INTEGRATION OF INTERDISCIPLINARY INNOVATION : STUDY OF TRI SERVICES, ATAL INNOVATION MISSION(AIM) AND NATIONAL MISSION ON INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (NM-ICPS)

A Dissertation submitted to the Panjab University, Chandigarh for the award of the degree of Executive Masters in Public Administration and Public Policy,

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by

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CERTIFICATE

I have the pleasure to certify that **Brigadier Marut Shukla** has pursued his research work and prepared the present dissertation titled '**Integration of Interdisciplinary Innovation: Study of Tri Services, Atal Innovation Mission(AIM) and National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS)**, under my guidance and supervision. The same is the result of research done by him and to the best of my knowledge; no part of the same has been part of any monograph, dissertation or book earlier. This is being submitted to the Panjab University, Chandigarh, for the purpose of **Executive Masters in Public Administration and Public Policy** in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration (APPPA) of Indian Institute of Public Administration (IIPA), New Delhi.

I recommend that the dissertation of **Brigadier Marut Shukla** is worthy of consideration for the award of Executive Masters Degree of the Panjab University, Chandigarh.

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Declaration

I, the undersigned, hereby declare that the dissertation titled '**Integration of Interdisciplinary Innovation : Study of Tri Services, Atal Innovation Mission(AIM) and National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS)**' is my own work and that all the sources I have accessed or quoted have been indicated or acknowledged by means of completed reference. The dissertation has not been submitted for any other degree of this university or elsewhere.

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Summary

The integration of Services Innovations Organisations (SIOs) with key national policies like Science Technology and Innovation Policy (STIP), and initiatives such as the Atal Innovation Mission (AIM) and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) is a strategic move aimed at fostering innovation, collaboration, and synergy across domains.

Services Innovations Organisations (SIOs)

SIOs should ideally represent a unique convergence of expertise from the Indian Army, Navy, and Air Force. However, the three Services presently maintain separate organisations within their respective structures, with no or minimal congruence. These Service specific organisations, namely the *Army Design Bureau of the Indian Army, the Indian Navy's Naval Innovation and Indigenisation Organisation (NIIO) and the Directorate of Aerospace Design of the Indian Air Force*, focus on developing cutting-edge solutions for defence and security challenges, and spearhead all innovation related issues. Their work spans areas of emerging technologies related to communication systems, surveillance technologies, robotics, and artificial intelligence.

Atal Innovation Mission (AIM)

AIM, established in 2016 under the aegis of NITI Aayog, serves as the Government of India’s flagship initiative to promote innovation and entrepreneurship.

Its multifaceted approach includes creating a culture of innovation in schools, colleges, and society at large. Key components of AIM include:

- Atal Tinkering Labs (ATLs): These state-of-the-art spaces in schools foster curiosity and innovation among students. ATLs provide access to tools like 3D printing, robotics, and IoT, encouraging problem-solving mindsets.

- Atal Incubation Centres (AICs): These world-class incubators support dynamic entrepreneurs, providing technical facilities, mentorship, and funding. AICs aim to nurture scalable and sustainable startups.

- Applied Research and Innovation for Small Enterprises (ARISE): ARISE focuses on solving real-world challenges faced by small businesses through innovation.

- Atal Community Innovation Centres: These centers engage local communities in problem-solving and innovation.

National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)

NM-ICPS, launched in 2018, aims to create a vibrant ecosystem for interdisciplinary research and development in cyber-physical systems (CPS). CPS integrates computation, communication, and control in physical systems, impacting areas like healthcare, agriculture, transportation, and smart cities. NM-ICPS focuses on:

- Research and Development: Encouraging collaborative research across disciplines to address complex challenges related to CPS.

- Human Resource Development: Building a skilled workforce proficient in CPS technologies.

- Infrastructure Development: Establishing centers of excellence, testbeds, and innovation hubs.

There is a felt need for a Tri-Services Innovation Organisation (TSIO) in order to represent collaborative entities within the defence sector, comprising the three Services i.e. Indian Army, Navy, and Air Force. Thisi organization will play a crucial role in driving innovation, technology development, and modernisation efforts across the defence establishment. In recent years, there has been a growing emphasis on fostering collaboration and integration among SIOs to leverage synergies and enhance operational effectiveness. Additionally, there have been concerted efforts to align SIOs with external innovation initiatives such as the Atal Innovation Mission (AIM) and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) to further accelerate innovation and technology development.

