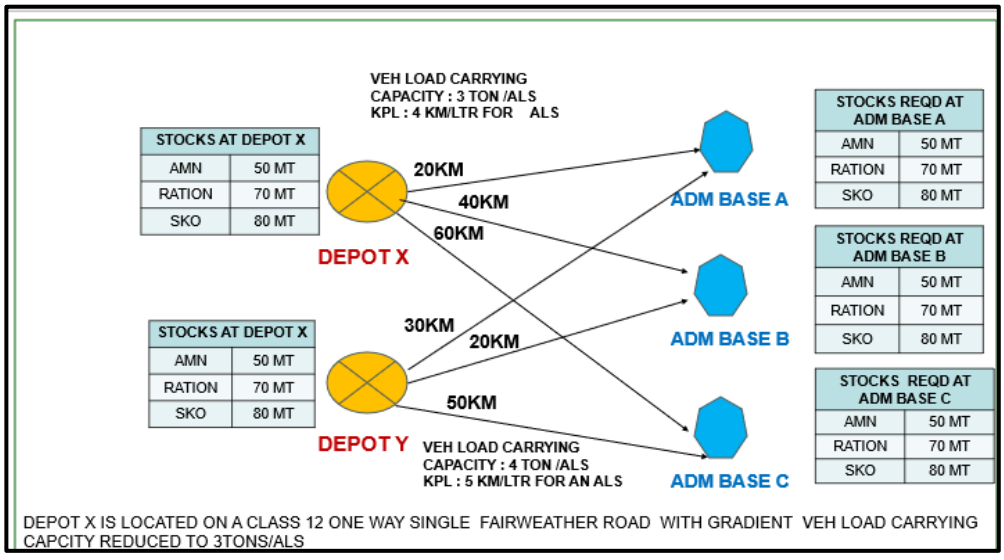

Figure 1: Schematic Structuring of Transportation Model in the Case Study

Faced with these pressures, the logistics team needed a defensible, optimised plan to complete AWS within a narrow operational window.

Aim

The exercise aimed to examine how Advance Winter Stocking of the remaining three Company Operating Bases could be completed within a limited time and operational challenges, through optimal and efficient allocation of available transportation resources, using analytical decision-making methods like the Transportation Model.

Theoretical Lens

Unpacking Decision Making Under Constraint. Structural limitations in the high-altitude logistics system and vagaries of weather exacerbated the situation. Conventional experience-based planning was insufficient on its own because: -

- Resource shortfalls had to be justified quantitatively to higher headquarters that

controlled the scarce transport resources and multiple sectors facing the challenge of early snowfall and incomplete stocking. A bid for 119 ALSs was unlikely to succeed in a competitive resource environment without analytical backing.

- The time available for execution was extremely limited. BRO had assured max three days' window for the upward and downward convoys. Situations of compressed timelines, competing demands and resource constraints transform logistics planning into a structured decision problem rather than a routine, intuitive administrative function. It is in this context that Operations Research offers analytical support.

Management Tool Applied: Transportation Model

Operations Research as a Beacon in Uncertainty. In defence literature, OR is praised for bringing objectivity to uncertain but quantifiable, high-stakes situations. The Simplex Linear Programming method works by systematically examining different possible allocation options within the given limits and gradually identifying the best possible solution. It helps determine how supplies should be distributed so that all requirements are met while using the least amount of resources, such as fuel or vehicles.

Transportation Model. This case is analysed using the Transportation Model, a specialised Linear Programming technique within Operations Research. The model is suited to problems with multiple supply points, multiple demand points, fixed supply and demand quantities, and transportation costs that vary by route. The model explains how optimal allocation decisions can be made when: -

- Multiple supply points exist (replenishment depots).
- Multiple demand points exist (administrative bases/ COBs).
- The demands at each COB must be met within the short window of opportunity amid many challenges highlighted earlier.
- Transportation costs vary by route and conditions (refer to Figures 1 & 2). The important aspect is the payload and fuel asymmetry. Due to the higher road gradient and lower Rd Classification from Depot X vis-à-vis Depot Y, the KPL of ALS operating from Depot X was reduced to 4 Km/Ltr, incurring a higher overall cost.

Depot	COB	Distance (km)
Depot X	COB A	20
Depot X	COB B	40
Depot X	COB C	60
Depot Y	COB A	30
Depot Y	COB B	20
Depot Y	COB C	50

DISTANCES

Depot	Cost/ Km (KPL)
Depot X	5
Depot Y	4

TRANSPORT COSTS

COB	Amn	Ration	SKO
COB A	30	40	50
COB B	40	30	40
COB C	30	20	30

DEMAND REQMTS

Depot	Amn	Ration	SKO
Depot X	50	70	80
Depot Y	60	60	90

SUP AVAILABILTY

Depot	Veh Cap (Tons)	Remarks
Depot X	15	Min 5 Vehs Cvy mandated due to CI Envt
Depot Y	20	

VEHICLE CONSTRAINTS

Figure 2: Constraints of the Transportation Model Problem

Cost as a Proxy. Although there will be various other Costs involved in the overall advance winter stocking, Figure 3 defines the cost based on Fuel only, which is used as a proxy in the OR Model for ultimately arriving at the minimum cost and thus the minimum resources (ALSs) required for the task in the given compressed timelines (the fewer the number of vehicles plying, the faster the stocking).

The Model Matrices. The model was solved using Excel Solver (it's an add-in available in Microsoft Excel; a screenshot is shown in Figure 4), enabling rapid scenario testing and validation of alternative plans. The highlighted cost values in each row of the matrix in Figure 5 are the feasible route costs taken from calculations shown in Figure 3. The very high '9999' values in the matrix (Figure 5) make the calculations prohibitively costly for these options, thus helping exclude infeasible allocations (ie, deny the co-transportation of mixed commodities in the same vehicle).

