college of defence management

dur drishti

DEFENCE MANAGEMENT JOURNAL

ISSN 0976-7347 | Volume XXIV – Issue 2 | September 2025

dur drishti

September 25

Volume XXIV - Issue 2

Editorial Team

Defence Management Journal
ISSN: 0976- 7347
Published by College of Defence Management, Secunderabad

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SCAN & PAY

Name : **Defence Management Fund**
A/c No : **30632200001212**
Bank : Canara Bank, Sainikpuri, Secunderabad
IFSC : **CNRB0013023**
UPI id: **213812305001212@cnrb**

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College of Defence Management

VICTORY THROUGH EXCELLENCE

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.

VISION

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.

MISSION

To develop and impart skills of management thought that lead to effective decision making, enlightened leadership and efficient resource management in a knowledge-centric environment to enhance the effectiveness of the Armed Forces.

FROM THE COMMANDANT'S DESK

Major General G Srinivas
Commandant
College of Defence Management

Dear readers,

It gives me immense pleasure to release the September 2025 issue of the flagship publication of the College, "Dur Drishti - The Defence Management Journal", a trusted source of high-quality literature on defence management and the only tri-services Journal publishing 'Research Articles'.

Over the years, the College has evolved to be the Centre of Excellence in the field of Research, and the results are evident through the flow of original and well-researched articles, which are appreciated and rated amongst the best by the stakeholders. A recent case in point is the research on Heat Waves & Its Impact in Delhi-NCR by Gp Capt Rashmi Dimri, which the officer authored in 2024 while attending HDMC-20. The research paper was selected by NDMA, and the author was invited to present her work during the prestigious World Summit on Disaster Management, 2025.

In addition to the in-house research papers, thought-provoking articles on various contemporary topics from the environment, especially from our Alumni, are being regularly received and have also been included in this issue. Further, as an initiative, we are planning to introduce a Re-Publication Section, wherein impactful academic works published in other defence journals shall be republished in DMJ & vice versa, to provide a platform for selected impactful articles from the three War Colleges, aiming to enhance outreach to readership, obviating limited circulation.

Indeed, the College Journal endures to be an important bridge to our alumni and to the defence fraternity, and we look forward to your invaluable feedback to further improve the content and quality of the Journal.

I compliment the Editorial Team for bringing out an informative and well-researched issue of 'Dur Drishti'.

'Jai Hind'

G Srinivas
Major General
Commandant

From the Editorial Team

It is with great pride that we present the latest edition of Dur Drishti. This issue comes at a time when the National Security environment is marked by volatility, impacted by unprecedented complexity in our neighbourhood and in the world order, and all this while the character of warfighting and associated technology is changing rapidly. These are the salient factors that demand transformative thinking and robust management practices of military leadership.

This edition of DMJ reflects a broad spectrum of these contemporary challenges and opportunities. A perspective by Brig MB Singh, 'The Russia-Ukraine War: Lessons for India in the Face of the Two Front Dilemma', examines strategic implications for India's defence posture in a multipolar world. The awarded Research Article that was recently showcased in the World Summit on Disaster Management, 'The Scorching Cost: Heatwave Impacts & Strategic Mitigation in Delhi-NCR', highlights the growing intersection of climate resilience and national security. A scholarly Review Article, 'Work-Life Balance in the Armed Forces', addresses a critical human resource dimension, emphasising well-being as a cornerstone of operational readiness. A Naval Engineer officer's perspective has been captured in 'Charting the Future Seas: Indigenous Technology Imperatives for the Indian Navy 2047', which underpins the need for technological self-reliance, strategic autonomy and innovation in maritime capability development.

Each contribution is a step toward enriching our collective understanding of defence management in its widest sense, spanning strategy, technology, environment, and human capital. We hope these insights will stimulate thought, dialogue, and reflection among our readers.

As always, we invite your feedback and encourage contributions from serving officers, veterans, and scholars to ensure Dur Drishti remains a vibrant platform for the exchange of professional discourse in the field of defence management.

'Jai Hind'

Commodore YV Ramakrishna
Chief Editor

DEFENCE MANAGEMENT JOURNAL
ISSN: 0976-7347

PERSPECTIVE

The Russia-Ukraine War: Lessons for India in the Face of the Two Front Dilemma

Brigadier MB Singh

"India's interest is best secured by maximising its options, maintaining its freedom of choices."
— S Jaishankar

Abstract

The Russia-Ukraine war has taught the military some difficult but valuable lessons about modern warfare. These experiences highlight the critical importance of technologically proficient and motivated soldiers, alongside tactically adept junior leaders. Senior commanders with extensive experience in large-scale conventional operations have proven equally crucial, as has the coordinated training of combined arms warfare. The significance of these lessons extends beyond immediate military considerations, especially as India navigates an evolving world order. With the rise of a global power adversary in India's neighbourhood, the country's commitment to an independent foreign policy and strategic autonomy faces unprecedented tests. The situation is particularly complex given that India shares unsettled borders with nuclear-powered neighbours, creating a potentially collusive two-front threat. These circumstances have shattered many previous assumptions that were based on observations of brief conflicts between mismatched opponents or non-state actors. The new reality demands not just military preparedness through robust manpower and material reserves, but also a nimble foreign policy approach. Self-sufficiency has emerged as a critical factor, requiring careful coordination among various instruments of national power to effectively handle these challenges. As the strategic landscape continues to evolve, India finds itself at a crucial juncture. The time has come when certain diplomatic positions that have been carefully hedged must now be stated unequivocally. This shift requires a delicate balance between maintaining strategic autonomy and forming clear alignments in an increasingly complex global environment.

Keywords. Russia-Ukraine War, Long Duration War, Strategic Autonomy, Collusivity, India's Defence Strategy, Two-Front Threat.

Introduction

On February 24, 2022, Russia launched a multipronged offensive on Ukraine. The Russian invasion began with the probable goals of capturing Kyiv, toppling the pro-NATO government, and capturing eastern Ukraine in time for a victory celebration on May Day 2023. Russia's war plans and the predictions of geostrategic analysts didn't come to pass. Figure 1 shows the initial offensive plan; however, it got stalled and didn't develop further. This assessment was made before the war started.

The war is in its 4th year, and its conclusion, nowhere in sight, is now entangled in geopolitical wranglings of world powers.

There are unambiguous lessons to be learned from how the war has been fought. In fact, this has put to the test several prewar theories on military advancements that were hotly debated among the strategic community prior to the war. This article seeks to derive lessons from this war that are relevant to the Indian Army, particularly in the current security scenario.

Current External Security Dynamics Surrounding India

India had considered Pakistan as its primary threat. Efforts to recognise China as a threat, like those by the then-defence minister George Fernandes in 1998 (Joshi M. , 1998) were rebuffed, and he was called out for being tempestuous. India preferred to manage the Chinese threat by passive isolative measures like ignoring infrastructure developments along own side of the LAC (Rajagopalan, 2021). Indian national security focus remained primarily on Pakistan. A notion of collusivity between China and Pakistan emerged in the early 2000s when China started upgrading the dual-use infrastructure along the LAC, began to voice concerns over Arunachal, PLA patrols began violating the LAC more frequently (Chellaney, 2010) and started to support Pakistan's infrastructure buildup in occupied Gilgit-Baltistan. By mid-2000, the strategic community in India was talking about a collusive threat to India and a two-front war. This was officially acknowledged and formally included in the Raksha Mantri's directive in Feb 2009 (N C Vij).

Military Lessons from Russia-Ukraine War for India in the Current Geo-strategic Milieu

Nature of War. There has been discussion for decades in the strategic community about the changing nature of war. Based on the USA-Iraq wars Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) and the Armenia-Azerbaijan conflict, it was believed that there would no longer be major manoeuvres of massed formations conducting high-intensity warfare (dubbed "Conventional War") (Barno, 2015). Since countries like India usually pursue strategically defensive war aims (Barno, 2015), the capture of territory as a bargaining chip was deemed irrelevant (Tarapore, 2020) and even politically and militarily counterproductive. With the Ukraine War, the debate about the

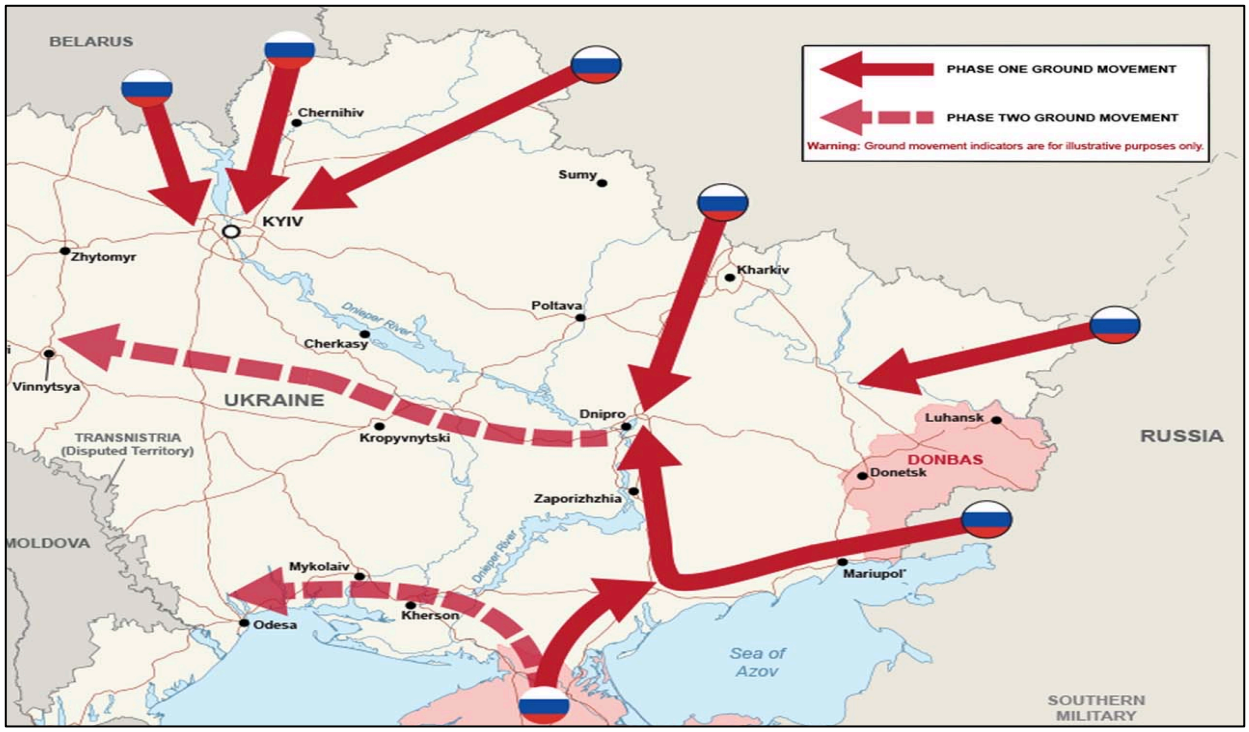

Figure 1: Russian Plan of Attack by the UK Intelligence (Ukraine-Russia War: The News as it Develops, 2022)

utility of a standing conventional army in modern times has also been brought to a conclusive end. From assertions that the days of full-fledged conflict are over to both the belligerents ordering national mobilisation, war in Ukraine has seen the return of all-out force. The nature of war remains unchanged, and the utility of a standing conventional army is undiminished in the Indian context.

Size of the Army. Ukrainian Armed Forces had been inherited from the Soviet Union. After the 2014 Crimean annexation, Ukraine undertook comprehensive reforms (Akimenko, 2018) and created a standing army and reservist Territorial Defence Forces (TDF). Though, despite the Russian threat, the idea of a peacetime small standing army was quite popular in Ukraine before 2022. The reason cited for a smaller standing army was budgetary constraints. The limited defence budget was purportedly utilised for the purchase of new hardware. When the war started, the Ukrainian army of about 2.1 lakh was inadequate to cover all the axes of the Russian advance. Paucity of ground forces was felt acutely by Ukraine. It was only the TDF reservist and a nationalistic mobilisation that could compensate for this acute shortage of manpower. Though the newly mobilised men/ women were inadequately trained, this has led to disproportionate casualties. As of now strength of the Ukrainian armed forces is over ten lakhs (McGarvey, 2022). Even the Russian Armed Forces are constantly feeling the strain of major manpower issues, which were the main driver of official mobilisation. Many countries in the region had not waited for the war to be over to learn the lessons. Germany has announced doubling its defence budget (Singh S. V., 2022), and Poland plans to increase the strength of its armed forces from 1.4 lakh to almost 3 lakhs over the next five years. It goes on to show that a great land power aspiration must be backed by a proportionately sized ground force; otherwise, it will lose its advantage on the battlefield (Satam, 2023).

Nuclear Deterrence. Possession of nuclear weapons matters. Russia's nuclear signalling has been the primary reason why NATO has not actively participated in the Ukraine war. At the same time, the US nuclear deterrence has allowed the West to resist Russia's nuclear threat, which has resulted in an open non-fighting support and delivery of military hardware to Ukraine (Lavikainen, 2023). The threat of economic sanctions has not deterred physical aggression; however, nuclear weapons have emerged as key levers of escalation dominance. This justifies the existence of nuclear weapons for preventing military coercion and escalation.

New Technology. In the decade preceding the war, there has been an animated discussion on non-lethal options such as offensive cyber- and grey-zone operations. These were touted to psychologically dislocate enemy military and political leadership with a minimum of loss of life, forcing the enemy to desist from attack. Both the armies resorted to instruments of the latest technology, such as cyber war, grey zone operations, war of narratives and information war, which were supposed to revolutionise the character of war. However, the results show that these had limited success when compared with the efficacy of kinetic means. Both armies continued to reinforce their forces with "old" technologies (Lavikainen, 2023) and capabilities such as infantry (most in demand), artillery, armoured personnel carriers and tanks in order to sustain their military effort. It is felt that the new tech is useful, but not the wonder weapon to win the war, which requires 'hard power'.

Self-Sufficiency. Self-sufficiency in terms of critical technologies and ordnance is a

prerequisite for the successful defence of a nation. Long drawn wars will require a large quantity of spares, ordnance and other war-like stores. A world-class military power like Russia ran out of basic supplies, ordnance and had to resort to imports, and Ukraine is struggling with fickle international donors to get its requirements. This explains the importance of being self-reliant and well-stocked. The Indian military has been thinking about future wars being short and intense. Indian operations are likely to happen in mountainous terrain, having tenuous lines of communication, and being prone to disruptions. It is imperative to maintain an adequate level of War Wastage Reserves (WWR). As per information available in the open domain, the Indian Military had reduced WWR from 30 days (N C Vij) to 15 days (Singh M. , 2020), which in many cases is down to 10 days (Kakkar, 2022). Ukraine war exemplifies the need to be prepared for long drawn wars and cater for reserves and WWR accordingly.

Operational Lessons

Capture of Territory. Ukraine and Russia have been fighting a war of beliefs: capitalism vs. communism. Their aim, however, has apparently remained the capture and control of territory. It appears that territorial gains will continue to be a sign of victory in future wars, especially fought between near-equal power states under a nuclear overhang. This accentuates the need for trained and technologically enabled fighting arms, especially infantry, in sufficient numbers, considering the enormous casualties suffered to achieve this goal by both belligerents.

Drones. The devastating and conflict-winning use of unmanned aerial vehicles (UAVs) and drones during the Azerbaijan-Armenia conflict brought them to the centre stage of discussion (Philip, 2020). Drones used in the early stages of war effectively halted Russian mechanised columns. Experts opined that drones have made tanks and fighter jets irrelevant legacy platforms (Marcus, 2022). However, after more than three years into the Russia-Ukraine war, it is now being realised that the drones could be used, with impunity, between two technologically unequal countries like the USA-Afghanistan or for surprise events; however, these are not effective in the heavily contested airspace of near equal powers and will either be jammed or shot down. Innovation, such as FPV (first-person view) drones with wire guidance to escape jamming, continues to be used at tactical levels and is being adapted to the dynamic technological landscape. The growing importance of loitering munitions and kamikaze drones in disputed airspaces is another crucial lesson from the EW environment in Ukraine. Their agility and expendability make them suitable for situations when expensive UAVs are in danger. The battle demonstrates that EW resistance and system redundancy, rather than only aircraft design or payload capacity, are crucial for survivability in contemporary drone warfare (Sharma, 2025).

Operational Art. Protracted war involving complex mobilisation, stage management and manoeuvre of large-scale force indicates that such a possibility in future is a likelihood. Such wars require different skills than the more common low-intensity warfare or No War No Peace (NWNP). One of the most prominent lessons of the war in Ukraine is the necessity of tactical and technical competence to conduct mobilisation, stage management and manoeuvre of forces from Brigade to Corps size. Highly coordinated combined-arms operations by large-sized forces against a massed enemy would be battle-winning skills rather than skills of operations against scattered teams of state or non-state actors or terrorists.