Current Collaborative Initiatives within SIOs

SIOs currently rarely engage in collaborative initiatives aimed at addressing common challenges, sharing best practices, and fostering innovation across the

defence services. These initiatives should ideally encompass joint research and development (R&D) projects, technology demonstrations, knowledge-sharing platforms, and capacity-building programs. Currently, the Defence Innovation Organisation (DIO) only serves as a central hub for collaboration between these SIOs. Additionally, SIOs independently collaborate with academia, research institutions, and industry partners to access external expertise, resources, and cutting-edge technologies. There is a definite lack of joint exercises, workshops, and seminars in order to promote collaboration, networking, and cross-fertilisation of ideas among defence personnel and stakeholders. The pertinent need for a single point agency responsible for undertaking all Innovation related activities, therefore, emerges very evidently.

Integration Efforts and Alignment with AIM and NM-ICPS

Despite the existence of numerous Government of India initiatives and mechanisms for promoting Innovations, there have been no concerted efforts at the Services or Tri-Services level to align SIOs with these external innovation initiatives such as AIM and NM-ICPS to leverage synergies and enhance innovation capabilities. AIM, launched by the Government of India under the aegis of NITI Aayog, aims to promote a culture of innovation and entrepreneurship across various sectors, including defence. SIOs can collaborate with AIM through various programs such as Atal Tinkering Labs (ATLs), Atal Incubation Centers (AICs), and Atal New India Challenges (ANICs) to access funding, mentorship, and market opportunities for innovative projects and startups. Additionally, SIOs could participate in AIM-led

innovation challenges and hackathons to showcase their technological capabilities and explore collaboration opportunities with startups and innovators.

Similarly, NM-ICPS focuses on driving interdisciplinary research and innovation in cyber-physical systems, offering opportunities for collaboration and knowledge exchange between defence and civilian domains. However, these technological initiatives have not been leveraged by the Services to enhance own capabilities. SIOs could actively engage with NM-ICPS through joint research projects, technology demonstrations, and participation in interdisciplinary workshops and conferences. By leveraging NM-ICPS's expertise and resources, SIOs can seek to advance research and development in critical areas such as cybersecurity, artificial intelligence, robotics, and IoT, thereby enhancing the resilience and adaptability of defence systems.

Challenges and Opportunities

Bureaucratic hurdles, funding constraints, and regulatory complexities often hinder collaborative efforts and innovation initiatives. Moreover, the divergent priorities and operational requirements of defence and civilian agencies may pose challenges to alignment and coordination. Additionally, intellectual property rights issues and security concerns related to sensitive defence technologies require careful consideration and mitigation strategies. However, the integration of SIOs with AIM and NM-ICPS also presents significant opportunities for driving innovation, enhancing national security, and fostering economic growth. By leveraging synergies and harnessing the collective expertise and resources of SIOs, AIM, and NM-ICPS,

India can accelerate its journey towards becoming a global innovation powerhouse, driving economic growth, societal progress, and national security in the process.

The integration of SIOs with AIM and NM-ICPS holds immense promise and opens up avenues for mutual benefits for civil-military application as under:-

- Cross-Domain Synergy: SIOs can leverage AIM's network of ATLs and AICs to explore dual-use technologies. Innovations developed for defence applications may find civilian use, and vice versa.

- Technology Transfer: SIOs can collaborate with AICs to commercialise defence technologies. Startups nurtured by AICs could contribute to defence modernisation.

- Skill Enhancement: SIO personnel can benefit from AIM's mentorship programs and skill-building initiatives.

- CPS Innovation: SIOs' expertise in communication and surveillance aligns with NM-ICPS goals. Joint projects can accelerate CPS research.

The integration of SIOs with AIM and NM-ICPS represents a strategic step toward a more innovative, resilient, and technologically advanced India. By fostering collaboration, knowledge exchange, and cross-domain innovation, this integration can propel India toward a brighter future in defence and civilian sectors alike.

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CHAPTER I

INTRODUCTION

"The only way to predict the future is to create it."