Depot	COB	Distance (km)
Depot X	COB A	20
Depot X	COB B	40
Depot X	COB C	60
Depot Y	COB A	30
Depot Y	COB B	20
Depot Y	COB C	50

DISTANCES

×

Depot	Cost per km
Depot X	5
Depot Y	4

PER KM TPTN COST

=

Depot	COB	COST
Depot X	COB A	20 x5 =100
Depot X	COB B	40 X5=200
Depot X	COB C	60x 5=300
Depot Y	COB A	30x4=120
Depot Y	COB B	20x4=80
Depot Y	COB C	50x4=200

TOTAL COST

COST IS ACTUALLY MILEAGE i.e. KPL OF ALSs eg 4KM/LTR OR 5 KM/LTR IN THIS CASE

Figure 3: Cost of Transportation Commodities from Depots to Adm Bases (fictitious figures for representation only)

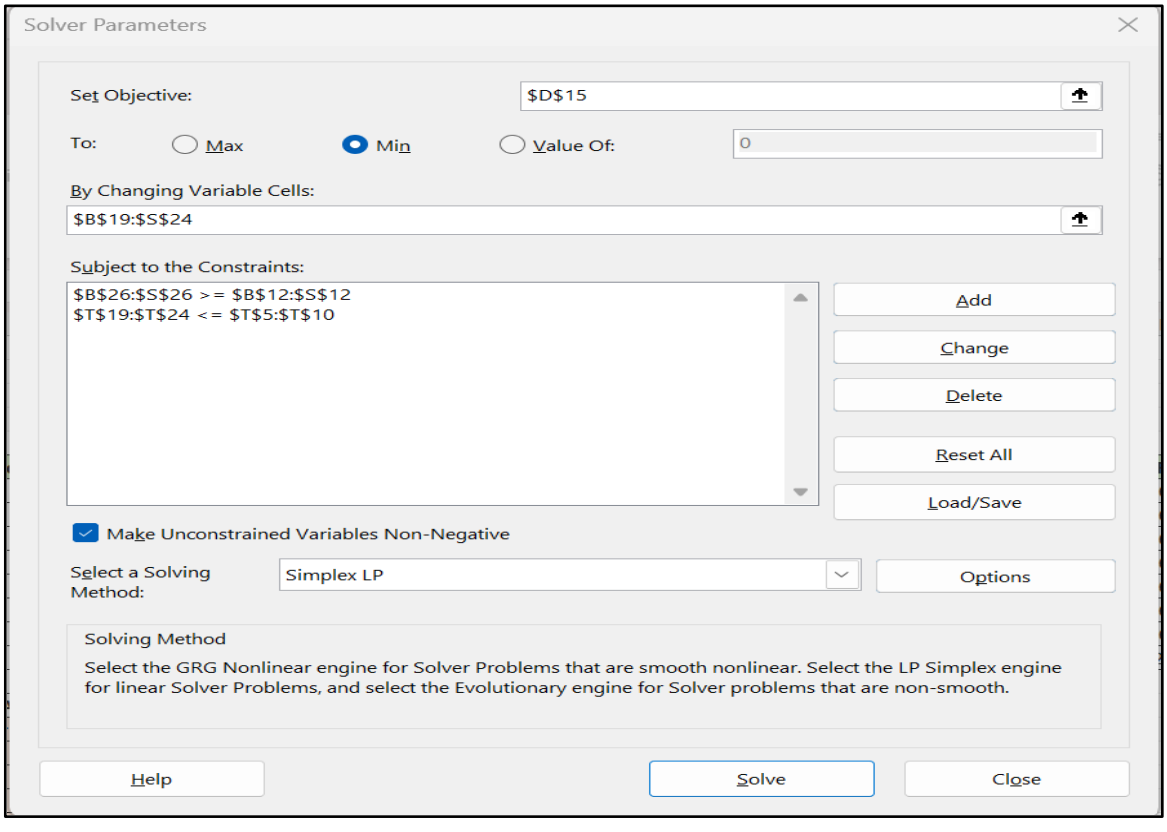

Figure 4: Excel Solver

Binding Constraints. The Demand row at the bottom and the Supply column on the right define the binding 'Constraints'. The Solver must find allocations that exactly satisfy every demand cell (each COB's AWS demand must be met) while not exceeding any supply cell (as supply cannot be more than the depot stock available).

	XAA	YAA	XRA	YRA	XSA	YSA	XAB	YAB	XRB	YRB	XSB	YSB	XAC	YAC	XRC	YRC	XSC	YSC	Supply
XA	100	9999	9999	9999	9999	9999	200	9999	9999	9999	9999	9999	300	9999	9999	9999	9999	9999	50
XR	9999	9999	100	9999	9999	9999	9999	9999	200	9999	9999	9999	9999	9999	300	9999	9999	9999	70
XS	9999	9999	9999	9999	100	9999	9999	9999	9999	9999	200	9999	9999	9999	9999	9999	300	9999	80
YA	9999	120	9999	9999	9999	9999	9999	80	9999	9999	9999	9999	9999	200	9999	9999	9999	9999	60
YR	9999	9999	9999	120	9999	9999	9999	9999	9999	80	9999	9999	9999	9999	9999	200	9999	9999	60
YS	9999	9999	9999	9999	9999	120	9999	9999	9999	9999	9999	80	9999	9999	9999	9999	9999	200	90
Max Demand																			
DEMAND	30		40		50		40		30		40		30		20		30		

Figure 5: Transportation Mathematical Model

The Model Outcome. Figure 6 shows the Excel Solver outcome within the defined Constraints. Solver minimises the total fuel cost to Rs 37,800/-, and the highlighted cells are the final distribution of stores, telling us what moves where! The payload asymmetry between Depot X (3 tons/ALS on a Class 12 road) and Depot Y (4 tons/ALS) means that even for bases closer to Depot X, there are alternatives where Depot Y is the more efficient source. The model identifies this interaction across all six commodity-route combinations simultaneously, a multi-variable optimisation that experience-based planning cannot replicate reliably under time pressure.