Logistics. There were logistics faux pas, Russian tank formations running out of fuel in the initial, critical days of war (Ukrainians Mock Russian Troops ... After Tank Runs Out of Gas, 2022) and basic issues of poor maintenance and supply support (Sauer, 2022). These deficiencies, compounded by the lack of technically and tactically trained maintenance personnel, affected Russia's ability to provide matching logistics support. Russian war goals ran out of logistical reach. After months of stalemate, the Russian Army moderated its unrealistic goals, improved logistics supply and marshalled resources in eastern Ukraine, where they have started succeeding. In combat, logistics are critical, especially for a protracted and long-range operation. Logistical and ordnance insufficiencies can undo hard-won victories and may force scaling down of war aims (Martin, 10 Feb 2023).

Communications. Effective and stable communication is a prerequisite for the existence of a military; otherwise, it is just a collection of men and material functioning independently as per individual appreciation of the situation and the unit's fighting spirit. The Ukrainian electronic command and control system was disrupted by the Russian cyber-attack on the very first day of the war. A vital lesson is the need to provide robust communications with inherent redundancy. SpaceX provided Starlink terminals to Ukraine to facilitate communication and coordination. Subsequently, SpaceX restricted Ukrainian troops from fully using the technology, stating that Starlink is not to be used for "offensive purposes" (Mizokami, 2023), which brings us to the second lesson of critical technologies being homegrown.

Cyberspace and Social Media. The conflict in Ukraine shows how important and ubiquitous social media and cyberspace are in contemporary warfare, impacting international support, civilian morale, and tactical actions. Ukraine successfully crowdsourced its digital defence and information operations in response to Russia's initial underestimation of its cyber resilience. The conflict demonstrates that flexibility, public participation, and solid multinational alliances are essential for success in these fields (Kirichenko, 2025).

Combined Arms Operations. The early setback to the Russian attack was due to uncoordinated and unsynchronised operations undertaken by different arms and services (Roper, 2023). Assessing minimum resistance and fearing civilian casualties, the Air Force was not used initially to bombard the entry points into Ukraine. Lack of air support made deep armoured penetration challenging, and when they finally penetrated, the absence of infantry precluded consolidation of gains. Combined arms operations are difficult, even for well-trained and well-equipped modern forces, and training and coordination of combined arms and multi-domain operations from battalion upwards will be critical for Indian infantry in any future conflict.

Duration of War. Russia started the war presupposing the impending collapse of Ukraine (Socor, 2023), which didn't materialise, and operations faltered. Russia's overoptimism about winning the war in Ukraine resulted in a series of mistakes. Russian troops arrived unaware of higher intent, for a short war, scanty logistics and outdated maps. The war has lasted longer than either of the countries or any military observer could have expected, baring the shortcomings in the once-famed Russian war machine and a lesson for the rest of the world.

Maintaining Reserve Forces. Ukraine started the system of territorial defence in 2014 (Green, 2016). Territorial Defence Force (TDF) battalions were reorganised in 2021. TDFs were

planned to relieve security and defence forces in the rear while guarding rear areas against pro-Russian saboteurs. On active fronts, TDF brigades were to complement defence forces while repelling Russian assaults. The makeshift character of territorial defence offered major advantages in the border area. TDF units have been used to complement regular formations in creating lines of resistance along major urban areas like Kyiv, Chernihiv, Kharkiv and Mykolaiv; or used on porous front lines to attack Russian unsecured lines of communications. After the war started, the TDF system enabled the addition of approximately 200,000 (Zbrojna, 2022) troops to regular formations quickly.

Tactical Lessons

Mission Command and Dissemination of Unambiguous Aim. The Russian plan of operation was known, initially, to only a small group of people. Most were unaware of the wider intent. The Russians, despite achieving a 12:1 force ratio, on the Kyiv axis were unable to follow through on initial success because they lacked a clear understanding of the higher commander's intent. The axes where the higher operational intent was understood and executed, the results were better. The advance on Mariupol represents that exception. During the encirclement of Mariupol on D plus 8 days, the route from Volonovaha was skilfully blocked (Mykhaylo Zabrodskyi, 30 November 2022), which prevented egress and ingress, setting up conditions for the siege of Mariupol. The success of the Russian offensive at Mariupol demonstrates the difference that could have been made elsewhere if Russian forces properly understood the intent and went about achieving it like a professional fighting machine.

Mission-Oriented Training and Psychological Tempering. The Russian troops were not psychologically tempered for the war at the beginning. These troops were unprepared for the fighting and had not anticipated heavy fighting. They were moving in administrative formations. There was no initiative to report the situation, to improvise or dig in to fight. On the other hand, Ukrainian troops, probably because they were defenders, believed in the cause, and the immediate task was clear to these units, retained the tactical initiative (Mykhaylo Zabrodskyi, 30 November 2022). As such, post-2014, Ukraine had adopted a mission-oriented training architecture designed to defeat the aggressor. Though at the tactical level, they fared better than the Russians initially, they had their own issues when it came to combined arms operations. Now, in the 4th year of war, the tables are turned.

Initiative and Innovation. Grass-roots level initiatives and innovations made battle-altering differences. For example, the defeat of precision is critical to unit survival. Defeating precision could be achieved even with very small innovations and did not always require expensive methods. When Russian reconnaissance troops began to mark Ukrainian defensive positions with laser designators, it was found that having laser warning indicators over strongpoints could alert personnel being targeted, who could then pop smoke grenades to disrupt the accuracy of the strike (Mykhaylo Zabrodskyi, 30 November 2022).

Shortage of Skilled Infantry. The Russian army has made an effort to convert itself from a volunteer force to a conscription force, though it was not a fully volunteer force at the time of the outbreak of war. Systems are also not conducive to retaining skilled and experienced NCO corps. This got accentuated with BTG (Battalion Tactical Group), a purported conceptual innovation implemented by the Russian army, personnel being deputed in different arms only for operations. There are no reserves to operate

enablers, and these groups are not well-regimented. The commanders do not know their people. Small nuclei of trained personnel provide instructions, but they do not know how they will fight together, which has not been impressive in any case. BTGs are also not able to absorb losses, and enablers become redundant once trained handlers become casualties (Mykhaylo Zabrodskyi, 30 November 2022).

Increased Frontages and Mobility. With increased precision, lethality and transparency, the only option to increase survivability is to disperse, have protection or mobility. Greater concentration often decreases the survivability of units because of the economy of the use of precision munitions. Though increasing dispersion and mobility will increase the span of control of company/ battalion commanders and strain their ability to communicate and command. Nonetheless, processes and mechanisms must be refined to enhance the survivability. Dispersal, though, enhances the challenge of Identification of Friend from Foe (IFF) significantly.

Leadership. At the time of war commencement Russian army was about 50 per cent conscripted, which entailed a lack of junior leaders and a professional NCO Corps. This resulted in many of the strategic assumptions being misunderstood at the grassroots level (Jimbo, 2023). What President Putin called "the special military operation" in Ukraine (Top Russian Military Officer Put in Charge of Troops Fighting in Ukraine, 2023) was presumed as a larger repeat of the 2014 Crimea operation, with little opposition and a low level of violence. No war gaming had been done. The Russian army had not foreseen the magnitude of the operation. The Russian army, officially the second strongest army in the world, appeared to be crumbling unexpectedly. There would be several reasons, which will be a matter of detailed analysis (Rifts in Russian military command seen amid Ukraine fighting, 2023); however, the leadership would be the main among these.

Precision Ammunition. Precision-guided munitions have increased the lethality of artillery. NATO's High-Mobility Artillery Rocket System (HIMARS) (Peck, 2022), firing GPS-guided ammunition up to 70 km, has been a game changer in engaging Russian targets in operational depth from stand-off distance. Precision fire combined with accurate intelligence has made a world of difference on the battlefield. Though this does not replace the requirement of mass artillery for close support of infantry, it just augments it (Peck, 2022).

Fighting Behind the Enemy Lines: Sons of the Soil. Ukrainian experience has demonstrated the efficacy of troops from border areas that have been used to disrupt long lines of operations and logistics behind the enemy lines. These have paid disproportionate dividends. India created the Special Services Bureau (SSB, now Sashastra Seema Bal) and Scouts Battalions as civilian and military outfits, respectively. These outfits were needed for "…an in-depth understanding and familiarity of the terrain as well as the culture and ethos of the border population" (Sashastra Seema Bal History, n.d.). However, these establishments have changed in perspective and employment. There is a strong case to relook and reorient the task envisaged for these outfits, in light of the Russia-Ukraine war experience.

Urban Warfare. Urban warfare has come a full circle. Small teams, with good communication and training, using roadblocks and MANPADS are extremely effective against armoured

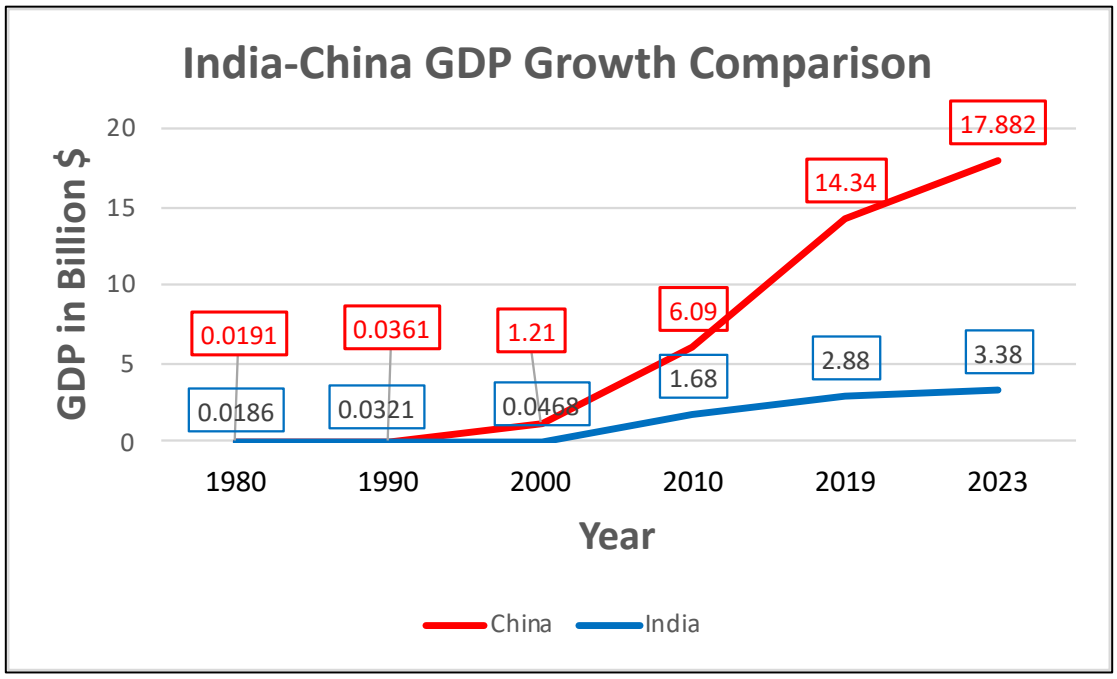

Figure 2: India-China GDP Growth Comparison (World Bank Data Bank, n.d.)

vehicles (Collins, 23 February 2023). Ukrainians formed small hunter-killer teams manoeuvring in urban terrain to launch ATGMs from raised houses, making good use of rubble into the thinly armoured roofs of Russian tanks. These teams are difficult to locate and can maximise the effectiveness of anti-tank weapons by skilfully using the cover and concealment offered in an urban area. Innovations like Molotov cocktails were used by Ukrainians with deadly effects in urban areas.

Tanks. After the drubbing in the Azerbaijan-Armenia conflict, the tanks were again challenged by drones and portable anti-tank weapons. Later, the Russians, as well as the Ukrainians, have been using the tanks in a combined arms concept. Tanks are effective alongside infantry, supporting artillery and helicopters and aeroplanes. But we're getting into a vicious circle - the precision and lethality of anti-tank weapons have increased, whilst the probability of a direct confrontation between tanks has decreased (Atanesian, 2022). This will force the tanks to reinvent the economic and survivable use of this once potent platform.

Recommendations Specific to Two Front Threat Scenario

A two-front scenario is becoming increasingly unmanageable due to the increasing national power gap between China and India. The gap between the Indian and Chinese economy, which was insignificant till the year 2000, continues to grow, as is evident from data in Figure 2, and it appears that the gap is not going to reduce anytime soon. The defence budget of China hugely outpaces that of India. This is supported by the fact that, with a score of 0.1184, India is ranked fourth in the Global Firepower Ranks Index 2025. China comes in third place with a rating of 0.0788, but it is equal to Russia (0.0788) and much closer to the USA (0.0744). Pakistan's value of 0.2513 places it at number twelve (2025 Military Strength Ranking, 2025). SIPRI data also supports this. According to the SIPRI report on global military spending, China,

India, and Pakistan will spend $266.8 billion, $75 billion, and $7.64 billion on defence in 2025, respectively (Global defence budget: How much India, Pakistan and China spend on military? Top 10 list, 2024). This gap is further accentuated when considered in conjunction with the development of advanced dual-use tech, the military-industrial base of China, Pakistan's presupposed collusivity and Chinese inroads in India's neighbourhood. Considering lessons from the Russia-Ukraine war, recommendations specific to handling this threat scenario are as follows.

Diplomatic

China-Pakistan strategic binary needs to be de-hyphenated. India should concentrate on its bilateral ties with China and Pakistan independently. Any collusive threat should be labelled as a contingency threat rather than a primary or alternative threat, with explicit measures to handle it without compromising force posturing towards a primary threat. The current dynamics of geopolitics require India to diversify its options, maintain flexibility, and avoid getting locked into any definitive military alliance, which, as such, is proving to be of little utility. India should continue to champion multi-polarity and avoid either option of supporting the preservation of the USA hegemony or China-led revisionist efforts.

India has favoured avoiding international power struggles in its neighbourhood. China, meanwhile, has been encroaching on Indian space in its neighbourhood out of fear of Indian influence and to perpetuate its dominance of South Asia. Until the Indian economy catches up to China's, India might not be able to match China dollar for dollar in its chequebook diplomacy. Till then, in addition to skilful management of its neighbours, India should look for nations with shared interests. For example, the confluence of Tokyo's Free and Open Indo-Pacific Strategy and New Delhi's Act East Policy (AEP), Australia's Japan-Australia-India Supply Chain Resilience Initiative (SCRI), and US investments in Bangladesh and Nepal, etc., to counterbalance Chinese influence.

Military

As discussed earlier, nuclear weapons have emerged as key levers of escalation dominance. It's a potential tool to preclude collusivity. India should increase the number of nuclear warheads and range of its delivery systems to cater for a collusive threat. It should change the declared nuclear posture from No First-Use to First-Use if two or more countries collusively pose a military threat.

India has tried to increase convergence with the USA when it comes to China. It has signed agreements in the field of security like the General Security of Military Information Agreement (GSOMIA), Communications Compatibility and Security Agreement (COMCASA), Basic Exchange and Cooperation Agreement (BECA), Logistics Exchange Memorandum of Agreement (LEMOA), Industrial Security Annex (ISA), the Security of Supplies Arrangement (SOSA) and a Memorandum of Understanding (MoU) on the Assignment of Liaison Officers, which enables a close partnership bordering military alliance (Menon, 2021) without a formal military alliance. There exists an instance of intelligence and situational awareness cooperation during the Galwan incident (India standing against a bully: Defence Secretary Giridhar Aramane, 2024). Such arrangements can be built upon when needed, without overreliance on them, as is being borne out by the current transactional and fickle nature of US foreign policy.
It is necessary to oppose and stop hegemonic forces in the oceans surrounding the Indian

subcontinent. To maintain the Indian Ocean region free, India needs to make use of mini- and multi-lateral organisations like IORA and QUAD, without overreliance on these. To protect Indian interests, care should be taken to prevent QUAD from becoming a military alliance or an Asian NATO.

Two Front threat should not be considered for planning ab initio, which makes any realistic and meaningful planning impractical due to the net national power as such. Two Front threat to be considered a contingency and measure to deal with, including diplomacy, nuclear posture, and military partnerships be defined.

Technology

As is evident from lessons from Ukraine, tech will dictate the national power of a State in the long run. India must develop its own cutting-edge technology base and innovate. No nation would share such technology, and it would be used to hold a nation hostage, as was evident from the Starlink episode early on during the Ukraine war. India should seek convergence with high-tech nations for tech infusion wherever possible. To acquire cutting-edge technology from like-minded partners, initiatives such as the Quad Critical and Emerging Technology Working Group, the Trade and Technology Council with the EU, and the Transforming the Relationship Utilising Strategic Technology (TRUST) (formerly Initiative on Critical and Emerging Technology, iCET) with the USA must be explored. With the introduction of DeepSeek, China has demonstrated that high tech does not have to be expensive, situated in Silicon Valley, or affiliated with Ivy League universities (Kumar, 2025). It should transform our approach to the global high-tech race.