- Peter Drucker

Background and Context

In today's rapidly evolving technological landscape, the pursuit of innovation is paramount for national development and global competitiveness. Traditional siloed approaches to innovation are increasingly being replaced by interdisciplinary collaboration, where diverse fields converge to address complex challenges and drive breakthrough advancements. Recognising the importance of interdisciplinary innovation, governments worldwide are establishing initiatives to foster collaboration across sectors.

Driving Innovation: Government Policies and Initiatives in India

Innovation has emerged as a key driver of economic growth, societal progress, and global competitiveness in the 21st century. The Government of India, with its ambitious vision of transforming the nation into a global innovation hub, has implemented a plethora of policies and initiatives aimed at promoting innovation

across sectors. Various strategies, programs, and regulatory frameworks introduced by the Indian government to stimulate innovation and entrepreneurship within the country are briefly explained in the succeeding paragraphs.

Policy Framework for Innovation. The Indian government has articulated a robust policy framework to foster innovation-driven growth. The National Innovation Initiative (NII), launched in 2005, laid the foundation for the country's innovation policies. Subsequently, the *Science, Technology, and Innovation Policy (STIP) of 2013* provided a comprehensive roadmap to promote scientific research, technological development, and innovation across sectors. The STIP 2020, the latest iteration, aims to address contemporary challenges and leverage emerging technologies to propel India's innovation ecosystem forward.

Intellectual Property Rights (IPR) Policy. India's Intellectual Property Rights (IPR) policy aims to foster innovation by providing robust protection to intellectual property assets. The policy emphasizes the importance of promoting creativity, innovation, and entrepreneurship while safeguarding the interests of creators and innovators. Efforts have been made to streamline the patent application process, enhance IP awareness, and strengthen enforcement mechanisms to protect intellectual property rights.

Startup India Initiative. Launched in 2016, the Startup India initiative is a flagship program aimed at nurturing and promoting startups across the country. It offers a conducive regulatory environment, tax benefits, funding support, and incubation facilities to startups. The initiative also includes schemes such as the

Startup India Seed Fund Scheme and Fund of Funds for Startups to provide financial assistance and support to early-stage startups.

Atal Innovation Mission (AIM). The Atal Innovation Mission, launched by NITI Aayog, is one of the most significant initiatives to foster innovation and entrepreneurship among students, entrepreneurs, and researchers. It comprises various programs such as Atal Tinkering Labs (ATLs) in schools, Atal Incubation Centers (AICs) to support startups, and Atal Community Innovation Centers (ACICs) to promote grassroots innovation. AIM aims to create a culture of innovation and problem-solving from a young age.

National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS). NM-ICPS, launched in 2018, aims to create a vibrant ecosystem for interdisciplinary research and development in cyber-physical systems (CPS). CPS integrates computation, communication, and control in physical systems, impacting areas like healthcare, agriculture, transportation, and smart cities. NM-ICPS focuses on:

- Research and Development: Encouraging collaborative research across disciplines to address complex challenges related to CPS.

- Human Resource Development: Building a skilled workforce proficient in CPS technologies.

- Infrastructure Development: Establishing centers of excellence, testbeds, and innovation hubs.

Make in India and Digital India. The Make in India and Digital India initiatives aim to leverage innovation and technology to boost manufacturing and digital infrastructure in the country. Make in India seeks to transform India into a global manufacturing hub by encouraging domestic production, fostering innovation, and attracting foreign investment. Digital India focuses on digital empowerment, infrastructure development, and e-governance initiatives to create a digitally inclusive society and economy.

Research and Innovation Clusters. The Government has established research and innovation clusters such as Science and Technology Parks (STPs), Technology Business Incubators (TBIs), and Research Parks to facilitate collaboration, knowledge exchange, and technology commercialization. These clusters provide infrastructure, mentorship, networking opportunities, and access to funding to startups, researchers, and innovators.

Research and Development (R&D) Incentives. To incentivise private sector investment in R&D, the government offers various tax incentives and subsidies. The Income Tax Act provides tax deductions for expenditures incurred on scientific research and development activities. Additionally, schemes like the Technology Development Fund (TDF) and the Technology Acquisition and Development Fund (TADF) provide financial support to industries for technology development and acquisition.