Zmin	37800

	XAA	YAA	XRA	YRA	XSA	YSA	XAB	YAB	XRB	YRB	XSB	YSB	XAC	YAC	XRC	YRC	XSC	YSC	Supply
XA	30	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	40
XR	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
XS	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	50
YA	0	0	0	0	0	0	0	40	0	0	0	0	0	20	0	0	0	0	60
YR	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	20	0	0	50
YS	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	30	70
Max Demand	30	0	40	0	50	0	0	40	0	30	0	40	10	20	0	20	0	30	
DEMAND	30		40		50		40		30		40		30		20		30		

Figure 6: Solver Outcome- Cost Minimisation and Final Distribution of Different Commodities from Different Depots

Finally, Figure 7 answers how many vehicles the Solver distribution actually mandates. The calculations convert the Excel Solver outcomes into ALS counts by dividing each allocated quantity by the payload capacity of the ALS on that route. The output is the minimum number of ALSs required to complete the task, which comes to 90 ALSs.

		ALS Reqd @3 Ton/ALS			
		Amn	Ration	SKO	Total
X-A-AMN	30	13.33			
X-C-AMN	10				
X-A-Ration	40		13.33		
X-A-SKO	50			16.67	
Total Supply	130	No of ALS reqd@ 3 Ton per ALS			43.33
		Commodity Wise			45

		ALS Reqd @4 Ton/ALS			
		Amn	Ration	SKO	Total
Y-B-AMN	40	15.00			
Y-C-Amn	20				
Y-B-RATION	30		12.50		
Y-C-RATION	20				
Y-B-SKO	40			17.50	
Y-C-SKO	30				
Total Sup	180	No of ALS reqd@ 3 Ton per			45.00

Figure 7: Total No of Load Carriers Required from Depot X and Depot Y to Respective Adm Bases

Analysis

Initial planning, based on empirical experience, estimated an overall requirement of 119 ALS loads for a single one-way convoy to complete stocking of the three COBs. However, higher headquarters could not allocate this demand, facing concurrent shortfalls across other sectors in the Corps Zone. Optimisation was the only viable path forward, and it is precisely here that OR offered a structured, evidence-based alternative to intuitive judgement.

The Transportation Model identified patterns of allocation that were previously not apparent. It demonstrated how little adjustments to allocation might drastically lower the overall cost of transportation and the number of vehicles needed, allowing for the approval of additional resources. The main underlying cause was a mismatch between environmental variability and anticipated stocking timelines, which was fixed by analytical optimisation that enabled adaptive reallocation under the compressed timelines.

OR intervened by revealing hidden efficiencies, optimal allocations reduced vehicle needs by approximately 25% in the given case (Figure 7), allowing completion within shrinking weather windows. Conceptually, this also reshapes military culture from reactive firefighting to proactive risk management.

Furthermore, using the Simplex LP engine in the Excel Solver, the model allowed for quick "what-if" scenarios called the Sensitivity Analysis. For instance, a 1-unit increase in vehicle availability results in a 5% decrease in total trips, supporting the need for more ALS requisitions. The model also revealed certain operational insights. Moving 10 ALSs from Depot Y to Base B may allow their use for high-priority SKO stocking, thereby increasing endurance without compromising on resource availability.

Aim was achieved in the ibid case narrative, stocking of balance three COBs could be completed in a mere three-day window using 90 ALSs against the initial intuitive demand of 119 ALSs. Critically, this case shows how the model's optimal allocation output can be converted into a quantified, time-bound vehicle requisition that provides a defensible and auditable basis for resource bids to higher headquarters.

Alternative Approaches and Recommendations

Based on the tools and theory applied, the following alternatives are recommended: -

- Institutionalise OR-based planning for all AWS/ AMS operations at the tactical/ operational level.
- Develop pre-built Transportation Model templates for rapid activation during contingencies.
- Incorporate weather-risk buffers directly into optimisation constraints.
- Strengthen data integration between logistics units, engineers and meteorological inputs.
- The same model could be used for Multi-Modal Transport stocking (Animal Transport, Rotary Wing & Fixed Wing Aerial Assets, Logistic Drones, Porters and Mechanical Transport).

Lessons for Management Practice

Important lessons include: -

- Analytical tools may not replace the Commander's judgement, but certainly enhance it. As seen in this case, the resulting allocation is not just 'better' than the manual intuitive plan, but mathematically optimal within the defined constraints of vehicle capacity and road classification.
- OR models improve the credibility of resource bids to higher headquarters by quantifying the outcomes unambiguously. In fact, it acts as a catalyst for institutional trust, transforming subjective 'bidding' for resources into objective, data-backed requirements.
- Logistics resilience depends on flexibility supported by data-driven planning.
- Standard Operating Procedures for AWS should mandate optimisation-based validation.
- Leadership culture must encourage analytical experimentation under pressure.

At the level of policy formulation, the case calls for greater importance to be laid on quantitative decision-support tools in professional military education and adoption in informed decision-making by Staff and Commanders.

Conclusion

This practitioner case shows that the Transportation Model is a potent facilitator of actual military logistics decision-making rather than just an academic concept. Commanders can guarantee mission success, troop sustenance and efficient use of limited transport resources (Air Transport, MT, AT, Lgs Drone, Porters/ Ponies) by implementing OR models under severe operational limitations. The case highlights the relevance of analytical decision-making in defence management procedures.

Explanatory Notes

Advance Winter Stocking (AWS): *Pre-Placement of supplies to sustain troops through winter, especially in isolated posts.*

Company Operating Base (COB): *Forward administrative and operational base.*

Superior Kerosene Oil (SKO): *Essential fuel for heating/ cooking, which is highly inflammable.*

All-Terrain Load-Carrying Vehicles of Make Ashok Leyland Stallion (ALS): *Specialised military transport.*

Simplex LP: *A step-by-step mathematical method used to solve linear programming problems. It works by systematically comparing different possible allocation combinations and moving toward the one that gives the best result (such as minimum cost or minimum vehicles used), while still respecting all operational constraints like supply limits, vehicle capacity and demand requirements.*

Shadow Price: *The additional benefit (or cost saving) obtained by increasing a constrained resource by one unit. In simple terms, it tells the Commander how much improvement can be achieved if one more vehicle, one more sortie, or one more day of convoy movement is made available.*

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End Note. All quantities, figures and data in this case study are notional and simulated for academic and illustrative purposes. They do not reflect actual operational details and are intended solely to provoke critical thinking and extract managerial insights as lessons for adoption in actual scenarios.