Conclusion

The Russia-Ukraine conflict has shattered many long-held assumptions while offering unprecedented military lessons and statecraft insights. As nations worldwide extract relevant lessons from this war, India faces unique challenges. Positioned between two nuclear-armed neighbours with hostile intentions, India must carefully apply these lessons to protect its path toward becoming a developed nation. This requires both diplomatic finesse and a coordinated approach to national power, combining military strength, economic leverage, and strategic partnerships to ward off potential threats.

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About the Author

Brigadier MB Singh was commissioned in the Infantry in 1999. He is an alumnus of Officers Training Academy, Chennai, Defence Services Staff College, Wellington and College of Defence Management, Secunderabad. He holds an MSc (Defence & Strategic Studies) degree from Madras University, a Masters in Management Studies from Osmania University and is currently pursuing a PhD from the CLAWS-MAHE joint doctorate program.

DEFENCE MANAGEMENT JOURNAL
ISSN: 0976-7347

RESEARCH ARTICLE

The Scorching Cost: Heatwave Impacts & Strategic Mitigation in Delhi NCR

Group Captain Rashmi Dimri

(DMJ/ XXIV/02/2025/01)

"Climate change is a threat multiplier. It not only intensifies environmental challenges but also exacerbates socio-economic disparities, particularly in vulnerable communities."
- Dr Rajendra Kumar Pachauri (Former Chair, Intergovernmental Panel on Climate Change)

Abstract

Heat waves pose significant environmental and socio-economic challenges and are becoming a global concern. National security is not just about guarding borders but also about safeguarding people and infrastructure from unconventional, silent threats associated with climate change. In the densely populated urban cities like Delhi, the rising frequency and severity of extreme heat events disproportionately impact the Economically Weaker Sections (EWS), who have limited resources to adapt and mitigate the exposure. The research article examines the economic and operational repercussions of heat waves on EWS communities residing in the Delhi National Capital Region (NCR). The study highlights adaptive mitigation measures like providing better livelihood and functional security to safeguard the vulnerable EWS populations residing in Delhi NCR in a gradually warming world.

This article was authored by the officer as part of her dissertation topic 'A Mixed Method Study to Analyse Impact of Heat Waves on Economically Weaker Sections of Delhi NCR and Propose Mitigation Strategies in the Context of Climate Change and National Security', undertaken in CDM Secunderabad between June and December 2024.

Keywords. Climate Change, Heat Waves, Delhi NCR, EWS, Work Efficiency, Economic Impact, National Security, Mitigation Strategies.

Introduction

Economically Weaker Sections (EWS) face significant challenges in coping with extreme heat conditions due to a lack of cooling infrastructure and inadequate housing facilities. Prolonged exposure to extreme heat increases health-related risks, which subsequently reduces their work efficiency. In today's era, climate change has been recognised as a threat multiplier, as it may lead to an increase in environmental crises, which can directly impact the well-being and productivity of vulnerable populations globally. Recognising these challenges is imperative to implement targeted climate resilience strategies to safeguard the vulnerable communities against escalating heatwaves.

As per Office Memorandum (OM) by Department of Personnel & Training issued on 31 Jan 2019 (DoPT, 2019), persons who are not covered under the scheme of reservation for SCs, STs and OBCs and whose family has gross annual income below ₹ 8 lakh (Rupees eight lakh only) are to be identified as EWSs for the benefit of reservation. Income shall also include income from all sources, i.e. salary, agriculture, business and profession. However, the term EWS has been applied more broadly in this study; it includes individuals and families who lack essential facilities like adequate cooling infrastructure, healthcare access and

occupational safeguards against extreme heat. This also includes Armed Forces personnel such as defence civilians, casual labourers, DSC guards & Jawans who may not technically qualify under EWS criteria due to limited family income. Hence, the term EWS in this study is applicable to individuals who are socio-economically vulnerable and lack adaptive capacity to cope with extreme heat.

Research Problem

Delhi's heat action plan primarily focuses on general advisories, overlooking the need for workplace safety regulations and targeted financial assistance to safeguard vulnerable individuals from risks associated with heat waves. Existing measures are not very effective in addressing the localised adaptation measures and often do not reach the EWS communities efficiently. Hence, there is a need to account for socio-economic disparities in the Heat Action Plans for the vulnerable EWS populations.

Research Questions

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

- Does increasing heat waves impact the productivity and work efficiency of EWS in Delhi NCR?
- Do EWS face any economic burden during periods of extreme heat conditions in Delhi NCR?
- What short-term, medium-term and long-term mitigation strategies can be suggested to enhance heat wave resilience in Delhi NCR?

Aim

This prescriptive study aims to analyse the impact of heat waves on EWS in Delhi NCR, focusing on work efficiency, economic burden, and proposing mitigation strategies.

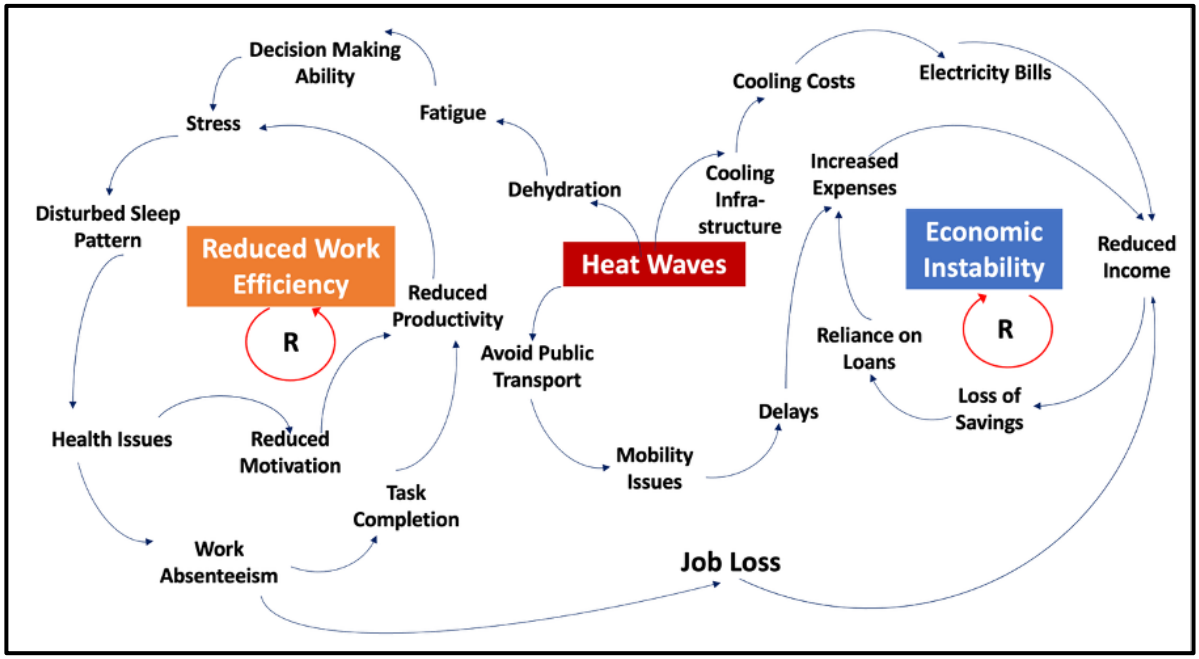

Figure 1: CLD depicting the Impact of Heat Waves on Work Efficiency and Economic Instability

Review of Literature

The literature review was carried out to explore the theoretical foundations for examining the impact of climate change. The IPCC Climate Change Report (IPCC, 2021) provides insights into global temperature projections and the escalating risks of heat waves. The Stern Review on the Economics of Climate Change (Stern, 2006) emphasised the cost-effectiveness of adaptation measures. Pielke's Climate Vulnerability (Pielke, 2005) highlights threats to essential resources. A study by Bhardwaj et al highlights the importance of urban planning in curbing the adverse effects of heat waves (Bhardwaj, Gupta & Sharma, 2022).

The Delhi Heat Action Plan 2024 mentions the government policies for curbing the impacts of heat waves; however, there are notable gaps for adaptation at the community level, financial assistance and safety protocols for the workplace. UN Secretary General's Report on Extreme Heat, released on 25 Jul 24 (United Nations, 2024), urged incorporating heat action aspects into urban development and improvement of the early warning systems.

The seriousness of the problem is depicted using a Causal Loop Diagram (CLD), which illustrates the reinforcing relationship between heat waves, reduced work efficiency and economic instability among EWS (Figure 1 refers). Rising temperatures lead to increased heat stress and associated health risks, causing lower productivity, higher absenteeism and financial strain, especially in the EWS. The solution lies in the targeted interventions to disrupt this vicious cycle and work towards enhancing the climate resilience for EWS.

Although there are adequate studies on heat waves, however impact on the work efficiency of vulnerable populations like EWS in Delhi NCR remains underexplored. Additionally, no study in the Armed Forces domain has been undertaken on how heat waves affect the armed forces personnel both in workplaces and residential areas, which may adversely affect operational efficiency & may also have indirect implications for national security. The focus of this study is to address this gap, which is crucial for developing targeted mitigation strategies for the vulnerable population. Accordingly, a research hypothesis was postulated for the quantitative phase based on the review of the literature.

Methodology

This prescriptive study followed a Convergent Mixed Methods Research (MMR) design, integrating findings of quantitative and qualitative phases (undertaken simultaneously) to assess the impact of heat waves on EWS personnel.

Quantitative Approach

Research Hypothesis. Heat waves significantly impact the Work Efficiency and Economic Stability of the Economically Weaker Sections (EWS) in Delhi NCR.

Sampling Plan. A stratified random sampling method was used to select the sample from EWS personnel working in Delhi NCR, including civilians working and residing in armed forces establishments. The EWS sample included household workers, casual labourers, street vendors, construction workers, etc. The armed forces group comprised civilians employed in military establishments, particularly those at Air Headquarters (Air HQ) and the defence residential area in Shankar Vihar.

Data Collection. Google Forms were used for online surveys of EWS workers with access to digital platforms. A physical survey was also conducted for civilians employed in armed

forces offices and residential areas. Additionally, two research scholars from the Climate Resilient Observing-Systems Promotion Council (CROPC) were enlisted to conduct structured interviews across different parts of Delhi, targeting EWS workers without digital access to ensure comprehensive representation. The questionnaire was designed in Hindi and English and covered work efficiency, economic hardships, health challenges and coping mechanisms. Responses were recorded using a 5-point Likert scale, ensuring consistency in data measurement.

Data Analysis. Descriptive and inferential statistical techniques were applied using Jamovi (v2.3.28).

Qualitative Approach

Sampling. A purposive sampling approach was used to identify key stakeholders, climate experts, policymakers and defence professionals to understand the implications of heat waves on EWS. Experts from the India Meteorological Department (IMD), National Disaster Management Authority (NDMA) and District Disaster Management Authority (DDMA) contributed with perspectives on policy frameworks and climate resilience measures. Additionally, Lt Gen Syed Ata Hasnain (Retd) from NDMA, AVM Sanjay Tyagi (Retd) and AVM AK Devrani (Retd) (both former Assistant Chief of Air Staff Met, the seniormost meteorological appointment in the IAF) were interviewed. Col Sanjay Srivastava (Retd) , who is Chairman of an NGO that deals with climate, weather, and disaster management, Climate Resilient Observing-Systems Promotion Council (CROPC), also provided insights on how rising temperatures impact personnel well-being, workforce productivity and operational readiness.

Data Collection. Semi-structured interviews of stakeholders were conducted to assess the effectiveness of heat action plans, policy gaps and mitigation measures.

Data Analysis. Thematic analysis was conducted using MAXQDA Pro (24.7.0) to identify key themes.

Findings

The analysis of survey data highlighted the impact of heat waves on work efficiency and economic stability among EWS.

Descriptive Analysis. A total of 722 people responded from the EWS of Delhi NCR. Analysis of descriptive statistics indicates that the identified constructs of Work Efficiency (CS1_WE) and Economic Impact (CS2_EI) have almost similar average values of 4.13 and 4.10, respectively, With small standard deviations of 0.399 and 0.372, respectively (Figure 2 refers) indicating limited variability in the responses received from the samples based

	CS1_WE	CS2_EI
N	722	722
Missing	665	665
Mean	4.13	4.10
Median	4.14	4.14
Standard deviation	0.399	0.372
Minimum	2.00	2.71
Maximum	5.00	5.00

One Sample T-Test

One Sample T-Test

		Statistic	df	p
CS1_WE	Student's t	75.8	721	< .001

Note. H_a $\mu > 3$

Descriptives

	N	Mean	Median	SD	SE
CS1_WE	722	4.13	4.14	0.399	0.0148

Figure 2: Results of One-Sample T-Test

One-Way ANOVA

One-Way ANOVA (Welch's)

	F	df1	df2	p
CS1_WE	0.325	4	236	0.861
CS2_EI	2.578	4	243	0.038

Group Descriptives

	Monthly Income	N	Mean	SD	SE
CS1_WE	> 70 K	67	4.13	0.560	0.0684
	50-70 K	75	4.10	0.353	0.0407
	< 20 K	259	4.14	0.335	0.0208
	36-50 K	136	4.11	0.387	0.0332
	20-35 K	185	4.14	0.439	0.0323
CS2_EI	> 70 K	67	3.98	0.474	0.0579
	50-70 K	75	4.09	0.298	0.0344
	< 20 K	259	4.15	0.343	0.0213
	36-50 K	136	4.10	0.362	0.0311
	20-35 K	185	4.07	0.394	0.0290

Figure 3: Results of One-Way ANOVA based on Income

on gender, age, monthly income, occupation and geographical location.

One-Way ANOVA

One-Way ANOVA (Welch's)

	F	df1	df2	p
CS1_WE	2.390	1	466	0.123
CS2_EI	0.222	1	479	0.638

Group Descriptives

	Gender	N	Mean	SD	SE
CS1_WE	MALE	489	4.11	0.401	0.0182
	FEMALE	233	4.16	0.392	0.0257
CS2_EI	MALE	489	4.10	0.379	0.0171
	FEMALE	233	4.09	0.359	0.0235

Figure 4: Results of One-Way ANOVA based on Gender

Impact on Work Efficiency. The statistical findings clarify that extreme heat conditions considerably affect work productivity. A large number of respondents have reported an increase in fatigue and health issues and opted for frequent rest breaks. This resulted in increased absenteeism, leading to a significant reduction in work output.

Impact on Economic Stability. Statistical analysis also reveals that heat waves result in substantial financial burdens on EWS households. This is mainly due to an increase in electricity bills, medical expenditure and a reduction in income due to reduced work hours. To manage extra expenses, many respondents exhaust their savings or take loans, leading to financial instability.

Quantitative Analysis

One-way ANOVA test results indicate that there is no marked variation in work efficiency across various income groups (CS1_WE, p = 0.861); but there is a significant difference in the economic impact between different income groups (CS2_EI, p = 0.038) (Figure 3 refers). During extreme heat conditions, lower-income groups (with a monthly income of less than 20,000) experience a larger financial burden compared to the individuals in higher income

ANOVA - CS2_EI

	Sum of Squares	df	Mean Square	F	p
Gender	0.0000	NaN			
AGE	−1.71e−13	0			
Monthly Income	1.3565	3	0.4522		0.018
Gender ✻ AGE	−1.71e−13	0			
Gender ✻ Monthly Income	0.0687	3	0.0229		0.916
AGE ✻ Monthly Income	1.3498	11	0.1227		0.528
Gender ✻ AGE ✻ Monthly Income	2.6363	11	0.2397		0.053
Residuals	91.5603	681	0.1344		

Figure 5: Results of ANOVA based on Gender, Age and Monthly Income

groups (with a monthly income of > 70,000). **Hence, it is revealed that individuals with higher income relatively experience lower economic burdens due to better access to cooling systems and healthcare**. One-way ANOVA results further signify that there is no major difference between the work efficiency or economic impact based on gender (Figure 4 refers). The ANOVA results indicate that monthly income has a statistically significant effect on economic impact (CS2_EI) with p=0.018 (Figure 5 refers), suggesting that financial stability plays a crucial role in mitigating heat wave-induced economic burdens.

These findings indicate an urgent requirement for government intervention to provide financial support, affordable cooling solutions and workplace safety measures for EWS populations.