International Collaborations and Partnerships. India actively collaborates with international organizations, governments, and research institutions to foster innovation through knowledge exchange, joint research projects, and technology transfer. Initiatives such as the India-UK Tech Alliance, Indo-US Science and Technology Forum, and bilateral agreements with countries like Japan and Israel facilitate collaboration in research, innovation, and technology development.

In conclusion, the Government of India has implemented a comprehensive suite of policies and initiatives to promote innovation and entrepreneurship across various sectors. From providing incentives for R&D and fostering a startup-friendly ecosystem to strengthening intellectual property rights and fostering international collaborations, these initiatives aim to create a vibrant innovation ecosystem that drives economic growth, societal progress, and global competitiveness. However, effective implementation, continuous evaluation, and stakeholder engagement are essential to ensure the success and sustainability of these initiatives in fostering a culture of innovation in India.

In the context of India, the integration of respective Services Innovation Organisations within themselves and subsequent alignment with the Atal Innovation Mission (AIM) and National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS) holds immense potential for catalysing transformative change and propelling the armed forces to achieve technological superiority and the nation towards a knowledge-driven economy.

Innovations for Defence Excellence (iDEX): Overview

The flagship programme launched by the ministry of Defence, Government of India in relation to Innovation Absorption has been the Innovations for Defence Excellence (iDEX). This innovation ecosystem for Defence titled 'Innovations for Defence Excellence (iDEX)' was launched in April, 2018 with an aim of creating an ecosystem to foster innovation and technology development in Defence and Aerospace by engaging Industries including MSMEs, Start-ups, Individual Innovators, R&D institutes and Academia and provide them grants/funding and other support to carry out R&D which has potential for future adoption for Indian defence and aerospace needs.

Defence Innovation Organisation (DIO). The Defence Innovation Organisation (DIO) of the Ministry of Defence (MoD) serves as a catalyst for fostering innovation and technological advancement in the country's defence sector. Established with the vision of promoting indigenous research, development, and innovation, the DIO plays a pivotal role in harnessing the creative potential of India's scientific and industrial ecosystem. At its core, the DIO facilitates collaboration between the government, academia, research institutions, and the private sector to drive innovation across various domains of defence technology. By providing a platform for collaboration and exchange of ideas, the organization aims to address critical technological gaps, enhance defence capabilities, and reduce reliance on imported defence equipment. Moreover, the DIO works closely with startups, incubators, and technology accelerators to identify and nurture innovative solutions with military applications. Through initiatives such as innovation challenges,

hackathons, and technology showcases, the organization encourages entrepreneurship and empowers innovators to develop cutting-edge technologies tailored to the specific needs of the armed forces.

Objectives of the Study

The primary objective of this dissertation is to comprehensively investigate the integration of TSIOs with AIM and NM-ICPS, with a focus on interdisciplinary innovation. Specifically, the study aims to achieve the following objectives:-

- Assess the current state of TSIOs and the levels of integration between them.

- Identify major challenges and barriers hindering the seamless integration of TSIOs with AIM and NM-ICPS.

- Identify areas of synergy between TSIOs, AIM, and NM-ICPS.

- Propose a framework for the integration of TSIOs aligned with AIM and NM-ICPS.

By addressing these objectives, this research endeavors to provide valuable insights into enhancing collaborative ecosystems for innovation and technology development in India.

Overview of Services Innovation Organisations, AIM, and NM-ICPS

Services Innovation Organisations represent entities within the defence forces, i.e. from the Indian Army (Army Design Bureau), Navy (Naval Innovation and Indigenisation Organisation), and Air Force (Directorate of Aerospace Design), who have been tasked by their respective organisations to tackle multifaceted challenges spanning defence, security, and technology. These Organisations serve as hubs for research, development, and innovation, with a mandate to enhance national defence capabilities through interdisciplinary approaches. However, almost all their efforts are presently independent of each other leading to sub-optimal utilisation of resources.

The Atal Innovation Mission (AIM) is a flagship initiative of the Government of India aimed at promoting a culture of innovation and entrepreneurship across various sectors. Launched under the aegis of NITI Aayog, AIM fosters innovation through a network of Atal Tinkering Labs, Atal Incubation Centers, and Atal New India Challenges, among other programs. Its overarching goal is to empower innovators and catalyse the creation of a vibrant innovation ecosystem in the country.