About the Author

Colonel Himanshu Pandey was commissioned in the Army Service Corps in June 2003. The officer is an alumnus of the National Defence Academy, Khadakwasla, the Military Institute of Technology, Pune and the Defence Institute of Advanced Technology, Pune. He is currently pursuing PhD from BITS Pilani, Hyderabad Campus.

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Book Review

Ready, Relevant and Resurgent II "Shaping A Future Ready Force"

By General Anil Chauhan PVSM, UYSM, AVSM, SM, VSM

ISBN 978-81-991162-6-9

Reviewed by Gp Capt Sukhminder Singh

The character of war is constantly evolving. In today's era of disruption, rapid evolution in technology is changing the way wars are planned and prosecuted. Though war is not a preferred option for any nation, one has to be ever ready to win it when the moment arises. Preparedness requires two important facets: firstly, a critical assessment of one's own capabilities and secondly, building a clear-cut roadmap to develop/ attain desired capabilities. While clarity of purpose is essential to realise a developmental path, mental mobility helps one to make necessary course corrections. As our adversarial challenges evolve, it is essential that our leadership not only charts a strategic roadmap for preparedness but also shares the vision with the nation so that India marches towards *Viksit Bharat*.

The book is a strategic contribution by the CDS in this direction. The book's articles make reader to think and bring back the idea that success is planned and is not stumbled upon by chance. The book helps to understand different problems as they are and encourages to think about how powerful India could be. The book doesn't boast or preach; it just makes things clearer. Sometimes this is the best thing to do.

The Author

General Anil Chauhan PVSM, UYSM, AVSM, SM, VSM, Chief of Defence Staff & Secretary DMA, needs no introduction. Being at the helm of affaires militaires, the CDS has insight into where we stand and where we need to be.

The CDS's literary works are a practitioner's insight and have abundant intellectual depth. His writing style is defined by clarity of thought, use of measured language and absence of sensationalism. In this literary work, he focuses on describing how national security, strategy and warfare are truly changing. He focuses on delineating real transformations in national security, strategy, military strategy and warfare.

What makes him different is that he connects strategy and society. He frequently links military power with leadership, innovation, knowledge, and civil-military fusion. Through the use of poetry, philosophy and cultural references, the author makes the point that he believes that security comes from moral and intellectual preparedness and is not merely a function of force projection. General Anil Chauhan is a soldier-scholar who writes for the benefit of explaining things rather than just adding to existing clamour. His writing contributes to the growth of a native strategic vocabulary in which the core content is based on experience, oriented to the future and built on history.

While also serving as CDS and Secretary DMA, he is the author of two books, Ready, Relevant, and Resurgent. The title itself indicates what the author

wants the Indian armed forces to be. The subtitle of the book, "Shaping a Future-Ready Force," is a statement of the author's vision. It indicates that the author believes in the need for the Indian Armed Forces to have thoughtful institutional designs, intellectual reforms and readiness in order to be effective.

The Book

The tone of the book is set at the very beginning in the foreword by the Hon'ble RM. It carries the blunt truth of our times; India can no longer count on incremental progress. The old ways of war and peace have changed, and the world's momentum has quickened. The foreword is so powerful that it makes the book seem larger than mere analysis – it is almost like a call to reorient.

The book has three sections: *Understanding War, Building Blocks and Leadership in Military Ecosystem.*

Understanding War: Its Evolution and Future

There are nine chapters in this section. They deliberate on the evolution of concepts of war, technology and the way people perceive war. Collectively, these chapters indicate that we have to change not only our perception of national security, but our institutions. We, as a nation, need to use our resources wisely in an era of multi-domain operations.

The chapter on Military Strategy challenges fixed ideas of strategy. The author portrays it as something that has to be adaptable and constantly in sync with the real world. He opines that there is a need to reassess existing security architectures and to rectify any mismatch between dated doctrines and modern realities. Wars with Clausewitz's Precepts also support this notion. The author maintains that classical theories should neither be disregarded nor lauded. They should be reinterpreted in light of new challenges of emerging technologies, increasing effect of cyber, space and cognitive domains beyond existing conventional ones. The conversation continues in Future wars and Indian Armed Forces to develop by providing military professionals a specific vocabulary to describe India's evolving security context. This chapter contributes to the conceptual framework necessary for a future-oriented threat assessment of hybrid conflict, grey-zone competition and integration of conventional and non-kinetic methods. The author highlights the need for the Military Staff System: Way Forward for Indian Armed Forces for achieving jointness and integration. They are viewed not just as an organisational reform but also as a cognitive need by the author. The author opines that the absence of a functional, integrated military staff system would make it exceedingly hard to achieve unity of effort in critical decision-making.

The chapter on Air Power and National Security discusses the importance of achieving air superiority while making any strategic shift. The author asserts that in any future contested A2/AD battlefields, air superiority and space power will be increasingly important. In the chapter Cyber Space: A New Frontier of Warfare, the writer alerts us to security vulnerabilities in military networks and critical infrastructure as well as economic systems, and opines that they are a threat to national security. He professes that, both the government and businesses should conduct rigorous audits and rectify any issues they discover. Space Enabled Operations must also be readjusted as the weaponisation of space is now a reality.

As we move forward, indigenous strategic thought will have a major influence on how decisions are made. Future Wars and the Relevance of Indian Principles of War calls upon us to link old wisdom with modern practical reasoning. The next chapter of Cognitive Warfare dwells upon superiority in information gathering and the importance of decision-making. This aspect is important beyond the military as well.

The section illustrates how India must transform its national security thinking. It professes that readiness for the future could not be based on an event or domain. It must be integrated, planned and built on knowledge.

Building Blocks

While the desire for an assertive India that is well poised to address any future conflicts is paramount, it is essential to lay the foundation well. This section lays down key elements on which India must shape its future.

Geographic realities coupled with the historical baggage of cartographic errors that our country faces have been given a first-hand experiential description in Frontier Borders, Et al. The author

opines that resolution of boundary issues needs a concerted multi domain efforts in historical, diplomatic, legal, technological, political and military domains. Preservation of military heritage has been highlighted as a cornerstone that is essential not only toward honouring the bravery and sacrifices of ancestors but also passing this legacy to future generations.