Qualitative Analysis

The qualitative data analysis highlights the challenges associated with heat waves and their broad impact on vulnerable communities. The key themes that emerged from the analysis are:-

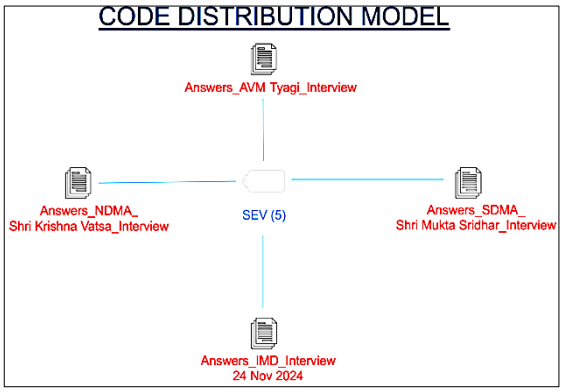

Figure 6: Thematic Analysis (a) Socio-Economic Vulnerability

Socio-Economic Vulnerability (SEV) of EWS. Experts unanimously agreed that EWS populations face the highest risks due to limited access to cooling and healthcare facilities and financial security (Figure 6a refers). A lack of targeted government interventions makes these communities more susceptible to the economic burden of extreme heat.

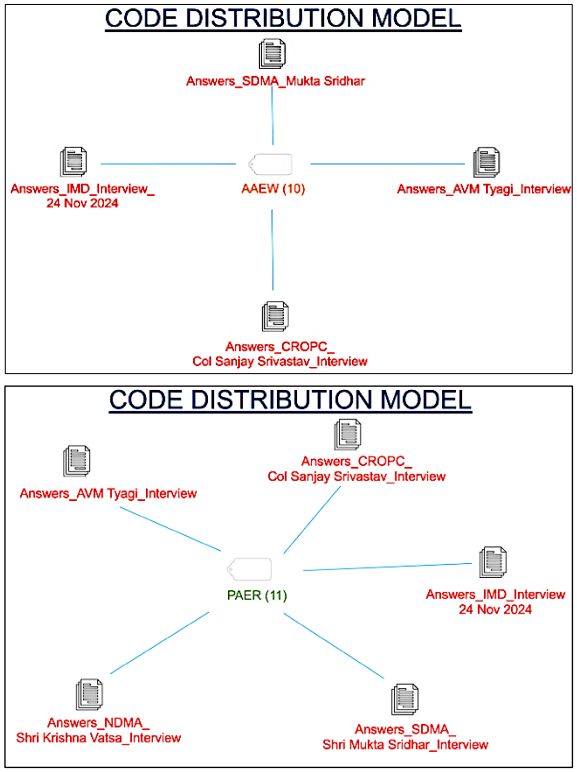

Figure 6: Thematic Analysis (b) Analytics and AI-Driven Early Warning Systems (c) Public Awareness and Emergency Response Campaigns

Analytics and AI-Driven Early Warning Systems (AAEW). Stakeholders emphasised the use of predictive analytics and AI-driven forecasting models for improving preparedness and response strategies. Experts from CROPC and IMD suggested integration of heat risk prediction models with socio-economic vulnerability mapping to facilitate targeted interventions (Figure 6b refers). Dr Mrityunjay Mahapatra (DG IMD) highlighted the need for advanced heat warning systems, especially for urban cities like Delhi.

Public Awareness and Emergency Response Campaigns (PAER). Experts from IMD and NDMA suggested leveraging mobile technology, community radio and multilingual advisories to enhance heat wave preparedness (Figure 6c refers).

Challenges in Implementation. Delhi's high population density and inadequate urban planning worsen the heat island effect, where cities trap heat due to extensive use of heat-absorbing materials like concrete and asphalt. Further, reduced vegetation and dense infrastructure make urban areas to remain significantly warmer than surrounding areas, especially at night. As a result, overcrowded EWS settlements face even harsher temperature extremes. Inadequate cooling centres, unreliable water supply and delayed heat wave alerts further heighten their vulnerabilities. Weak coordination among government agencies, NGOs and local authorities limits effective mitigation.

National Security Implications and Military Readiness. Interviews of experts with a defence background, viz. Lt Gen Hasnain (Retd), AVM Sanjay Tyagi (Retd), AVM Anil Devrani (Retd) and Col Srivastava (Retd) brought out that extreme heat not only affects civilians' and soldiers' health but also impacts the operational efficiency and critical logistics for the military. In today's era, national security is not limited to guarding the territorial borders; it includes ensuring the safety and resilience of all personnel against emerging unconventional threats like climate change. With rising temperatures, defence infrastructures like barracks, training areas and cantonments come under strain, thus need additional cooling resources and upgradation of existing health support. Gen Hasnain also emphasised that climate-induced vulnerabilities can result in the displacement of the population, which may lead to internal security challenges. Defence experts also highlighted that armed forces personnel who are operating in extreme heat conditions may face significant risks due to an increase in heat stress and fatigue, which may lead to operational inefficiencies. Thus, it emerges that there is an immediate requirement for the heat-adaptive workplace environment, which is needed for the optimum Operational Readiness of Armed forces personnel (ORA) (Figure 7a refers). This can be achieved with regular heat stress management training and by enhancing Climate Resilient Military Infrastructure (CRMI) (Figure 7b refers).

Strategic Mitigation Measures. Gen Hasnain underlined the link between climate change and national security, especially in densely populated cities like Delhi. He pointed out that urban heat crises can trigger cascading effects such as

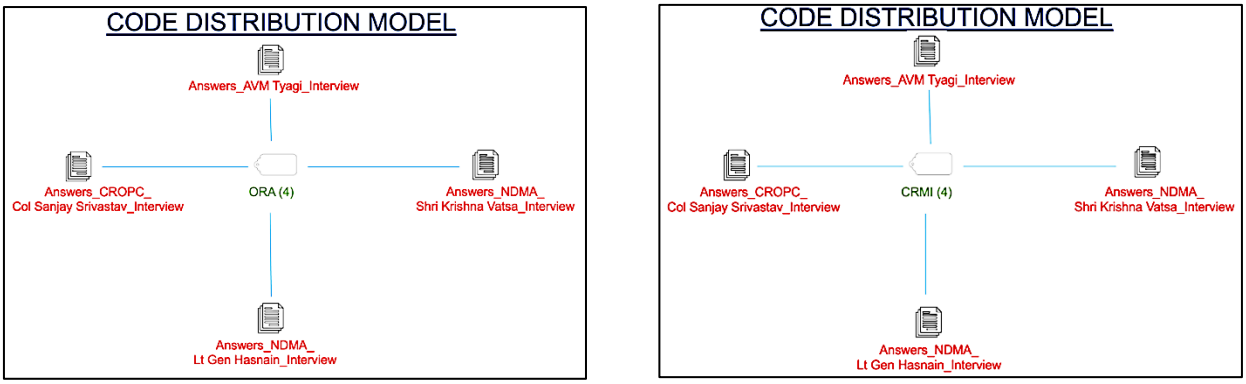

Figure 7: Thematic Analysis (a) Operational Readiness of Armed Forces (b) Climate Resilient Military Infrastructure

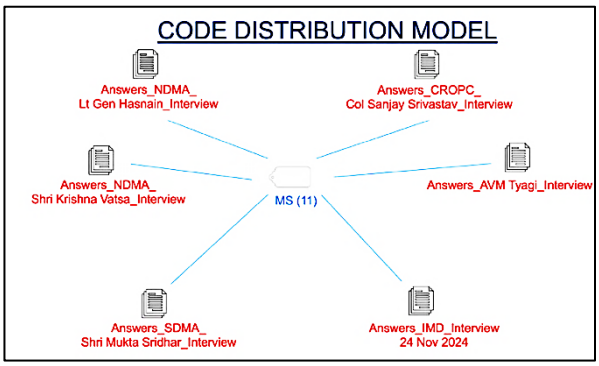

Figure 8: Code Distribution Model for Mitigation Strategies

migration, resource conflicts and pressure on healthcare systems. Climate-driven economic distress among EWS groups, like job loss or income instability, can fuel unrest and social tension. Drawing examples from history, he quoted how extreme climatic events have reshaped regions and governance structures in the past. If left unaddressed, such crises can disrupt law and order and directly threaten national security. Hence, integrating climate resilience into national security frameworks is crucial for developing effective Mitigation Strategies (MS) for protecting vulnerable populations and also for the anticipation of geopolitical and socio-economic risks (Figure 8 refers). This also calls for immediate action to include climate resilience in defence policies and strengthen infrastructure adaptation in military installations.

Discussion

Graph indicating Delhi's rising temperature trend (Figure 9 refers) indicates a gradual rise in maximum temperature with warning signs of temperature exceeding 55°C by 2040, which is a great cause of concern.

The United Nations Secretary General's report on extreme heat reinforces these concerns, urging global action for equitable cooling solutions and targeted adaptation strategies (United Nations, 2024). This study highlights the need for predictive tools, improved infrastructure and heat mitigation policies to protect the vulnerable populations. The revision and timely implementation of the Heat Action Plan before the onset of next summer season, supported by modern technology and learnings from global best practices, can greatly strengthen India's heatwave preparedness. Also,

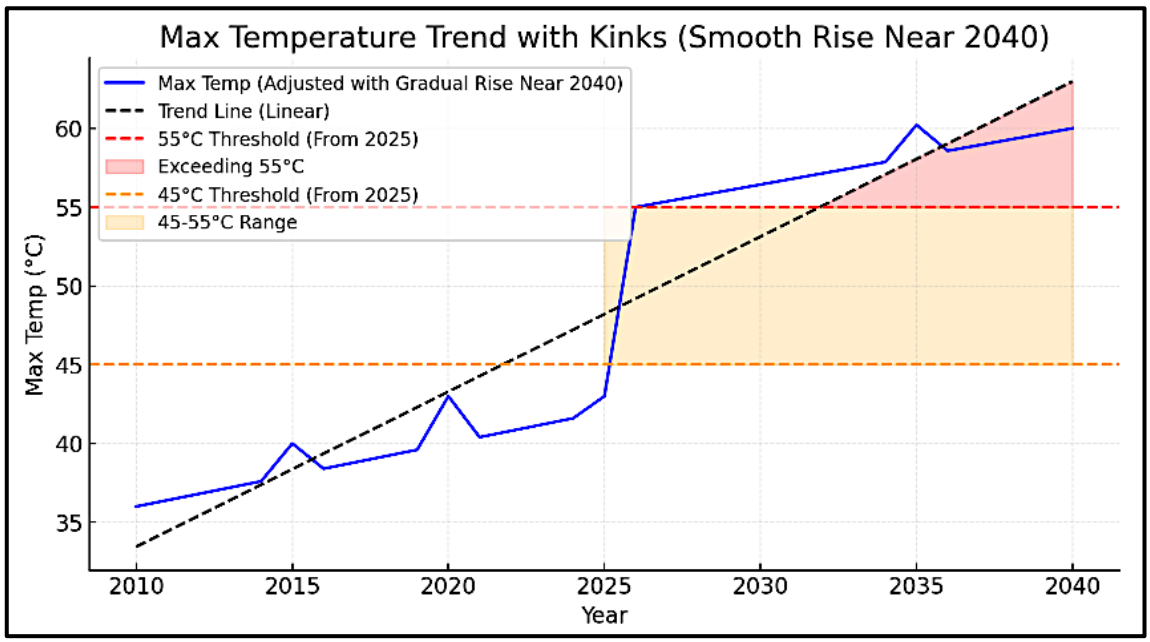

Figure 9: Maximum Temperature Trend of Delhi

inter-agency coordination between the Government, local Administration and NGOs is the need of the hour. To tackle challenges associated with extreme heat waves, experts stressed the need for robust mitigation strategies in the short, medium and long-term. Some of the suggested measures are elaborated below.

Short Term (2025 - 2026): Immediate Relief Measures: -

- Installation of shades and cooling centres in public spaces.
- Availability of essential clean water, hand fans and ORS sachets.
- Temporary water points in slum areas and busy locations.
- Deployment of mobile health units for first aid and treatment in vulnerable areas.
- Installation of large, fixed umbrellas with solar-powered fans along the pedestrian paths.
- Enhancement of community cooling areas.
- Provision of subsidised energy-efficient cooling appliances to low-income households.
- Awareness campaigns and community training programs.
- Enforcement of workplace cooling guidelines.

Medium Term (2026 - 2029): Building Resilience:-

- Developing green belts through tree plantations and parks to enhance urban cooling.
- Installation of solar-powered cooling units in EWS areas.
- Construction of shaded walkways and parking sheds near transport hubs and integrating them into Smart City projects.
- Provision of heat-resistant materials and reflective paints at subsidised rates.
- Adaptive work schedules and limiting outdoor labour during peak heat hours.
- Implementation of mandatory rainwater harvesting for enhancing municipal water supply.
- Improvement in Public Transport in terms of air-conditioned buses and shaded waiting areas, with subsidised tickets for EWS.
- Marking of Urban Heat Mitigation Zones around high heat-prone areas.
- Introduction of micro insurance models for EWS to cover health expenditures and income loss during extreme heat conditions.
- Efforts towards the reduction of air pollution to mitigate heat-related suffering.
- Monitoring of heat stress indicators using IoT devices to provide real-time data to stakeholders for timely interventions.

Long-Term (2029-2035): Sustainable Interventions.

- Promotion of Climate Resilient Housing with heat-resistant construction materials.
- Enhancement of green spaces in urban areas to create cooling corridors.
- Installation of renewable energy systems, like rooftop solar panels, for energy saving.
- Improved satellite data monitoring and forecasting for timely heat stress evaluation and issuing of alerts.
- Encourage a shift to cleaner transport like EVs and green hydrogen to cut excess heat and ease the impact on the environment.
- Promote urban cooling measures like vertical gardens, water features and mist systems in building designs.
- Enhance Delhi's cityscape with greenery and water features to help ease the effects of extreme heat.

- Construction of Climate Resilient Military Infrastructure.
- Population Management in urban areas for urban decongestion.
- Research on Weather Modification Techniques for heat wave mitigation.

Limitations

Time constraints restricted the overall scope of the study. Limited access to Subject Matter Experts (SMEs) and respondents also curtailed opportunities for deeper exploration. Since the research was a prescriptive study focusing on developing mitigation strategies, emphasis on the qualitative approach was greater vis-à-vis that for quantitative methods.

Future Scope

This research highlights the need to prioritise the welfare of vulnerable populations amidst climate change. A nation's true progress lies in how well it protects those most affected by the crises. There is a need to develop a comprehensive heat action plan that addresses the specific requirements of EWS populations, strengthens national preparedness and builds a resilient future for all. The findings also highlight the importance of conducting similar studies across other metropolitan areas to enhance the country's overall climate resilience in the gradually warming world.

"प्रजा सुखे सुखं राज्ञः, प्रजानां च हिते हितम्। नात्मप्रियं हितं राज्ञः, प्रजानां तु प्रियं हितम्।"

- कौटिल्य (अर्थशास्त्र)

"In the happiness of the people lies the happiness of the king; their welfare is his welfare. What pleases him personally is not important; what pleases the people is what matters!"

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DEFENCE MANAGEMENT JOURNAL
ISSN: 0976-7347

REVIEW ARTICLE

A Soldier's Two Fronts: Work-Life Balance in the Armed Forces

Colonel RS Chauhan

(DMJ/ XXIV/01/2025/02)

"If I have seen further, it is by standing on the shoulders of Giants."
- Isaac Newton

Abstract

Military personnel perform multiple roles during their service; soldier, family member and member of society, which often conflict with one another. The most concerning is the clash between work and family life, affecting both the individual and organisational effectiveness. A systematic review and meta-analysis of quantitative studies from 1996-2024 found that Work-Family Conflict (WFC) has a significant impact on job satisfaction. Gender, resilience, social support, and organisational commitment moderate this relationship. WFC levels also vary with career stage. The review recommends further studies on armed forces personnel and proposes several hypotheses.

This review article was authored by the officer as part of his PhD.

Keywords. Work-Family Conflict, Job Satisfaction, Armed Forces, Organisational Development, Systematic Review.

Introduction

A military person undertakes multiple, often conflicting roles, as a soldier, family member, individual, and member of society. One major source of mental stress is the inability to manage these inter-role conflicts, particularly Work Family Conflict (WFC). It is often assumed to be a personal issue addressed through welfare associations, recreation facilities, organisational support, leave policies and social events. However, job pressures frequently force soldiers to compromise on leave, family time, or social engagement, leading to accumulated stress. In trying to make up for lost family time, many also neglect their own mental and physical health. Unaddressed, this stress can result in extreme outcomes such as marital discord, suicide, desertion, or premature exit. If left unchecked, the problem could cause serious personnel management issues, diminish the appeal of military service, accelerate talent loss, and ultimately reduce the efficiency and effectiveness of the armed forces.

Objective of Review

The objective of this review is to examine Work-Family Conflict (WFC) and its impact on job satisfaction among members of the armed forces, with the aim of sensitising the environment to recognise and address this issue.

Methodology. The review followed a systematic approach, applying inclusion criteria that focus on WFC and job satisfaction, along with theories related to achieving Work-Life Balance (WLB). The period of analysis spans over three decades, from 1996 to 2024. The literature was thematically analysed to understand the constructs and inter-relationship between WFC and job satisfaction, the moderating factors, the influence of different strata, and the theories for achieving WLB.