The National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS) is another strategic initiative aimed at driving interdisciplinary research and innovation in the domain of cyber-physical systems. NM-ICPS seeks to leverage advancements in areas such as artificial intelligence, machine learning, internet of things (IoT), and robotics to develop solutions addressing societal needs and industrial requirements. By promoting collaboration between academia, industry, and

government agencies, NM-ICPS aims to position India as a global leader in cyber-physical systems.

Significance of Integration

The integration of TSIOs with AIM and NM-ICPS holds significant implications for India's socio-economic development and national security. By fostering collaboration between defence, innovation, and technology sectors, integration can facilitate the cross-pollination of ideas, expertise, and resources, leading to the accelerated development and deployment of cutting-edge solutions. Moreover, integration can enhance the resilience and agility of India's defence infrastructure while simultaneously driving innovation-led growth and job creation across industries. Thus, the seamless integration of TSIOs with AIM and NM-ICPS is not only imperative for strengthening India's defence capabilities but also for fostering a dynamic innovation ecosystem capable of addressing emerging challenges and opportunities in the 21st century.

Chapterisation. In the subsequent chapters, this dissertation will delve deeper into the assessment of current integration levels, identification of challenges and barriers, exploration of synergy areas, and formulation of a comprehensive integration framework aligned with the objectives of AIM and NM-ICPS. Through rigorous analysis and strategic recommendations, this research aims to contribute to the advancement of interdisciplinary innovation and its transformative impact on India's trajectory of growth and development. The layout and content of the Chapters is as explained below.

- Chapter 1: Introduction. This Chapter will delve on the background and context of the research bringing out the advent of innovation absorption in the Services and the highlights of the 'Atal Innovation Mission (AIM)' and the 'National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)'.

- Chapter 2: Review of Literature. Review of literature related to overview of defence innovation initiatives, previous research on the subject, case studies of similar integration models of other countries and key concepts related to process refinement will be enumerated in this Chapter. Gaps in the existing literature will also be highlighted to understand the need for study in specific domain.

- Chapter 3: Research Methodology. The Research Methodology adopted with explanation of the Research Problem, Research Objectives, Research Questions, Research Strategy and Design along with the associated data collection methods, data analysis techniques, sampling plan and size etc will form of this Chapter.

- Chapter 4: Analysis of Current State of Integration. An overview of the existing collaboration within the TSIOs, and also between TSIOs, AIM, and NM-ICPS will be carried out in this Chapter. Assessment of collaborative initiatives and projects, identification of challenges and barriers to integration will also be highlighted in this Chapter.

- Chapter 5: Major Challenges and Barriers Hindering the Seamless Integration. This Chapter will identify the challenges and hindrances in integrating these organisations with special emphasis on lack of Interdisciplinary Synergy, identifying Human Capital and Skills Gaps, Resource Allocation and Funding, and Policy and Regulatory Hurdles.

- Chapter 6: Developing an Effective Integrated Framework. This Chapter will catalogue the assessment, opinions, suggestions and recommendations of all the stakeholders associated with the issue. This will involve engaging government agencies, industry partners, academia, and the Services. Case studies of successful projects, if any, will also be highlighted in this Chapter.

- Chapter 7: Suggested Organisation of a TSIO. This Chapter will comprise of the findings/results of the research with specific details related to development of a comprehensive integration framework, strategies for fostering interdisciplinary collaboration and policy recommendations and reforms.

- Chapter 8: Conclusion. This Chapter will contain the summary of key findings and recommendations, implications of the research for policy and reforms as also highlight the essence of the need to undertake this research and why it was ‘worth the doing’. Scope for future research/study will also be listed out in the Chapter related to the subject.

CHAPTER II

REVIEW OF LITERATURE

"Change is crucial. It brings new thought; new thought leads to innovative actions."[1]

- ***Former President of India, Dr A P J Abdul Kalam***

Introduction

The review of literature for the dissertation on the "Integration of Interdisciplinary Innovation: Study of Tri-Services, Atal Innovation Mission (AIM), and National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS)" delves into existing research, scholarly works, and theoretical frameworks relevant to the integration of interdisciplinary initiatives in the context of defence, innovation, and cyber-physical systems. This section provides a comprehensive overview of key concepts, theoretical perspectives, and empirical studies that inform the understanding of the topic and contribute to the development of the integration framework.