The Indian Ocean shall remain a strategically important location with multi-player involvement. The chapter on the Great Game in IOR takes a balanced approach towards emerging challenges in the region and professes the use of soft diplomacy to emerge as a preferred security partner. The churn in World Order has been equated to the mythological Samudra Manthan, with its greatest modern manifestation being in the Indo-Pacific region. The chapter on Charting a Comprehensive Vision of Security in the Indo-Pacific highlights India's USP and leveraging it to prosper even in this quagmire.

The author professes that the future lies in the space domain, which provides ample scope for both civilian and military use. Military Space Culture has transformed into a contested military arena and offers a unique opportunity to emerge as a world leader in this domain. The author incites military leadership to emerge as a leader in space thought. Also, as geopolitical competitions transition to the space domain, a deft Military Space Diplomacy has become paramount to manage stressors as well as collaborations. The author feels that nations rise because they think deeply. The long-due case for the Indian Defence University, a place where new military thoughts and ideas would germinate, will provide the much-needed fillip to transformative thinking, thus strengthening national security.

Maintenance of strategic autonomy can only be achieved if a nation has its own defence manufacturing ecosystem, thus reducing reliance on other players. Empowering India's defence Industry Future is the only way to attain a deterrence that is credible. The chapter lists a few themes and mantras towards achieving this desired capacity and capability.

Leadership in Military Ecosystem

The final section explores the importance of human capital in shaping a resurgent India. In this section, the author takes on the role of a mentor. His reference to the Bhagwat Gita and writings of renowned personalities such as Dr APJ Abdul Kalam, Rudyard Kipling, and Shri Sohnanlal Diwedi integrates Indian values with modern leadership techniques. The author urges young entrepreneurs to harness their potential and act as the catalyst for transformation. He motivates them to “dream, innovate and build a legacy that will shape generations to come”. The final chapters are something unusual for a defence-oriented book. But give a glimpse of the emotional component of national security. The sections suggest that India's future lies in a human capital that has a “never-never-ever give up” attitude.

Comments

General Anil Chauhan's thoughts on India's defence readiness take the reader into a place where strategy and philosophy are not at loggerheads, but are mutual allies. Exploring the book was like hearing a brilliant military mind talking out loud in a very straightforward way. For soldiers, the book is like a lighthouse that provides guidance for future challenges. It is a call to every Indian to “Arise, awake, and stop not till the goal is reached”.

The book has clarity and conviction. It demonstrates that one's intellect and introspection need not be compartmentalised. The CDS gives strategy and leadership a combined voice that is strong and steady. The book makes one ponder, even after one is done reading it. This book isn't simply about India's military future. It narrates the path for our national endeavours and what kind of nation India must choose to become- *Sashakt, Surakshit* and *Viksit Bharat*.

About the Author

Group Captain Sukhminder Singh was commissioned into the Technical Branch of the Indian Air Force in 2001. He holds an M.Tech degree from IIT Kharagpur. The officer is an alumnus of the Defence Services Staff College, Wellington and the College of Defence Management, Secunderabad. He holds an MSc (Defence and Strategic Studies) from Madras University and a Master's in Management Studies from Osmania University.

DEFENCE MANAGEMENT JOURNAL
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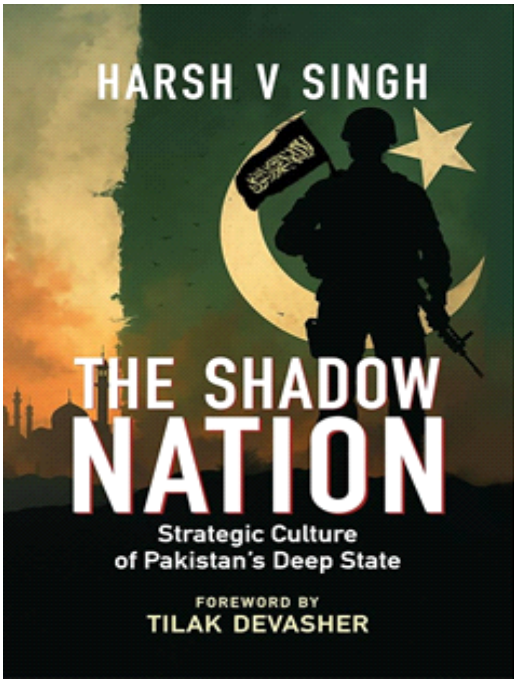
Book Review

The Shadow Nation: Strategic Culture of Pakistan's Deep State

By Harsh V Singh

ISBN: 9788198748447

Reviewed by Colonel NVS Subrabmnaya Kumar



Introduction

The Shadow Nation: Strategic Culture of Pakistan's Deep State by Harsh Vardhan Singh is a critical study on the ever-lasting control of the Pakistan Military on the state. The book argues that the Pakistan Military is the 'Guardian of the Idea of Pakistan,' or the 'Nazariya-e-Pakistan', and that it is "Capitalising on this ideological claim to pursue an anti-Indian and Islam-based strategic culture against India."

It consists of three major parts:

- The Meaning of "Deep State", "Ideology" and "Structure of the Three Pillars".
- Control mechanism and strategic confluence: The way the military wield their control over the internal and external fronts against India.
- The Strategic Shock and Future Response: Analysis of the 9th May 23 riots, indicative of a strategic shock to the Deep State and the strategy for the future.

Chapter 1: Introduction- Framing the Shadow Nation

The author brings forward the "shadow nation" of Pakistan as "a country where security institutions exercise hegemony over political identities and policy choices." The chapter gives clarity on some of the terms used, which include strategic culture, deep state, and strategic coexistence. It describes the framework for analysis of the subject, which is entwined by history, military ideology, and governance. Pakistan is introduced as "a country beset by threat perceptions and militarisation of institutions." The powers of the country's military are given as extending beyond the security of the country, and it affects "the national consciousness and the civil governance" of the country. The author places the context of analysis of the subject against the security scenario of South Asia and holds that "the development of Pakistan cannot be comprehended without factoring in the Deep State."