Review of Literature

Role Conflict. Intra-personal conflicts can be either goal-based or role-based. Figure 1 illustrates the various types of intra-personal conflicts experienced by members of an organisation. R.L. Kahn's *Role Conflict Theory* defines inter-role conflict as "an unpleasant emotional feeling due to opposing psychological pressures from incompatible roles of a person" (Kahn et al., 1964). Inter-role conflict occurs when competing demands from different roles create incompatible pressures (Kahn et al., 1964). It is a form of intra-personal conflict distinct from intra-role conflict, which arises from incompatible expectations within a single role. Military personnel are required to fulfil multiple roles throughout their service life, such as being a soldier, a family member, and a member of society, which often become incompatible and lead to inter-role conflict. One of the major sources of mental stress in military life is the inability to resolve such conflicts, particularly Work-Family Conflict, where the demands of work life and family life compete for the individual's time, energy, and attention. Role conflict intensifies when both roles hold central importance to the individual and when there are strong negative consequences for failing to meet the demands of either role (Greenhaus et al., 1985).

Work-Family Conflict. Jeffrey H. Greenhaus later defined Work-Family Conflict (WFC) as a type of inter-role conflict arising from incompatible roles—such as being a family member and an organisational member—held by the same person (Greenhaus, 1985). The opposing pressures of these roles create intra-personal conflict, especially when both roles are central to the individual and when strong negative sanctions exist for failing to meet either role's demands. Although two constructs are identified under WFC—family interference with work and work interference with family—research shows that family interference has an insignificant impact on job satisfaction. Therefore, WFC is largely defined by work interfering with family life (Keisha et al., 2010).

Dimensions of WFC. Greenhaus et al. (1985) identified three dimensions of inter-role conflict: time-based, strain-based, and behaviour-based.

Time-Based WFC - Multiple roles compete for an individual's time and effort, creating workload conflicts. Time pressure from one role makes it impossible to meet the requirements of another role.

Strain-Based WFC. Strain in one role reduces performance in another role (Pleck et al., 1980). Psychological and physical demands at work can produce stress, anxiety, and physical exhaustion, leading to emotional spillover or burnout. Support from spouses, social networks, or colleagues, as well as a conducive

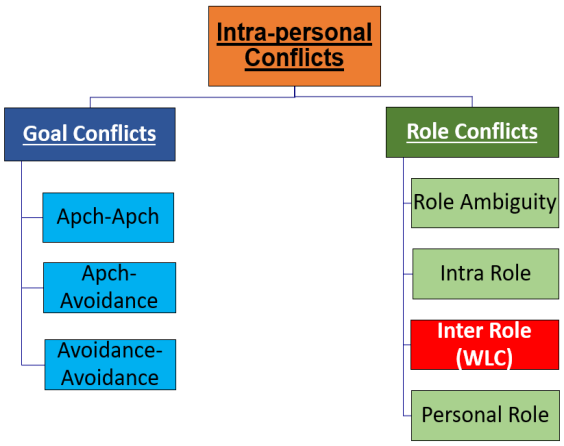

Figure 1: Types of Intra-personal Conflicts

work environment, can reduce strain-based WFC (Greenhaus et al., 1985).

Behaviour-Based WFC - Behaviour patterns suitable for one role may be incompatible with those required in another. This occurs when a person cannot adjust behaviour to meet different role expectations (Greenhaus et al., 1985). For example, behaviour at workplace, centred on logic, power, and authority, may not be appropriate in a family setting, where openness, empathy, respect, and sympathy are expected (Burke et al., 1981).

Likely Reasons for WFC. WFC is more likely when work and family responsibilities are equally important but have different demands, expectations, and requirements. Both domains require substantial time, focus, effort, and energy. Breakdown of the joint family system and rise of nuclear families, driven by social and economic changes, have reduced social support and increased the individual's commitments. This shift has intensified financial and social pressures on the earning member of the family. For example, delays in completing work-related tasks may cause irritation, stress, and frustration (Diana et al., 2020), which can negatively affect attitudes towards the job. Carlson, Kacmar, and Williams developed scales to measure WFC in one of their studies (Carlson et al., 2000). Research also shows that women experience more WFC than men, largely due to differing social expectations (Xu, 2009).

Job Satisfaction. Job satisfaction is defined as a pleasant emotional state at workplace and is a key factor in assessing the work environment. It generally has a positive effect on employee performance (Soomro et al., 2018). Schneider et al. (1975) described it as a pleasurable or positive emotional state arising from the appraisal of one's work experiences. Paul Spector developed a job satisfaction measurement tool with nine factors (Kumara et al., 2018), later reduced to five: compensation, promotion, job itself, work environment, and relationships with colleagues (Fatwa & Tentama, 2020).

Impact of WFC on Job Satisfaction. A meta-analysis of articles published between 1977 and 1999 found that WFC reduces job satisfaction among employees (Allen et al., 2000). A study involving a sample of 166 employees in U.S. cities reported that WFC negatively impacts job satisfaction, with a correlation coefficient of $r = –0.343$ (Keisha et al., 2010). Differences in perceived levels of WFC and job satisfaction have been observed across various strata, including gender, marital status, type of work, stage of parenting, career stage, and years of job experience (Kumara et al., 2018). In a smaller study of 56 employees at Bank Rakyat Indonesia, organisational commitment was found to significantly moderate the effect of WFC on job satisfaction by 26.4% (Diana et al., 2020), as illustrated in Figure 2.

Another study found that job satisfaction mediates the relationship between WFC and turnover intention (TI) by 39.9% (Kumara,

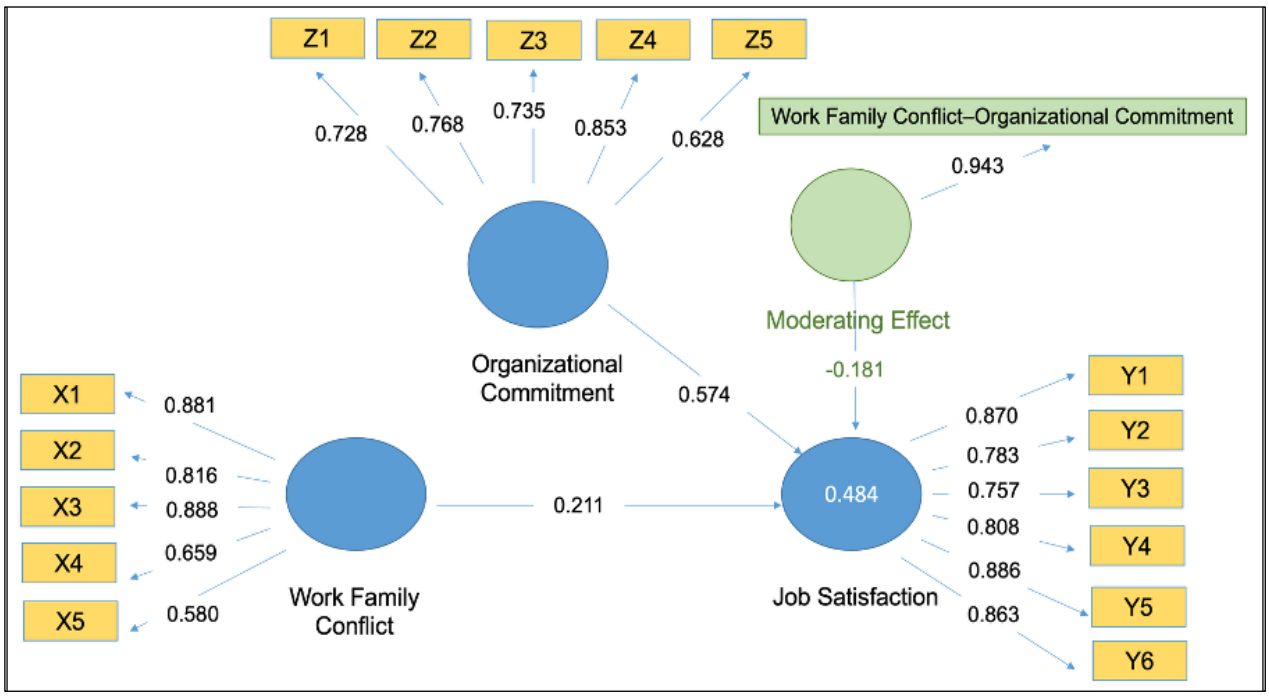

Figure 2: Moderation by Organisational Commitment

2018), as illustrated in Figure 3. Husbands of professional or working women often experience more intense WFC than other husbands, as they must share a greater portion of family responsibilities. Lower levels of support from colleagues and superiors also contribute to higher WFC and lower job satisfaction (Greenhaus, 1985). Other contributing factors include inflexible working hours and jobs requiring extensive travel.

Meta Analysis

A meta-analysis of quantitative studies conducted between 1996 and 2024 (Table 1 refers) indicates that the impact of WFC on job satisfaction ranges from –0.001 to –0.362 (weak yet significant) at the 95% confidence level, with t = –2.36 and a standard deviation of 0.262. The level of impact shows no correlation with sample size (r = 0.191, p = 0.576). Gender, resilience, social support, and organisational commitment have been identified as moderators in the relationship between WFC and job satisfaction. The level of WFC is also linked to a person's career stage. Of the two major dimensions of WFC- work interference with family (WIF) and family interference with work (FIW), WIF is both more prevalent and has a stronger negative correlation with job satisfaction.

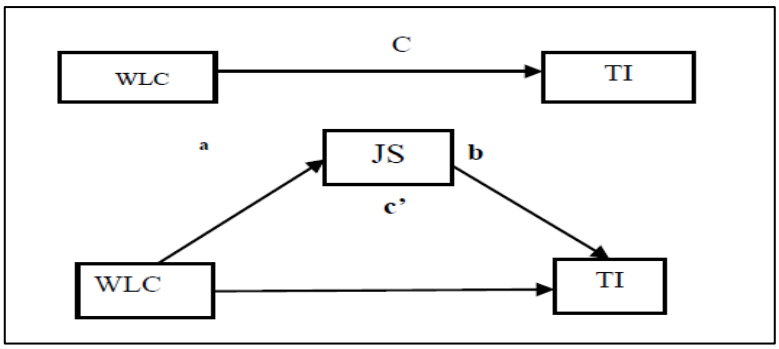

Figure 3: Paths for Regression and Baron & Kenny Mediation Analysis

Study	Sample Size	Occupation of Subjects	Value of Correlation Coefficient (r)	
			Negative r	Positive r
Work life conflict and its impact on Turnover intention of Employees: The Mediation Role of Job satisfaction	100	Employees of Apparel Industry, Sri Lanka	-0.762	
Role stress, inter-role conflict, and job satisfaction among **university employees**: the creation and test of a model	166	Employees of University of Missouri, USA	-0.28	
The Effect of Work-Family Conflict on Job Satisfaction with Organizational Commitment as the Moderator Variable	56	Bank Employees in Indonesia	-0.211	
Examine the Relationship between Work-family Conflict and Its Impact on Job Satisfaction Leading to Turnover	200	Pakistan Telecom Industry employees	-0.002	
Impact of Work Family Conflict on Job and life satisfaction	473	BHEL employees, India	-0.131	
Development and Validation of Work-Family and Family-Work Conflict Scales	532	High School Teachers and Administrators, USA	-0.36	
Gender as a Moderator between Work-Family Conflict and Job Satisfaction of Medical Doctors: The Case of Ghana	354	Medical Doctors in Ghana	-0.15	
Effect of Work-Family Conflict on Job Satisfaction of Small Enterprise Managers	293	Managers of SSEs, in Ghana		0.12
Impact of work-family conflict on job satisfaction and job stress: Mediation model from Indonesia	382	Bank Employees in Indonesia		0.210
Work-family conflict in East vs Western countries	506	Public & Pvt Sector Organisations in Malaysia & Australia	-0.14	
Gender as a Moderator between Work-Family Conflict, Job and Family Satisfaction	339	University Junior Staff, Ghana	-0.342	
Mean	309		-0.186	
Median	339		-0.150	
Standard deviation	169		0.262	
Statistical Estimation for 95% CL			-0.362	-0.0101

Table 1: Meta Analysis of Literature

Other WLB Theories

Spillover Theory. Originally proposed by Wilensky (1960), the spillover model is based on the belief that experiences in the work sphere can extend into non-work sphere (Parker, 1971). Spillover is characterised as positive or negative.

- **Positive spillover** occurs when positive experiences in one domain lead to fulfilment and achievement in another domain (Vijayakumar & Janakiram, 2017).

- **Negative spillover** occurs when negative experiences at work adversely affect non-work spheres (Staines, 1980).

Boundary Theory. Boundary theory proposes that there are psychological, physical, and/or behavioural boundaries between work and non-work aspects of an individual's life (Allen, Cho, & Meier, 2014). Clark (2000) further argued that individuals actively manage and negotiate these domains to achieve balance. This theory assumes that work and non-work are separate but exist on a continuum ranging from **segmentation** to **integration** (Voydanoff, 2005). The relationship depends on:

- **Permeability**. The extent to which boundaries allow psychological or behavioural elements to pass from one domain into another.

- **Flexibility**. The degree to which the borders between the two domains are malleable (Saarenpää, 2016).

Enrichment Theory. In contrast to Role Conflict Theory, Enrichment Theory was developed by Powell and Greenhaus (2006). It defines enrichment as a process where experience in one role improves the quality of life in another role. Enrichment involves gaining resources and experiences in one domain that help individuals meet challenges in another. Powell and Greenhaus (2006) describe two pathways:

- **Affective enrichment** - transferring positive behaviours and emotions between work and family.

- **Instrumental enrichment** - applying skills and behaviours acquired in one domain to increase effectiveness in another.

Facilitation Theory. Facilitation is defined as *"a form of interaction in which resources linked with one role improve or make easier participation in the other role"* (Voydanoff, 2004). Frone (2003) explains it as the extent to which participation in one role creates experiences, skills, or opportunities that ease participation in another. According to Wayne, Grzywacz, Carlson, and Kacmar (2007), facilitation consists of three components: engagement, gains, and enhanced functioning. Gains can be:

- **Development gains**. Skills, knowledge, or competencies acquired.

- **Affective gains**. Improvements in mood and behaviour.

- **Capital gains**. Benefits such as monetary resources, health, and social assets.

- **Efficiency gains**. Increased ability to perform tasks effectively.

Compensation Theory. Compensation Theory suggests that when fulfilment is lacking in one domain, individuals seek it in another (Mathew et al., 2014). Since work and family share the same life environment, each can have a

compensating effect on the other. Edwards and Rothbard (2000) identify two forms of compensation: Decreasing participation in the dissatisfying domain and increasing participation in the satisfying domain. Pursuing rewards in another domain to counter dissatisfaction in one. Compensation can be further classified as:-

- **Supplemental compensation**. Seeking rewards in another domain when they are insufficient in one.

- **Reactive compensation**. Counteracting undesirable experiences in one domain with desirable experiences in another (Zedeck et al., 1990).

Analysis

Research Gap. Most existing studies on Work-Family Conflict (WFC) have been conducted in non-military contexts. However, WFC is often more acute in the military due to the demanding and inflexible nature of service life. This highlights the need for focused research on armed forces personnel. Similar to earlier studies, future research can examine the moderating effects of resilience, organisational commitment, and social support. Differences in WFC and job satisfaction can also be explored based on marital status, career stage, and gender. These factors should be studied in conjunction with Work-Life Balance (WLB) theories to identify effective strategies for reducing WFC among members of the armed forces. The primary research hypothesis for future studies is: **"WFC reduces job satisfaction among personnel of the armed forces."** Following sub-hypotheses flow out of the research hypothesis:-

- WFC exists among the personnel of the armed forces.

- Job satisfaction is inadequate among personnel of the armed forces.

- There are differences in perceptions of WFC among personnel of the armed forces.

- There are differences in perceptions of job satisfaction among personnel of the armed forces.

- WFC negatively impacts job satisfaction among personnel of the armed forces.

Conclusion

The demanding and often competing roles that military personnel must navigate as soldiers, family members, and individuals can create significant stress. These contestations contribute to a perception of reduced job satisfaction and have a direct, detrimental effect on work efficiency. This systematic review establishes a need for detailed research in the context of the armed forces. It is envisaged that the recommended research will address the core issues and not just the symptoms.