The literature review begins by exploring the significance of interdisciplinary innovation and its role in addressing complex challenges across diverse domains. Drawing upon seminal works by scholars such as Peter Drucker and Steve Jobs, the review highlights the centrality of innovation in driving economic growth, societal

[1] https://www.ndtv.com/india-news/national-technology-day-2021-on-national-technology-day-top-5-quotes-of-apj-abdul-kalam-to-share-2439233

progress, and national security. Moreover, it examines the evolving nature of innovation ecosystems and the increasing emphasis on collaboration, knowledge exchange, and cross-sectoral partnerships in fostering innovation-driven development.

Furthermore, the literature review examines existing literature on defence innovation, with a focus on the unique challenges and opportunities associated with integrating Services Interdisciplinary Organisations (SIOs) with initiatives such as AIM and NM-ICPS. By synthesising insights from academic research, policy documents, and case studies, this section elucidates the multifaceted nature of defence innovation and the importance of interdisciplinary approaches in enhancing military capabilities and strategic readiness.

Additionally, the literature review explores theoretical frameworks and models relevant to the integration of interdisciplinary initiatives, including innovation ecosystems theory, systems thinking, and collaborative governance. By critically analysing existing frameworks and their applicability to the context of SIOs, AIM, and NM-ICPS, this section lays the groundwork for the development of a comprehensive integration framework aligned with the objectives of the study.

In summary, the review of literature provides a robust theoretical foundation for the dissertation, synthesising diverse perspectives and empirical evidence to inform the analysis of integration challenges, identification of synergy areas, and formulation of strategic recommendations for enhancing interdisciplinary innovation in the defence sector.

Reviewed Literature

Behera(2014) examines India's defence innovation performance, especially of the Defence Research and Development Organisation (DRDO) and the defence industry. He argues that the innovation performance of these two players is constrained by lack of a higher organisational structure which could provide direction and required thrust to the indigenous R&D. At the same time, the innovation performance is also constrained by poor investment on R&D, 'miserly attitude' of the defence industry towards R&D, poor human resource base, and the lack of reform of the entities responsible for innovation.

Behera (2018) further explains that India has expended a great deal of energy and resources to set up a vast defence economy to innovate and produce state-of-the-art weapon systems for use by the armed forces. However, the performance of the defence economy has been largely suboptimal, leading to poor self reliance in arms procurement and heavy dependence on foreign sources for meeting the key defence requirements. An examination of the causes of poor performance exhibits a number of shortcomings related to India’s both ‘hard’ and ‘soft’ innovation capacities. Inefficiency and lack of reforms of the main research and development (R&D) and manufacturing players, meager R&D and procurement budgets, poor management of human resources, lack of strong support from the political leadership, and a weak acquisition system, leave India’s defence innovation in a poor state.

Mohanty (2014) charts out that the story of the Indian defence technology sector, led by the Defence Research and Development Organization (DRDO), has so far been a

concoction of hyper dreams, intricate individual and institutional problems, relative isolation, and virtual non-accountability. It is not surprising that despite possessing a few ‘pockets of excellence,’ the sector has delivered little on the ground over the decades, thereby perpetuating arms import dependency. The historiography of Indian defence technologies suggests that innovations—product, process, and organizational— have shown degenerative tendencies despite reasonable state support. Unless deficiencies and difficulties in the core areas of structural-organisational rigidities (organizational), demand-supply dynamic (product), and scientific institutional- industrial collaboration (process) are addressed under a larger, self-reliant defence science and technology and industrial (DSTI) landscape, the dismal story of Indian defence innovation is likely to persist for the long term.

Pant and Bommakanti (2023) bring out the fact that the application of emerging technologies will play a key role in the performance of India’s armed forces. All three services understand the significance of these technological innovations in modern warfare, although their development has been uneven across the branches. This analysis provides an overview of how far the three services of the Indian armed forces have gone in integrating Artificial Intelligence (AI), cyber technology, and quantum technology in their ecosystems. It evaluates the differences in their approaches, and explores the regulatory, institutional and legal issues that may be impeding efforts of the armed services to leverage frontier technologies.