Chapter 2: The Roots and Development of Statehood Identity

This chapter discusses the evolution of the politics and institutions of Pakistan in the wake of partition. The initial problems of displacement, economic turmoil, and a series of Indo-Pakistani relations caused the Pakistani military to take on the mantle of the country's protector. The lack of strong civilian leadership and constant changes within the Pakistani government created a power vacuum that the Pakistani military moved to fill, and over a period of time, legitimised their intervention in politics. The serial wars and crises contributed to the development of the notion among the people of Pakistan that only the military was capable of instilling order and ensuring survival within the

state. This period begins the vicious cycle of disequilibrium within the civilian-military relationship in Pakistan.

Chapter 3: Societal Stressors and Ideologies Societies face

The author explores homegrown factors: ethnicity, provincial grievances, and sectarian divisions, which made it hard for a unified Pakistani nation to emerge. The military addressed this by designing a collective national identity based on Islamic ideology and an eternal mindset for security. While religion was used, it was deployed for the militarisation of the country to de-legitimise any opposition. Social diversity in the country was effectively portrayed as a source of threats to justify security protocols and centralisation. The author brings forth how political marginalisation and higher ideological polarity ripened the alienation within provinces such as Balochistan and Sindh. In short, the chapter concludes that ideology was at once a binding force in Pakistani society, and yet, eventually, it became a structural hindrance to diversity.

Chapter 4: Terrorism, Proxies, and External Threats

This chapter analyses the issue of proxy war developed by Pakistan and its strategic implications. Beginning from the formation of alliances in the era of the Cold War, this chapter illustrates that the foreign policy of the country increasingly uses non-state actors as policy instruments, particularly in Afghanistan and Kashmir. This chapter demonstrates that the state pursued two parallel strategies. It adopted a formal counterterrorism policy aimed at preventing terrorist activity within its territory and beyond. On the other hand, it continued to extend selective support to certain militant groups in pursuit of geopolitical objectives. Although the post-9/11 international environment prompted significant policy adjustments, particularly in response to global counterterrorism pressures, civilian democracy returned, but the military's primacy remained intact.

Chapter 5: Military Thought, Institutions, and Doctrine

The author describes the way the military institutions create a unique strategic perspective, Guardianship, Moral Superiority, and Culture of Siege. These aspects are bred through training networks, staff, and in-house literature. The author points out that there is a very heavy dependence on the support of the public service because of the stronger historical constructs and the constant enemy in the shape of India. These are then transposed into a dogma that focuses on centralised control, deterrence, and principled opposition. The author highlights, "the 'deep state' itself is not a kind of Mason operative conspiracy theory" because an organisational mindset permeates the military setup to the extent that it remains deeply ingrained in its structure, which is reproduced through incentives, prestige, and legitimacy on which the entire system sustains. Even as the change may come gradually, institutions must continue to exist to preserve the military's strategic edge and cultural cohesion. This continuity serves as the foundation for Pakistan's military establishment's strategic control over the country's course.

Chapter 6: Case Studies and Historical Events

The author moves from theory to practice, using his framework of analysis on several critical events in the history of Pakistan, from military coups and counter-insurgency operations to crises such as Kargil. In this way, he identifies a clear pattern of strategic behaviour characterised by kinetic actions, a constant sidelining of political reconciliation, and repeated strategic miscalculation. Throughout the various episodes that have been considered, the author illustrates how the security sector maintains its position by interpreting failures as further proof of the presence of a threat. Instead of accepting failure as a reason to make structural changes, failures are interpreted as confirmation of the stance that led to the failure. The chapter ends on a warning note: "Unless these basic attitudes in the security establishment change, Pakistan might remain trapped in a cycle that sustains itself."

Chapter 7: Consequences and Regional Implications

The author widens the scope to examine the regional implications of Pakistani strategic actions. The contention offered in this chapter points to the militarised nature of governance in the country,

which is relevant in relation to the concept of Deterrence Stability, crisis management, and the economy in the wider South Asian context. This is in addition to the permanent enmity between India and Afghanistan, and further the reliance upon international alignments, entwining China with the United States, which finally integrates completely into an elaborate web of security. He then correlates the domestic militarisation with economic underperformance, giving the reason that spending too much money on defence hinders developmental capability towards education and infrastructure. The chapter ends by contending that it is impossible to think of a prospect of peace in South Asia without reconstructing the concept of security beyond perpetual confrontation.

Chapter 8: Modus Vivendi and Policy Prescriptions

This further highlights the road to strike a balance within the system of governance as well as regional peace in the final chapter. In this case, instead of something sudden happening, a change is needed that will build the civilian components of the system, as well as the judiciary and bureaucracy, to counterbalance military forces. The regions around the Indian boundaries with the potential of trust-building factors, military budget transparency, as well as a cut-back strategy regarding the employment of proxies, might form the starting point of such a change. The conclusion of this chapter states that it is possible to turn around the strategic equation with the role of the economy as well as the role of international cooperation as an imperative of obtaining stability at a regional level.

Key Takeaways. The important lessons from the book are as follows:-

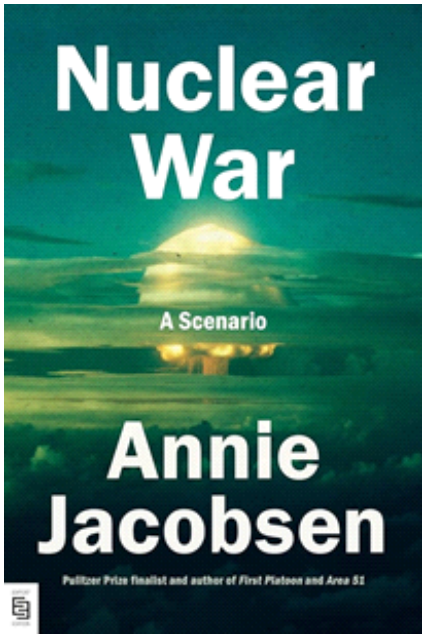
- Ideological custodian of Nazariya-e-Pakistan by the military, claiming legitimacy through the defence of the state's ideological foundations.
- Tripartite Strategic Culture: Founded on anti-India animosity, the ideological objective of Islam/Jihad, and military supremacy
- State-Military Fusion. The policies of the Pakistani state are largely skewed toward military needs, such as military predominance and funding.
- 9th May 23, A Strategic Shock: The unrest in 2023 has shown the degree of discontent with the situation among the general public and the division within the political-security establishment.
- Comprehensive Regional Response: The author contends that India should adopt a long-term multidimensional strategy-combining deterrence, diplomatic engagement and internal resilience to counter the military strength of Pakistan.