About the Author

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DEFENCE MANAGEMENT JOURNAL
ISSN: 0976-7347

PERSPECTIVE

Charting the Future Seas: Indigenous Technology Imperatives for the Indian Navy 2047

Commodore Abhinand Ramakrishnan

"Self-reliance is not just about reducing dependence, but about our capacity to shape the future."
- Shri Narendra Modi, Honourable Prime Minister of India

Abstract

The world is currently experiencing the Fourth Industrial Revolution, or Industry 4.0, characterised by an exponential rate of progress in technologies that are more disruptive than those of earlier technological eras. In order to keep pace with these global developments, the country and our military urgently need to identify functional domains and relevant technologies required in the next 20 years to channelise our efforts towards complete self-reliance. This paper examines the approach followed hitherto by our defence R&D, which is an equipment or system development approach along with associated technologies, as against a technology adoption approach followed by Western militaries. Based on our military capability requirements, the paper identifies critical criteria for Emergent and Disruptive Technologies (EDT), followed by presenting a few technologies for adoption by the Navy to transition to the future requirements of modern warfare.

Keywords. Indian Navy, Industry 4.0, Defence R&D, Emergent and Disruptive Technologies (EDT), Technology Adoption, Self-Reliance, Military Capability, Modern Warfare.

Introduction

In the Industry 4.0 era, adopting and implementing new technology is far more complex, as it requires the integration of a broad range of interconnected technologies. This, in turn, demands transformations of work processes and large-scale industrial practices. Notwithstanding, the pace of this evolution is exponential, and the disruptive impact of these technologies significantly exceeds that of previous technological eras (Mina Saghafian, 2021). These technological advancements (or leaps) are also expected to alter the combat force structure of the Indian Navy in the coming decades. Since many of these niche/ disruptive defence technologies are not likely to be made available by our strategic partners, indigenous efforts would be required to develop the desired capability. Additionally, this leap would necessitate a change in maintenance philosophies and the associated upskilling of human resources essential in a technology-intensive multi-disciplinary domain (Afef Saihi, 2023).

India's "Atmanirbhar Bharat" ecosystem is being galvanised to achieve the development and manufacturing of indigenous military technology and equipment. There is, however, still a significant gap in the availability of niche R&D technology for shipborne systems, and the major areas that need impetus are weapons and sensors, including EW Equipment, propulsion systems, etc, which are, to a large extent, still being imported (VAdm Raman Puri, 2022).

Need for Technology Adoption Approach

MoD has promulgated the Technology Perspective and Capability Roadmap (last issued in 2018) and a Positive Indigenisation List (to

promote indigenous defence equipment manufacturing) (Ahmed, 2023) with an aim to accelerate the technology development process in the defence industry. Whilst the focus has been primarily on products and systems required to meet future capabilities onboard Naval platforms, the technology to build these equipment/ systems would also need to be developed. The Navy, and the armed forces in general, seem to have no existing plan to develop niche technologies and/ or future technologies indigenously to meet desired military capabilities (Kochchar, 2021). This gap has led to a visible duplication of efforts by the three Services, with multiple niche technology variants being developed piecemeal by various MSMEs or startups in the country. An apt example of this is the swarm drone concept that is actively being pursued by all three services, independently. This piecemeal approach has led to duplication of efforts for niche technology development, resulting in missed opportunities for synergy and cost savings.

The U.S. Department of Defence's Defense Advanced Research Projects Agency (DARPA) adopts a distinct approach, emphasising investments in breakthrough technologies aimed at strengthening National Security. It operates within an innovation ecosystem that brings together academic, industry, and government partners, while maintaining a consistent focus on the nation's military needs. NATO does not have a single, direct equivalent to DARPA. Instead, its functions are distributed among several bodies focused on collaborative research, technology development, and innovation across member nations, with the NATO Science and Technology Organisation (STO) as its primary agency for coordination.

In the Indian Navy's Sonar programme of the early 1980s, India too has a shining example of the DARPA approach. The Naval Physical and Oceanographic Laboratory (NPOL) steered research from foundational principles in SONAR technology to the successful design and development of the APSOH sonar. Subsequently, with this know-how, NPOL developed a family of sonars, namely HUMSA, USHUS, ABHAY sonars (Figure 1), which became the Navy's mainstay sonars over the next 30 years (Krishnan, 2003).

Whilst the relationship between technology and capability is complex and can work in both directions, for the Navy, there is a need for specific operational capabilities in the future, which should stimulate the development of new technologies indigenously. The moot point that arises is, 'Does technology drive military capability?' or 'Does the need for military capability drive technology development?'

Emergent and Disruptive Technologies (EDT) for the Navy

To explore, develop, and harness cutting-edge technologies capable of delivering optimal

Figure 1: The HUMSA and USHUS Sonar Systems

military solutions for the Navy, it is vital to identify and understand the technologies that are emergent and disruptive in the world today. NATO, in its '*Science and Technology Trends 2023-2043*' report published in 2023, described the common factors that link future military revolution technologies as *Intelligent, Interconnected, Distributed and Digital* (I2D2) in nature (D.F. Reding, 2023).

In the corporate industry, one of the widely used methodologies to understand technology evolution over time is the *Gartner Hype Cycle* (Figure 2). Whilst the model has been criticised for not being scientifically accurate, it provides an assessment of the maturity and potential of emerging technologies over the next 10 years. Another means of assessing the technology maturity is the use of the *Technology Readiness Levels (TRL)* method, originally developed by NASA. These levels serve as a valuable measure for assessing technology maturity and are therefore widely adopted across industry and government sectors, including the DRDO.

With this background, the next section will focus on technologies, rather than products, that are emerging in the industry and need to be adopted by the Navy to transition to the future requirements of modern warfare over the next 20 years. These technologies have been selected based on the following criteria: -

- Expected to mature over the next 15 years.
- Transformative in nature for the armed forces.
- They are emergent and constitute a generational shift in technology development.

Transition to the Cloud for Data Centric Capability

Data is now a strategic asset in modern warfare, with cloud capability as its core enabler. Unlike rigid on-site infrastructure, the cloud offers flexible and advanced capabilities, making it central to the Navy's move toward data-centric, tri-service warfare (MoD U. , 2023). Effective cloud migration will pave the way for AI adoption and faster OODA loops, providing a decisive edge in future operations (Heller, 2020).

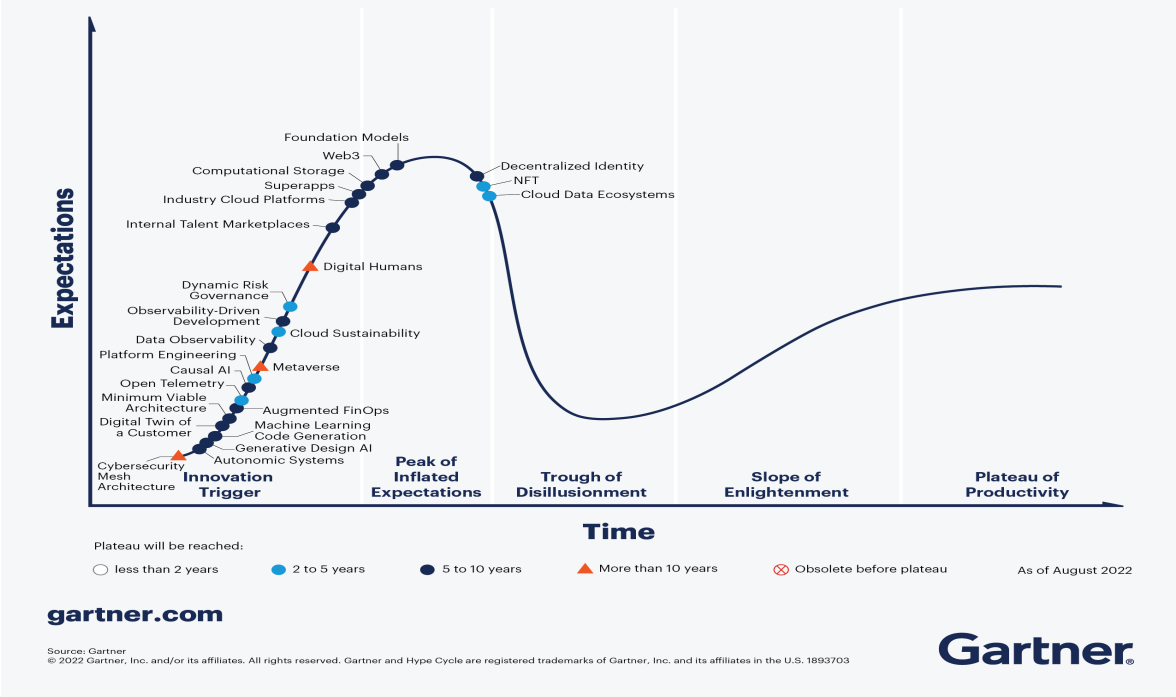

Figure 2: Gartner Hype Cycle for Emerging Tech, 2024

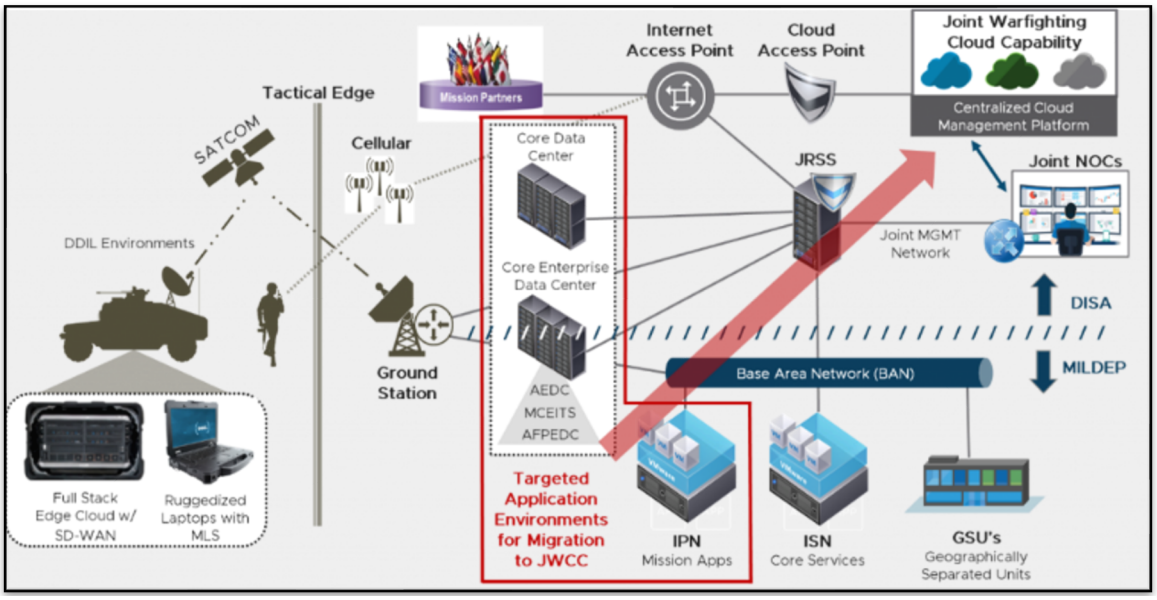

Figure 3: US DOD Joint Warfighting Cloud Architecture

Other Militaries. It is for this reason that advanced militaries have already commenced migrating to the cloud to handle growing data demands and enhance force connectivity. The U.S. DOD's 2022 Joint Warfighting Cloud Capability contract (Figure 3) enables secure commercial cloud access for all mission types, supporting priorities like JADC2 and AI-driven initiatives (Oracle, 2022). The UK's 2023 Cloud Strategic Roadmap aims for rapid adoption within three years, while Japan is integrating its Self-Defence Forces' systems into a unified cloud for greater interoperability (Miki, 2023).

Our Data Network. Amongst the three services, the Navy has a robust data network with two parallel but physically separated Fibre-Optic networks for administration and operations. Further, unlike the Air Force and Army, which have an application-centric data structure, the Navy is creating a data-centric structure (including infrastructure) for centralised data availability, to enable analytics for better insight and sense-making to units at sea. However, as the scale of data ingestion and need for greater and instant accessibility increases, migration to the cloud would become an inescapable necessity. This will ensure the rapid implementation and growth of data-centric decision-making within the service and for future tri-service requirements.

Based on the unique needs of the military, cloud services must meet the following four critical requirements (Heller, 2020): -

- Be capable of supporting all levels of security classification.
- Must ensure global accessibility.
- Be synchronised with and interoperable across the cloud initiatives of other services.
- Designed to accommodate the future requirements of AI and ML programs, implemented in a phased manner. This is the most important criterion.

Adoption of Cloud Systems. India has established a National Cloud initiative known as Project Meghraj, developed by the National Informatics Centre, Pune, and supported by the Ministry of Electronics and Information

Technology (MeitY). Launched in 2014 to deliver Infrastructure as a Service (IaaS), it has since evolved to include Platform as a Service (PaaS) and Software as a Service (SaaS). Whilst there is a growing emphasis on cloud security to protect critical data, this platform currently lacks the capacity to meet the specialised needs of the Navy (Godbole, 2020).

As cloud technology exists in the industry, the Navy needs to adopt this technology rather than indigenise the same. Therefore, a strategy is needed to customise the available technology to meet the Navy's unique requirements. Towards this, the following steps are recommended:-

- Adopt a tri-service strategy and jointly collaborate with industry and academia to develop a cloud strategy that is futuristic and capable of migrating existing legacy applications through suitable re-architecting of security protocols. This strategy must involve migration to a Development-Security-Operations (DevSecOps) approach in its software development and evolve to a model of continuous development, continuous testing, and continuous delivery.

- The National Cloud Meghraj can be ramped up to facilitate secure exchange of voluminous, mission-critical data between formations on land, air, sea and sub-surface. This will allow full utilisation of the advantage of newer features being developed by the Government, such as Data Analytics as a Service (DA-SaaS), AI as a Service (AI-SaaS), etc.

Integrated Electric Propulsion (IEP) for Future Platforms

The significance of inducting Integrated Electric Propulsion (IEP) or Hybrid Electric Propulsion (HEP) has been discussed in detail in the Navy over the past two decades. The typical Mechanical and Electric Propulsion Configuration is shown in Figure 4. Apart from the higher propulsion efficiency achieved in IEP systems, the need for more electric power on warships is also driven by the induction of more powerful sensors (particularly radars), the proliferation of computers and other IT systems inside ships, and the future introduction of directed energy weapons systems.

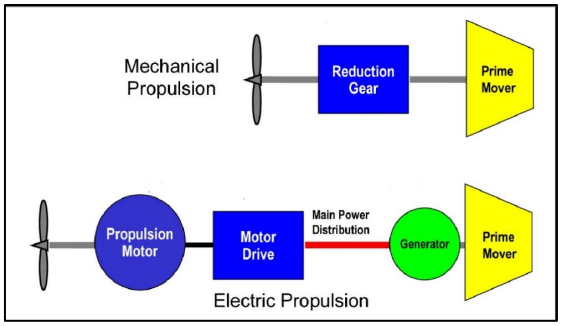

Figure 4: Typical Mechanical and Electric Propulsion Configuration

Amongst the global navies, the USA and UK are early leaders in terms of integrating electric propulsion systems into their naval fleets, embracing IEP across various classes of ships. China is advancing quickly in its adoption of electric propulsion, while nations like Russia and India have been more cautious and exploratory. In these Navies, IEP is especially being favoured for auxiliary ships, smaller vessels, and specific experimental or future vessels where the goal is to enhance stealth capabilities and contribute to a more sustainable naval environment. The Indian Navy, being a major stakeholder of the Indian maritime industry, adopted IEP technology in 2020 by commissioning its first electric propulsion ship,

designed to meet the country's R&D requirements. Since then, most of the new warship projects, either under construction or planned for the next decade, continue to be designed with conventional propulsion systems based on Combined Diesel and/ or Gas Turbine configurations (CODAG or CODOG), which provide cruising and high-speed dash capabilities, respectively, to the warship. Currently, only limited future platforms, such as the Landing Platform Dock (LPD) project, are envisaged to be electrically propelled. The Indian shipping industry has also not seriously embraced IEP and is still operating conventionally powered merchant ships. One of the reasons for the same is the absence of an industrial ecosystem for electric propulsion in the country and its insignificant contribution of less than one per cent to the global shipbuilding industry.

Based on the above, the adoption of electric propulsion by the Navy has to follow a mixed approach of indigenisation through in-house R&D and industry partnerships. Reinforcing this model, the MoD had identified Electric Propulsion as one of the 18 technologies for industry-led R&D under the 25% R&D budget allocation in the Union Budget 2022. There has, however, been no further visible progress.

The following steps are, therefore, recommended for the indigenous development of IEP technology:-

- Development of electric motors and podded propulsors can be progressed through the Indian Industry, engaging with foreign OEMs. M/s BHEL's MoU with M/s GE Power Conversion, UK, in 2022 to develop integrated electric propulsion systems for the Navy is a step in the right direction (Thakur, 2025).

- The Propulsion Control System and Integrated Power Management Systems for IEP require Navy-specific configurations to be met and, therefore, are best suited for in-house

development through DRDO. Setting up a Navy-DRDO joint Centre for Marine Electric Propulsion Technology would projectise the technology development process and ensure the progressive adoption of this new technology in our future platforms.