Bitzinger (2014) evaluates the Indian Defence Industry and states that India possesses the largest and most ambitious defence industrial base in the Asia-Pacific, if not the entire developing world, and yet the performance of its defence industry over the past

50 years has been disappointing in the very least. Defence industrial reforms also have some powerful allies in the government and the military. So long as India continues to shield and coddle its traditional military-industrial complex in the name of self-sufficiency and strategic imperative, it will never be able to remake the local defence industry into something capable of supplying the Indian armed forces with the equipment it requires.

Bitzinger (2018) later goes on to evaluate other countries wherein he writes about Israel and Singapore. He states that these are both countries with small populations and no strategic depth, and both see technology as a crucial force multiplier when it comes to national security. Israel, however, has been much more successful than Singapore in developing a range of indigenous military-technological innovations. The reasons are both geostrategic and cultural. Israel faces a much more looming and imminent threat which demands more military-technological innovation. Moreover, Israel's informal and anti-hierarchical society is much more supportive than Singapore's when it comes to risk-taking and experimentation.

Dmitry (2018) states that since its establishment, the State of Israel has cultivated itself as a defence technological-industrial power. This intentional and focused policy has made it possible for Israel to embark upon significant programs of military technological and industrial development and has spurred Israel to major advances in military innovation, defined here as radical defence transformation, in which new organizational structures, together with novel force deployment methods, usually but not always driven by new technology, change the conduct of war of a given actor and contribute significantly to its overall military effectiveness. This research brief argues

that the Israeli approach to military innovation has been a function of geopolitical drivers and shaped by the social organizational characteristics of the country's strategic mentality and culture. The brief reflects on the evolution of the Israeli approach to military innovation and describes its proclivities, in order to enable comparative analysis and a more generalisable analytical framework. It first describes the structural factors that account for the Israeli fixation on the military-industrial complex and defence innovation; then it outlines the social-organisational factors, which have enabled and conditioned its realisation. It concludes with an evaluation of the strengths and weaknesses of the Israeli approach and a review of recent trends.

Cheung (2018) in his brief provides an analytical framework to identify, categorise, and assess the diverse array of factors that are involved in the pursuit of defence innovation, as viewed through an innovation ecosystem prism. Defence innovation systems are engaged in highly complex, time-consuming and resource-intensive work. Innovation does not occur in isolation but requires extensive interaction and inputs from many sources and should be viewed from a broad-based and systemic perspective. Many of the insights from this framework are derived from an extensive examination into the state of innovation in the contemporary Chinese defence science, technology, and industrial system, examined in more detail in the next brief in this volume.

Cheung (2021) describes that gaining a decisive technological edge is a never-ending pursuit for defence establishments. Intensifying geo-strategic and geo-economic rivalry among major powers, especially the U.S and China, and the global technological revolution occurring in the civilian and military domains, promise to

reshape the nature and distribution of global power. This article provides a conceptual framework for a series investigating the state of global defence innovation in the twenty-first century. The series examines defence innovation in small countries with advanced defence innovation capabilities (Israel, Singapore), closed authoritarian powers (North Korea, Russia), large catch-up states (China and India) and advanced large powers (U.S.).

Gopal(2021) analyses that many countries across the world are harnessing disruptive technology to maintain technological superiority over their adversaries. Research and development (R&D) organisations are key to this task. In the defence sector, focused R&D drives critical innovations and product development. India continues to lag in defence technology and remains dependent on imports. A crucial impediment is long product development cycles. Under the current government's self-reliance and indigenization mission, India must consider establishing a dedicated R&D organisation at the services level of the Indian Army. A robust R&D ecosystem can accelerate technology development and reduce the gestation period of projects. This paper examines defence R&D organisations across countries and proposes a Synergised Army Technology Initiative for the Indian Army.

Gholz and Sapolsky (2018) have enunciated that the US defence innovation system enjoys tremendous advantages that other countries cannot readily replicate. It has accumulated capabilities over decades of funding and experimentation that dwarf other countries' efforts, and the incentives to innovate in the United States are not easily replicable elsewhere. The unique US political system favors substitution of technology for labor, openness to new ideas, and competition among decentralized

organizations to solve national security challenges. The constant worrying that the United States is losing its defence innovation advantages is simply part of the politics that keep the United States far, far ahead of its potential rivals.