The Shadow Nation is an essential reading for defence strategists, military commanders, and policy makers, particularly those engaged with the Pakistan theatre. This book helps in understanding Pakistan's deep state architecture and the military's ideological custodianship of Nazariya-e-Pakistan, the use of non-state actors and proxy warfare as instruments of state policy. Singh's meticulous framework equips the reader to anticipate Pakistan's behaviour that is likely to remain a shadow nation where the military's ideological conviction overrides political pragmatism.

About the Author

Colonel NVS Subrabmnaya Kumar was commissioned in the Corps of Signals in the year 1993. He is an alumnus of the Indian Military Academy. He holds an MTech in Electronics and Communication Engineering from Jawaharlal Nehru Technological University, Hyderabad.

Book Briefs



Nuclear War: A Scenario

By Annie Jacobsen

Paperback: 373 pages / ISBN: 978-0593476093

Publisher: Dutton, an imprint of Penguin Random House LLC (2024)

Annie Jacobsen's Nuclear War: A Scenario offers a vivid, expert-informed exploration of how a nuclear conflict might unfold in the modern era. Drawing on dozens of interviews with military leaders, defence planners, scientists, and policymakers, the book constructs a plausible, high-stakes scenario involving miscalculation, legacy nuclear doctrines, and geopolitical tensions that could trigger a global nuclear exchange. Beyond technical systems and strategy, Jacobsen sensitively reflects on the human and political dimensions of nuclear deterrence, early-warning systems, and decision-making under extreme pressure, making it a compelling read for security scholars, defence professionals, and policymakers alike.

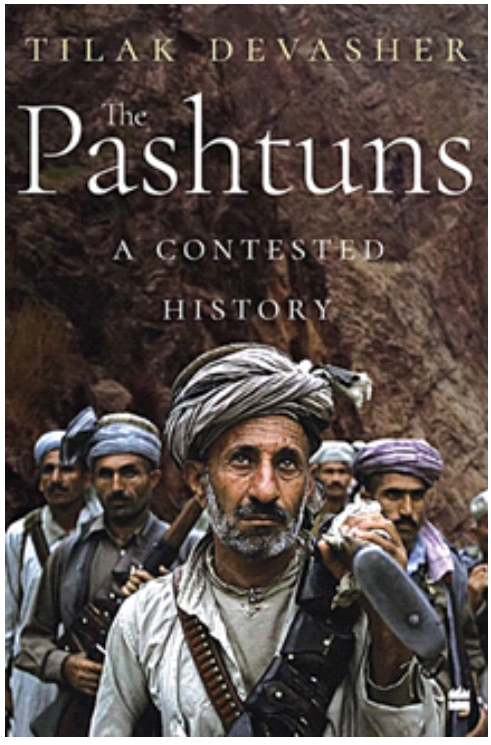
The Pashtuns: A Contested History

By Tilak Devasher

Paperback: 304 pages / ISBN: 978-9394407633

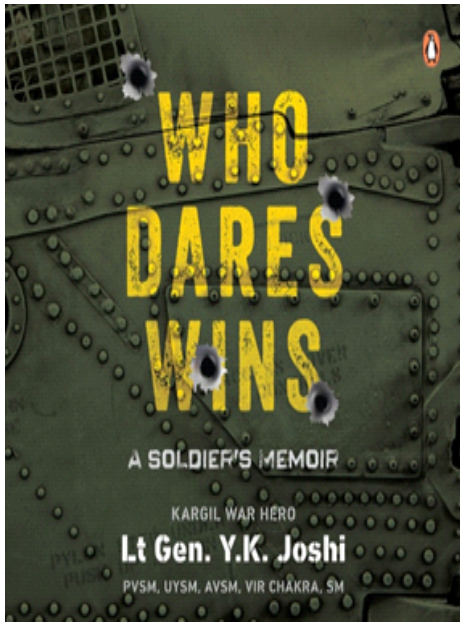
Publisher: Harper Collins Publishers India (2022)

The Pashtuns: A Contested History traces the multifaceted history, identity, and geopolitics of the Pashtun people, one of South Asia's largest ethnic groups without a sovereign state. Tilak Devasher navigates through centuries of tribal resilience, colonial contests, regional conflicts, and shifting power dynamics, offering both narrative depth and analytical insight. The book explores how Pashtun society has been shaped by geography, empire, war, and statecraft, and how it continues to influence contemporary politics in Afghanistan, Pakistan, and beyond, making it a valuable resource for readers interested in ethnic politics, regional security, and South Asian history.



Who Dares Wins: A Soldier's Memoir

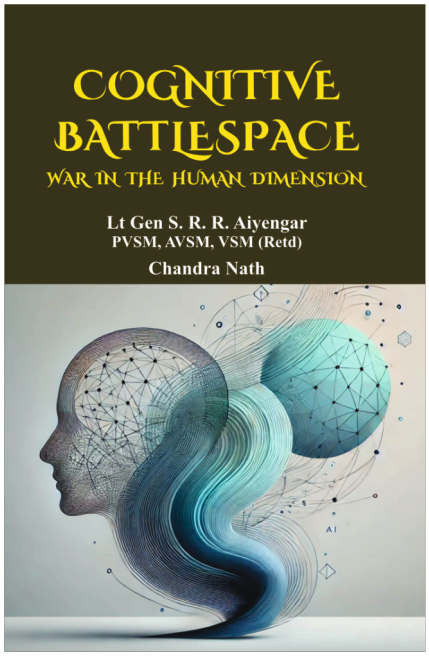
By Lt General Yogesh Kumar Joshi, PVSM, UYSM, AVSM, VrC, SM, ADC (Retd)



Paperback: 240 pages / ISBN: 978-0143467632

Publisher: Penguin Random House India Pvt. Ltd (2025)

Who Dares Wins is the compelling personal memoir of Lt General Y. K. Joshi, chronicling his journey from his early days in the Indian Army to leadership in pivotal operations. Celebrated as a key figure in operational successes, including strategic manoeuvres in Eastern Ladakh and decisive roles in major conflicts, Joshi reflects on leadership, strategy, resilience, and the ethos of military service. Blending battlefield narratives with introspective insights on duty and decision-making, this book provides readers with an authentic window into the life of a soldier and strategic commander, making it especially relevant for defence professionals and leadership scholars.