- Energy storage systems for IEP are still an emerging area of technology development, but require equal impetus for future propulsion systems in Naval platforms. Buoyed by Govt policies such as Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles or FAME, the Indian Automobile industry is aggressively pursuing the indigenous development of EV battery systems. The Navy can leverage this situation and push for indigenous design and development through an industry R&D approach/ Technology Development Fund schemes with MSMEs.

Augmented Reality Solutions for Maintenance and Repairs

Over the past two decades, Augmented Reality (AR) technology has gained significant momentum and is now being successfully applied across both civilian and military domains. In comparison to Virtual Reality (VR), AR offers a more natural mode of interaction, a stronger sense of immersion, and lower hardware requirements. As a result, it has found widespread use in sectors such as education, medicine, industry, and entertainment. With the increasing complexity of

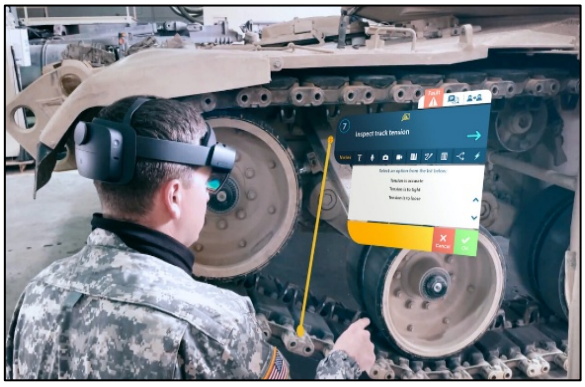

Figure 5: VirtualWorx AR System

military equipment and systems, AR holds particular potential in two key areas: first, for training military personnel, and second, for enhancing the efficiency of Maintenance, Repair, and Overhaul (MRO) of platforms, equipment, and systems.

Other Militaries. The US Navy is exploring AR to maintain onboard systems using the latest technologies. A suitable example is the SPY-6 Radar, which will be inducted with every new surface ship in its fleet. The *VirtualWorx* AR system (Figure 5), co-developed by Raytheon, gives the ship's crew augmented visual help to remotely diagnose and repair its complex systems. The AR system is designed to deliver secure and HD-quality information in environments where bandwidth is low (Raytheon, 2023).

Indian startups such as AjnaLens, Mumbai, are in the process of developing AR solutions for the Army through the IDEX scheme. Whilst the current focus is on military training through AR, there needs to be a special focus on MRO solutions through AR technologies, so that this technology matures in the Navy over the next 15 years.

Adoption by the Navy. Remote Software Support (ReSS) is an indigenous technology developed by the Indian Navy with the help of CDAC, Chennai and the local industry. ReSS allows seamless remote access to ship systems of different OEMs and origins without any intrusion into the system's existing hardware or software layers (Figure 6). The remote access is usable over SATCOM links; thus, the technology has immense potential for use onboard warships, aircraft and forward posts of the Army for providing base support or central monitoring, including operation of sophisticated equipment installed at these locations. ReSS is already inducted on the latest Naval ships in the form of a portable 'Lab-in-a-Box', rapidly deployable next to any system. As the next logical step, the development of AR-based applications within the equipment package would enhance this concept further and bring both applications on a single base.

It is appreciated that AR technology will rapidly mature and be primarily driven by the commercial industry. Accordingly, the following steps are recommended for the technology transition: -

- Considering the wide-ranging needs and uses of AR in the services, the Navy and DRDO need to jointly standardise sensor integration, AR devices, user interfaces, networking protocols, etc. Development of AR technology for maintenance and repairs of

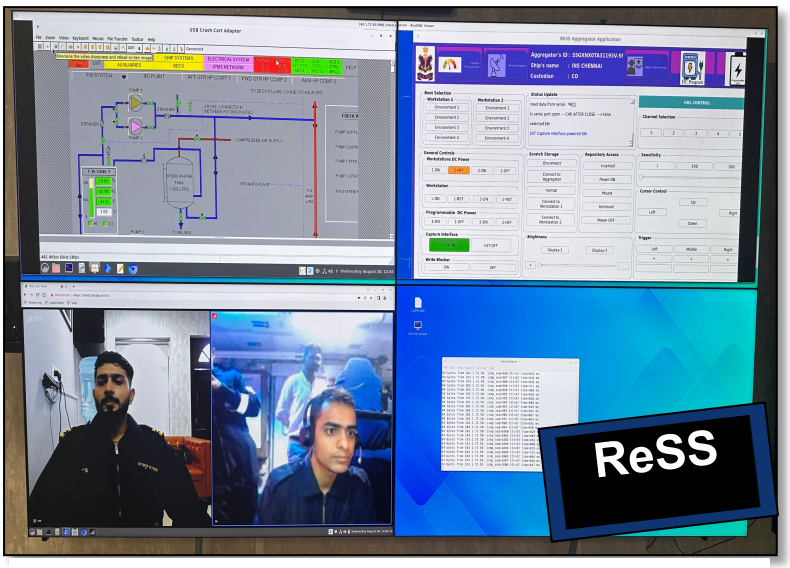

Figure 6: ReSS system onboard IN Ships

complex shipborne systems should be progressed using the IDEX scheme.

- Equipment OEMs/ DPSUs should be encouraged to develop and provide AR solutions to the Navy as part of the equipment package during procurement.

Other Technology Requirements Specific to the Navy

Apart from the above, based on current Science and Technology trends, some of the other enabling technologies identified for military applications up to 2040 (D.F. Reding, 2023) are Quantum Technologies, Advanced Materials, Autonomous systems, Space Technologies, Biotechnology, etc. The Navy-specific applications for some of these EDTs are discussed in the succeeding paragraphs.

Low RCS Antennae. Stealth in warships has been a multi-dimensional pursuit, requiring convergence of various technologies. While significant progress has been made towards Radar Cross Section (RCS) reduction, one dimension where progress has been lacking is in the design of low RCS antennae. The challenge for designers has always been that antennas can also be the dominant scatterers for large RCS platforms. Thus design of stealthy antennae has become a pressing need. Towards this, the Japanese UNICORN (UNIted COmbined Radio aNtenna) integration masts, in use in the JSDF ships (Figure 7), employ a dome that houses all antennas in one structure and thus significantly reduces the overall RCS. India and Japan signed an MoU on 15 November 2024 for the co-development of UNICORN masts for fitment on board future warships (Bharati, 2023). The agreement involves co-development of the antenna by Japanese NEC Corporation with Bharat Electronics Ltd, and is a promising development that needs to be carefully supported till an early completion.

Figure 7: UNICORN Mast on Japan Navy Ships

Quantum Technologies. Among all the EDTs, quantum technologies are attracting the most significant national and commercial investments worldwide, including in India. Over the past decade, quantum properties, particularly superposition and entanglement, have been harnessed to drive the creation of breakthrough technologies. These next-generation advancements include ultra-sensitive sensors, highly precise clocks, unbreakable encryption and communications, as well as quantum computing (D.F. Reding, 2023).

For the Navy, the technology has the potential for revolutionary impact. It is already working with QNu Labs, a quantum technology startup, and has deployed 25 QKD systems in 2024 for

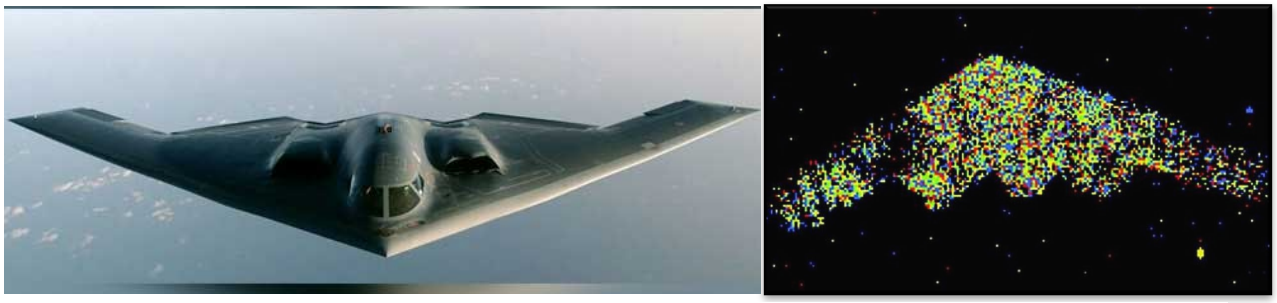

Figure 8: Quantum Radar Display

secure wireless communication. Other applications include employing ultra-sensitive magnetic and acoustic sensors that will greatly enhance the effectiveness of underwater warfare operations, as well as improve the performance of small UAVs due to their small size, weight, and power requirements. (Battersby, 2019). Quantum radar holds the potential to render stealth technologies ineffective, enable more precise target identification (Figure 8), and facilitate covert detection and surveillance (O'Donnell, 2019). Highly accurate clocks will facilitate the development of precision positioning, navigation, and timing (PNT) systems for use in GPS-denied or inaccessible environments. The Navy, therefore, needs to identify specific capability enhancements today for the industry and academia to develop and provide over the next decade.

Conclusion

The exponential pace of current EDT development demands a re-examination of the fundamental approach to technological capability attainment by the Navy. Unlike the current approach of developing products for future Naval platforms, the need of the hour is for developing technologies indigenously for meeting future military capabilities, and the products will assuredly follow. Keeping 'Atmanirbhata' as the way forward for military self-reliance, the Navy needs to select EDTs for future Naval platforms and pursue a combination of industry-led R&D, OEM partnerships, and in-house R&D to develop, integrate and sustain these EDT over the next 20 years.

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DEFENCE MANAGEMENT JOURNAL
ISSN: 0976-7347

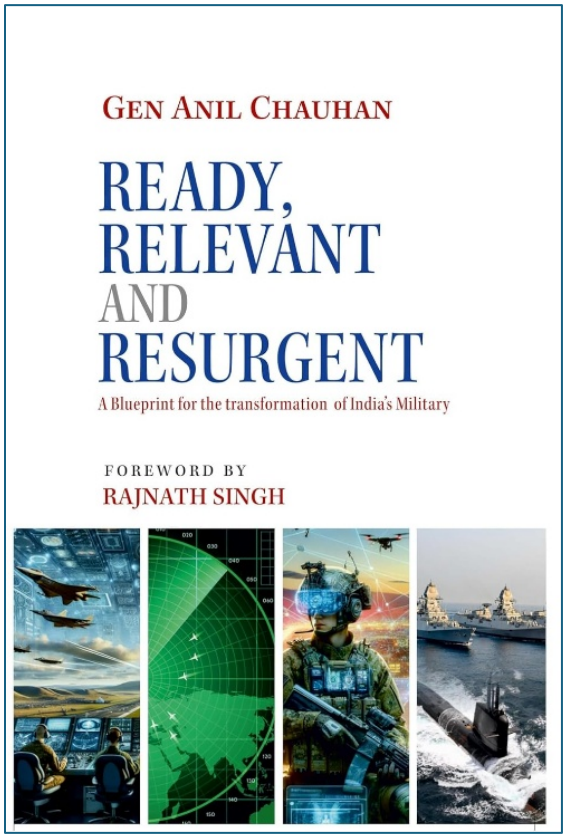
BOOK REVIEW

Ready, Relevant and Resurgent: A Blueprint for the Transformation of India's Military

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

ISBN: 9788198445865

Review by Col Digvijay Singh



In the current complex geopolitical dynamics with endless uncertainties and technological disruptions, General Anil Chauhan's latest book titled 'Ready, Relevant and Resurgent' arises as a timely and imposing explanation of India's military transformation. The author, as the serving Chief of Defence Staff (CDS) and Secretary, Department of Military Affairs, leverages both real-world experience and strategic foresight, offering all readers an elaborate, honest and comprehensive guide to the future progression of India's rise in defence capabilities.

A Rare Strategic Voice. In the present world order, it's very rare for a serving four-star general, let alone the CDS, to author a functional text while in service. Released on 22 May 25, the book was unveiled by Defence Minister Rajnath Singh. The book is based on a series of essays and speeches. It echoes on the theme chosen at the Combined Commanders' Conference in March 2023. More than a philosophy, the book reads like a well-documented doctrinal roadmap reflecting General Chauhan's belief that India can't rely only on genetic paradigms but must progress its defence posture to tackle challenges posed in the 21st century.

Foundational Pillars. The book addresses three pillars as per the combined commanders' theme: Readiness, Relevance and Resurgence. The author argues interestingly that India's military power must grow beyond traditional frameworks into a flexible, niche, integrated force capable of addressing multi-dimensional threats, varying from conventional warfare to grey zone warfare and hybrid threats in cyber, space and informational domains. The author's major work is its cultural analysis of military and human geography and underscoring terrain as a critical factor, even in this era of digital age.

Historical Insights. The author's description is predominantly enriched by historical understandings and an unusual emphasis on

integrating traditional Indian strategic wisdom. His examination of ancient texts like the 'Artha Shastra and Mahabharata' as resources for modern strategic thinking complements a distinctive cultural and philosophical wisdom rarely found in other strategic literature, appealing to both intrigue and debate within international strategic scenarios.

Change Management. While highlighting change is the unwritten law of nature, ie 'परिवर्तन ही प्रकृति का नियम है' as highlighted in 'Srimad Bhagwat Gita', the author highlights many reforms in the Armed Forces, key among those is 'move from Single Domain to Multi-Domain Operations'.

Reforms. Perhaps the most significant portion of the book addresses structural reforms. The author presents a persuasive case for theatre commands, advocating a shift from service-specific structures to joint operational frameworks. He makes a robust argument for enhancing India's defence through indigenous production capabilities, reflecting broader national imperatives of self-reliance or 'Atmanirbharta'. The Author's approach proficiently balances idealism with realism, recognising bureaucratic and institutional challenges that could hinder such striving reforms.

National Security Strategy (NSS) Framework. Fascinatingly, the author also highlights the antagonistic debate on the necessity of a written NSS document for India. His claim that India's recent strategic actions already embody an inherent NSS, challenges the necessity of a traditional explicit Western military doctrine. The argument provokes thoughtful discourse on strategic transparency versus practical efficacy.

Indigenisation. The Author also highlights the imperative of self-reliance in his book:

- India needs to drastically reduce its dependency on foreign arms and defence systems.
- Procurement plans and indigenous design must prioritise domestic development, particularly in evolving and niche technologies.
- Intellectual and logical autonomy, deep-rooted in ancient strategic wisdom, must balance material self-sufficiency for future needs.

These themes discussed by the author meticulously mirror India's broader efforts, such as 'Make in India', Atmanirbharta and upgrading of defence research and development.

Building the Higher Defence Organisation (HDO)

The book marks the Indian Defence HDO structure, ie Department of Military Affairs (DMA) and post of CDS, as critical to reform:

- The DMA, led by the CDS, bridges the gap between cabinet or ministry-level directions and execution by respective services.
- General Chauhan also argues that actual transformation only happens when mindsets change by sharing practices, inculcating jointness and nurturing trust among all three services.
- He offers a proposal for moving beyond disjointed thinking, leveraging layered and systemic reforms to shape comprehensive national resilience.

Technological Influence and Impact. The author's laborious exploration of technological influences on future national strategies, predominantly the convergence of artificial intelligence, robotics and cybersecurity, is highly insightful. The Author reveals acute awareness of emerging and niche technologies'

transformative potential, promoting robust integration of ingenious innovation into defence planning, development and execution.

Critique. While the book is overwhelmingly commended for its ingenuity, clarity and visionary approach, sceptics may question the pace and feasibility of a few reforms as recommended by the author, mainly keeping in mind India's bureaucratically impenetrable and politically nuanced atmosphere. Nonetheless, the Author's pragmatic nod to these hindrances lends genuineness, authenticity and realism to the vision shown in his book.

Who Should Read It? This Book is an essential reading for:

- Defence analysts are discovering the future course of Indian military reform.
- Bureaucrats and policymakers are involved in procurement plans and policy formulation.
- Strategic military leadership is aligned with higher defence structures.
- Scholars and students are inquisitive about the strategic arc driving India's rise as a future superpower and relevant defence power.

End Summary. The book 'Ready, Relevant and Resurgent' emerges as a seminal work that deeply enriches strategic discourse on military transformation and modernisation, not only within the Indian context but also in the global arena. General Chauhan's vision, as mirrored in his book, is a crucial reading for policymakers, defence analysts, researchers of international security and military practitioners, especially for all those looking for an understanding of India's military trajectory amidst global power shifts. The book charts a course of action for military transformation and enunciates a coherent vision that integrates ancient wisdom, philosophy, geography and niche technology into a singular strategic narrative. General Anil Chauhan's book is less hypothetical discourse and more operational, as well as an effective roadmap. It combines the doctrinal exposition with strategic realism as highlighted by:

- His vast field experience in the Indian Army for over four decades, and the development of higher defence reforms.
- An ambition to make India's military doctrine futuristic, integrated and much aligned with 'Viksit Bharat by 2047'.