Cognitive Battlespace

Lt Gen S R R Aiyengar, PVSM, AVSM, VSM (Retd)

Paperback: 355 pages / ISBN: 978-93-93402-85-1

Publisher: Uday Publishing House (2026)

In 'Cognitive Battlespace: War in the Human Dimension' by Lt Gen S. R. R. Aiyengar (Retd) and Chandra Nath, the human mind emerges as 21st-century war's decisive "high ground." Cognitive warfare transcends information operations by targeting perception, belief, and trust through AI-driven engines like deepfakes, reflexive control, and memes that exploit attention, emotion, memory, and institutional erosion. For India, threats intensify: Pakistan's ISPR-ISI nexus fuels Kashmir psyops and digital astroturfing, while China's "Intelligentized Warfare" deploys algorithmic micro-targeting and "Three Warfares," as seen in Doklam (2017), Galwan (2020), and Pulwama (2019). Resilience demands a "Trust Architecture" across individual layers (Yoga for prefrontal clarity, bias literacy), organisational transparency, and societal cohesion. Practical tools include Appendix A's Critical Thinking Questions for PME red-teaming and Appendix B's Cognitive Security GPT for predictive foresight. Ethically anchored in Satya (truth) and Dharma (righteousness), the book urges India to blend technological edge with civilisational wisdom, securing cognitive sovereignty to outthink adversaries and preserve democratic fabric.

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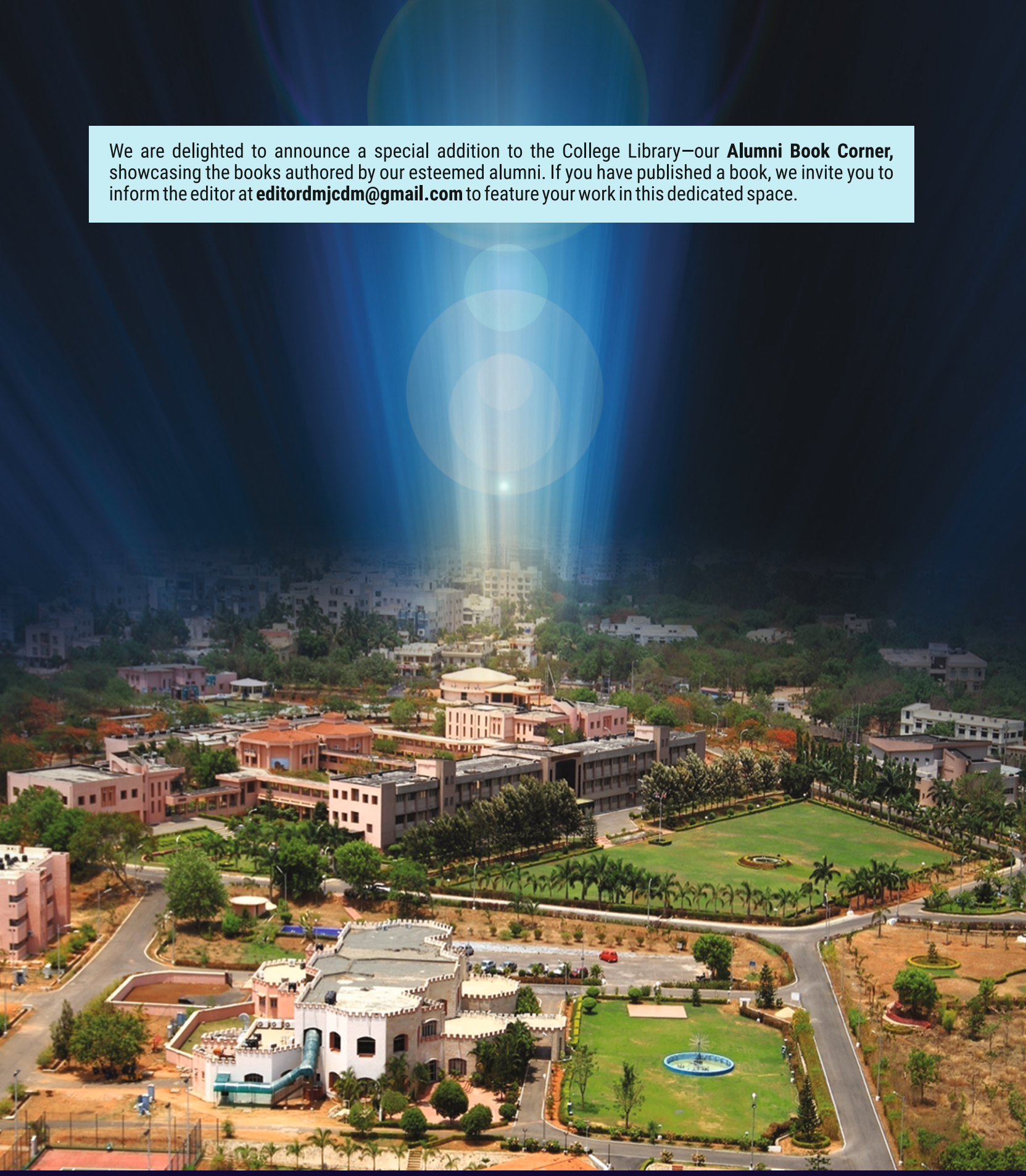

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Sainikpuri (PO), Secunderabad, Telangana, India - 500 094
Ph: +91 40 27113400
Email: editordmjcdm@gmail.com | Visit us at https://cdm.gov.in