If someone is interested in India's growing military strategies or the structural optimisations under current leadership, or the intellectual foundations of ongoing defence reforms, this book is strongly recommended.

Final Thought. General Chauhan's book offers a great voice of both reflection and challenge. It articulates a vision at strategic levels for a unified purpose: repositioning India's military as ready, relevant and resurgent in the present uncertain geopolitical scenario. As the suggested reforms unfold, the narration will become guidance that may anchor the tempo.

About the Reviewer

Col Digvijay Singh was commissioned into the Regiment of Artillery in December 2004. The officer is an alumnus of the School of Artillery, Deolali, Military Institute of Technology, Pune and the College of Defence Management, Secunderabad. He holds an MSc (Technology) and an MSc (Weapon Technology) from Savitribai Phule Pune University and a Master's in Management Studies from Osmania University.

DEFENCE MANAGEMENT JOURNAL
ISSN: 0976-7347

BOOK REVIEW

Beijing's Global Media Offensive: China's Uneven Campaign to Influence Asia and the World

By Joshua Kurlantzick

ISBN: 9780197744659

Review By Colonel Hemant Mathpal

In today's socially connected digital world, information is the most vulnerable space, yet it is the space that is most accessible. The media has expanded beyond print and television to a wide range of platforms, and nations have adapted themselves to dominate the space effectively. In this quest, one country that has been very aggressive and possibly the leader is China. The promulgation of the three-warfare strategy in 2003 made the official indictment of China's attempt to aggressively use the manipulation in cognitive space; however, the background work on this can be traced back to Sun Tzu's Art of War and winning without fighting. In his book Beijing's Global Media Offensive, the author presents a well-researched and nuanced perspective on China's efforts to shape narratives and perceptions by exploiting its vast media and information operation capabilities.

Joshua Kurlantzick, in this book, examines how China is attempting to build a media and information superpower. He also highlights China's media and information failures and the negative consequences of China's aggressive and often alienating diplomacy. Despite these setbacks, China's media and political influence campaigns are likely to continue to expand and potentially damage press freedoms, human rights, and democracy abroad. As authoritarian regimes across the globe have resorted to increasingly leveraged information as a strategic tool, the author evaluates how China, under the CCP, is executing a long-viewed, far-reaching campaign to influence foreign audiences, both elites and the general public, across the globe.

The book has 12 chapters, which are arranged progressively to understand the Chinese Global media operations. Chapter 1 Building a Giant or a Giant Failure? starts with the Malaysian election of 2018 and how there were attempts to shape the outcome by the Chinese government. It gives the reader an introduction to the Chinese Motivation of increasing efforts to wield power within other countries and leveraging its media and information tools. He examines the scale of Beijing's investments in state media and influence operations, questioning whether these efforts have yielded the desired outcomes or fallen short due to various challenges. The progression to Chapter 2 traces the concept of Soft Power and Sharp Power in the Chinese context. He defines Sharp power as using manipulative diplomatic, media, and other tactics to pierce, manipulate and distract other countries so as to influence public opinion. It underlines the soft power approach of opening Confucius Centres so as to use virtues to attract others to the Chinese cause, or the Charm

Offensive as the author calls it. The narrative thereafter shifts towards China's initial forays into global influence during the early 2000s, highlighting how these early efforts laid the groundwork for current strategies. He discusses the successes and limitations of China's attempts to project a positive image abroad. Chapter 4 discusses the Motivations for China's Modern Influence Campaign, where it explores Beijing's desire to reshape international narratives, counter Western criticism, and legitimise its governance model. He explores domestic and international factors that converge to motivate these campaigns.

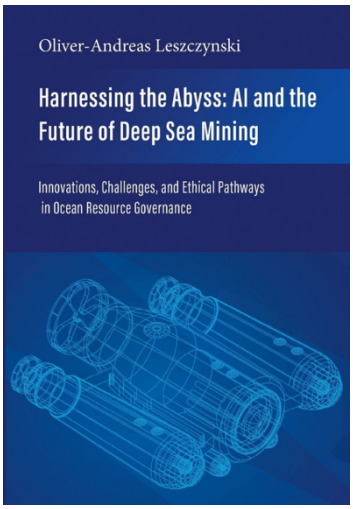
In the latter part of the book, the narrative shifts towards the global conditions that have facilitated China's media expansion and the openings created for Chinese media due to declining trust in Western media and other factors affecting the traditional news outlets. The discussion on Xinhua News Agency explores how content-sharing agreements, along with strategic partnerships, have extended Chinese media reach and have allowed Chinese narratives to permeate foreign media landscapes. The chapter on The Sharp-Power Tool Kit: Media and Information Slipping Through the Back Door delves into covert influence tactics, such as cyber operations, manipulation of social media, and clandestine funding, so as to dominate the infrastructure of global information flow. There is an examination of the traditional methods, such as economic incentives, relationship building and leveraging diaspora by the Chinese and brings out how these are being used to complement modern media strategies. The author, towards the end, discusses the outcomes of China's global media offensive and gives examples of both successes and failures. He brings about the contradiction in the Chinese approach, where its influence has grown in some areas but has faced resistance, thereby limiting its overall effectiveness. In the concluding chapter, the author offers recommendations for democracies to counter China's influence operations. He advocates for strengthening independent media, enhancing transparency, and fostering public awareness to build resilience against foreign interference.

The book draws on studies and the author's own knowledge of Southeast Asia and beyond to construct a driving narrative. It reveals how deeply Beijing is involved both overtly and covertly in media and politics overseas and how it exercises soft and 'sharp' power to achieve its aims. The book gives a big picture of how a mechanism to target disinformation should be a priority for all governments. The book by Kurlantzick is a good read for students of IR and policymakers to get an insight into the influence operations of the Chinese and ways to counter them. Overall, the book is a good read and is recommended for gaining strategic insights into long-term influence operations that will be characteristic of the digital era.

About the Reviewer

Colonel Hemant Kumar Mathpal was commissioned into the Infantry in June 2004. The officer is an alumnus of the National Defence Academy, Khadakwasla, Defence Services Staff College, Wellington and College of Defence Management, Secunderabad. He holds an MSc (Defence and Strategic Studies) from Madras University, M Phil from Punjabi University, Patiala and a Master's in Management Studies from Osmania University. He is presently pursuing his PhD from Punjabi University, Patiala.

Book Briefs



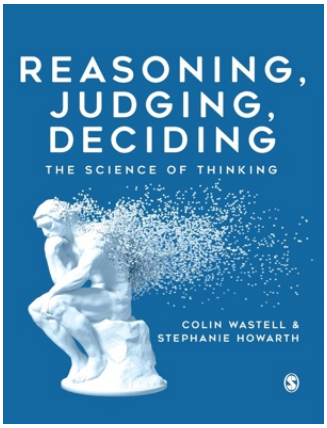
Harnessing the Abyss: AI and the Future of Deep Sea Mining
By Oliver-Andreas Leszczynski

Hardbound: 386 pages/ ISBN: 978376933708-2
Publisher: BoD - Books on Demand (2025)

Harnessing the Abyss examines how artificial intelligence (AI), robotics, and modern ocean technologies are reshaping the frontier of deep-sea mining. Leszczynski explores how AI can enhance seabed resource exploration, drive efficient extraction, and enable real-time environmental monitoring. The book does not shy away from ethical and ecological challenges: it critically discusses environmental risk, sustainable governance of ocean resources, and the moral responsibilities tied to exploiting the deep seabed. It aims to present a balanced view of opportunity and responsibility, offering strategic and policy-oriented insights for stakeholders in maritime industries, resource governance, and environmental planning. The book reflects the latest thinking on deep-sea mining, relevant in a rapidly changing global resource environment. Insightful, thought-provoking, and deeply relevant, Harnessing the Abyss is both a guide and a call to action for those navigating the complexities of deep-sea mining. It challenges us to harness the power of innovation with care and foresight, ensuring that the treasures of the deep are not squandered but serve as a foundation for a sustainable and equitable future.

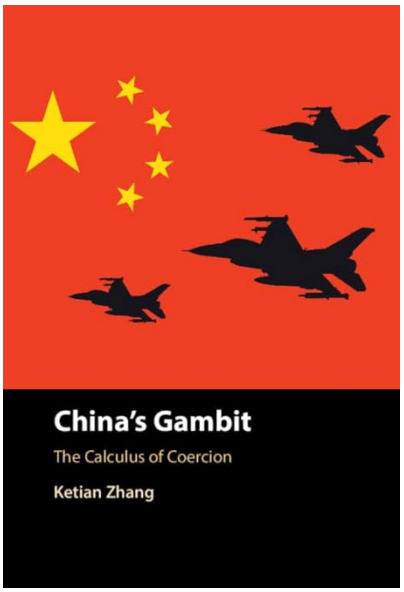
For anyone interested in India's future maritime security challenges, this book is a must-read.

Reasoning, Judging, Deciding: The Science of Thinking
By Colin Wastell, Stephanie Howarth



Paperback: 432 Pages/ ISBN: 978-1526491084
Publisher: Sage Publications (2021)

Are humans effective thinkers? How do we decide what is right? Can we avoid being duped by fake news? Thinking and Reasoning is the study of how humans think; exploring rationality, decision making and judgment within all contexts of life. With contemporary case studies and reflective questions to develop your understanding of key dilemmas, this book covers the fundamentals of the science behind thinking, reasoning, and decision-making, making it essential reading for any student of Thinking and Reasoning. From heuristic biases to the cognitive science of religion, and from artificial intelligence to conspiracy theories, Wastell and Howarth's text clearly and comprehensibly introduces you to the core theories of thinking, leaving no stone unturned, before showing you how to apply theory to practice. 'The unique selling point of the book is the inclusion of current topics and recent developments, a very good structure, and it approaches the field from a very wide angle.



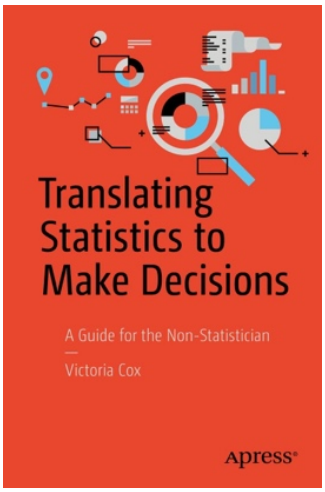
China's Gambit: The Calculus of Coercion
By Ketian Zhang

Paperback: 245 Pages/ ISBN: 978-1009423830
Publisher: Cambridge University Press (2023)

Emerging from an award-winning article in International Security, China's Gambit examines when, why, and how China attempts to coerce states over perceived threats to its national security. Since 1990, China has used coercion for territorial disputes and issues related to Taiwan and Tibet, yet China is curiously selective in the timing, target, and tools of coercion. This book offers a new and generalisable cost-balancing theory to explain states' coercion decisions.

Author Ketian Zhang demonstrates that while China has used coercion for territorial disputes and issues related to Taiwan and Tibet, it is curiously selective in the timing, target, and tools of coercion. She shows that rising powers do not always default to military force, often preferring non-military instruments like economic sanctions, diplomatic pressure, or grey-zone coercion. The book illuminates the subtleties of coercive statecraft in an era of global economic interdependence, making it highly relevant for scholars and practitioners of international security and defence policy.

Translating Statistics to Make Decisions: A Guide for the Non-Statistician
By Victoria Cox

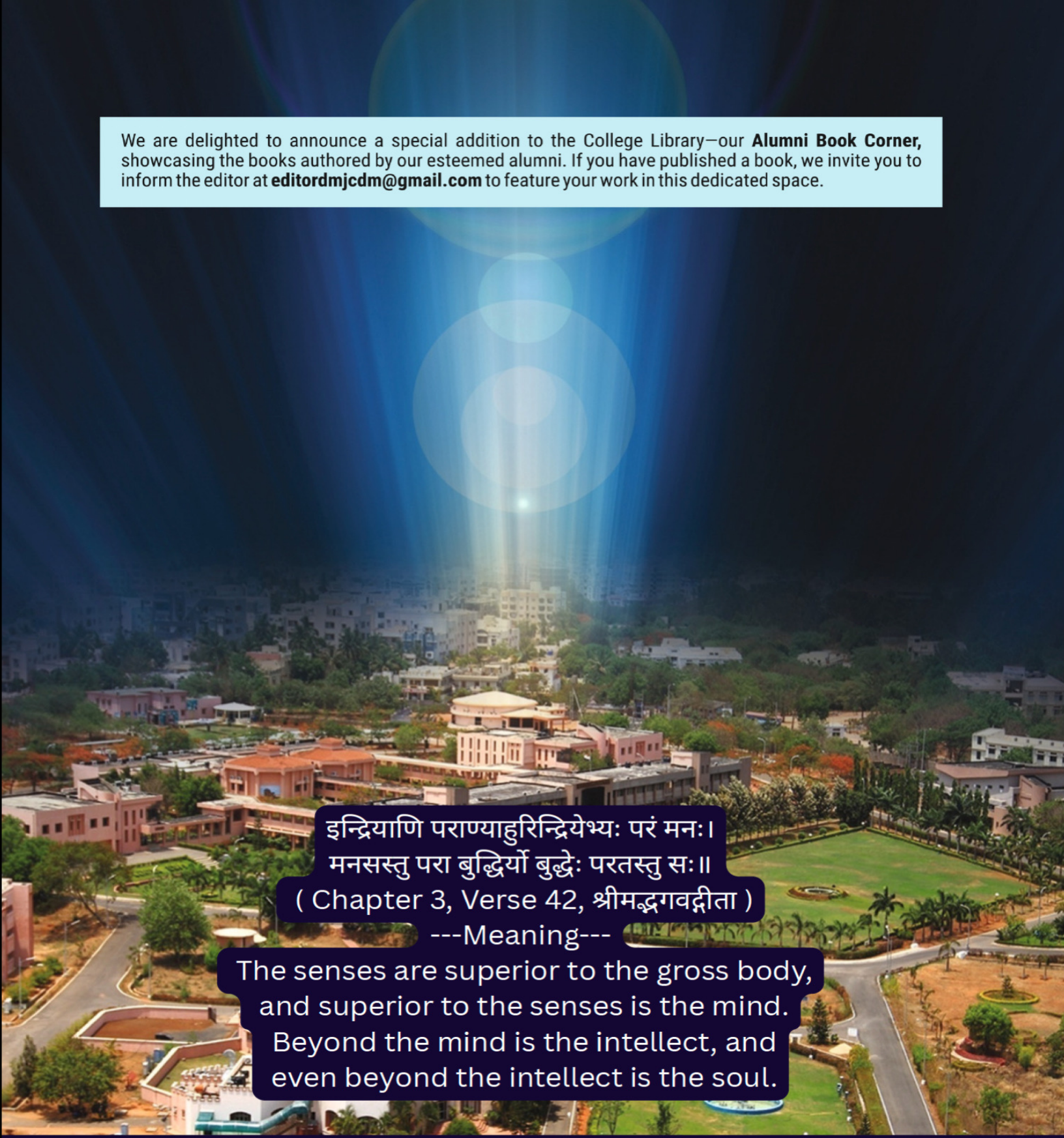


Paperback: 324 pages/ ISBN: 978-81484222553
Publisher: APress (2017)

Victoria Cox, senior statistician at the United Kingdom's Defence Science and Technology Laboratory (Dstl), distils the lessons of her long experience presenting the actionable results of complex statistical studies to users of widely varying statistical sophistication across many disciplines: from scientists, engineers, analysts, and information technologists to executives, military personnel, project managers, and officials across UK government departments, industry, academia, and international partners.

Translating Statistics into Better Decisions teaches statistically naive readers enough about statistical questions, methods, models, assumptions, and statements that they will be able to extract the practical message from statistical reports and better constrain what conclusions cannot be made from the results. For non-statisticians with some statistical training, this book offers brush-ups, reminders, and tips for the proper use of statistics as well as solutions to common errors. To fellow statisticians, the author demonstrates how to present statistical output to non-statisticians to ensure that the statistical results are correctly understood and properly applied to real-world tasks and decisions. The book avoids algebra and proofs, but it does supply code written in R for those readers who are motivated to work out examples.

We are delighted to announce a special addition to the College Library—our **Alumni Book Corner,** showcasing the books authored by our esteemed alumni. If you have published a book, we invite you to inform the editor at **editordmjcdm@gmail.com** to feature your work in this dedicated space.



इन्द्रियाणि पराण्याहुरिन्द्रियेभ्यः परं मनः।
मनसस्तु परा बुद्धिर्यो बुद्धेः परतस्तु सः॥
(Chapter 3, Verse 42, श्रीमद्भगवद्गीता)

---Meaning---

The senses are superior to the gross body, and superior to the senses is the mind. Beyond the mind is the intellect, and even beyond the intellect is the soul.

Forging Strategic Minds, Securing Future Fronts

ISSN 0976-7347

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