Heras (2021) articulates that introducing innovative technologies or processes in the defence domain can only be successful if done hand in hand with the defence industry. The interview finds out how Europe's defence producers are coping with innovation-driven challenges and the impact of the current innovation push on their way of working.

Joshi (2022) highlights that military modernisation was the fourth and last of Deng Xiaoping's 'Four Modernisations'. Even before the third modernisation got underway— that of science and technology—China began using commercial technologies to advance its military capabilities. This strategy has gained salience since Xi Jinping came to power in 2012 and made it the state's key goal to transform the PLA into a "world-class military". Military- Civil Fusion (MCF) became a focus of this effort and was designated as a national strategy in 2014. This has provoked concerns across the world, especially in the United States which has unrolled a series of policies to contain MCF. This paper analyses China's strategy of leveraging its flourishing commercial technology sector and rising capabilities in innovation, to drive military modernisation. It explores the potential implications for Sino-Indian military balance and the overall relations between the two countries.

Srivastava (2021) highlights a distinct line between innovation and invention in this article and claims that military hardware has been more a product of innovation rather

than invention. He then proceeds to elucidate the drivers of ‘military innovation, types, innovators involved and its process. He concludes with the statement that India has a lot of ground to cover, but thankfully has the building blocks existing.

Thal Jr and Shahady (2019), in this article, the authors quote Chambers (1999), who suggests that the defence community has been at the forefront of innovation over the past century. Despite their success though, many organisations in the defence community struggle to explain specifically what they do to facilitate and implement innovation. To some, “being innovative” is interpreted as a means to empower employees to make decisions and solve problems at the lowest level possible. To others, “being innovative” is viewed as having open work spaces that lead to increased collaboration. However, innovation requires a much deeper understanding if it’s to be successful. Beyond acknowledging the importance of innovation and inspiring the workforce though, what can leaders do to ensure their organizations are ready for innovation? To help answer that question, we think a good place to start is to review the organization’s processes and dynamic capabilities. In many ways, these two concepts represent the DNA of the organization and whether the organization is structured to facilitate innovation. We will then introduce a conceptual model that leaders can use to foster disruptive innovation. These three concepts, processes, dynamic capabilities, and the conceptual model, are equally applicable to organisations in both the public and private sectors.

CHAPTER III

RESEARCH METHODOLOGY

"Creativity is seeing the same thing but thinking differently."[1]

- Former President of India, Dr A P J Abdul Kalam

Statement of the Problem

The integration of Tri-Services Innovations Organisations (TSIOs) with a focus on alignment with the 'Atal Innovation Mission (AIM)' and the 'National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)' represents a critical challenge in the contemporary landscape of defence and technological advancement. This problem statement aims to address the multifaceted issues like lack of Interdisciplinary synergy, resource allocation and funding, technological integration, and stakeholder engagement, associated with establishing a cohesive framework for collaboration and synergy between Tri-Services Innovations Organisations and the AIM and NM-ICPS initiatives.

Objectives of the Research

- To assess the current state of TSIOs and the levels of integration between them.

[1] https://economictimes.indiatimes.com/news/politics-and-nation/apj-abdul-kalams-birth-anniversary-most-inspiring-quotes-by-missile-man/end-is-not-the-end-if-fact-end-means-effort-never-dies-if-you-get-no-as-an-answer-remember-no-means-next-opportunity-so-lets-be-positive-/slideshow/59792393.cms

- To identify major challenges and barriers hindering the seamless integration of TSIOs with AIM and NM-ICPS.

- To identify areas of synergy between TSIOs, AIM, and NM-ICPS.

- To propose a framework for the integration of TSIOs aligned with AIM and NM-ICPS.

Research Strategy and Design

The study is exploratory. The research strategy adopted for the study will be quantitative and the research design would be exploratory and descriptive and analytical. However, the study will also utilise some relevant data as available in the unclassified domain.

Research Rationale

The rationale for conducting research on the topic of integrating Tri-Services Innovations Organisations (TSIOs) aligned with the 'Atal Innovation Mission (AIM)' and the 'National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)' is derived from several factors and imperatives, as elucidated in succeeding paragraphs.

- National Security and Defence Innovation. The integration of TSIOs with AIM and NM-ICPS is crucial for bolstering national security. Effective

defence innovation is essential to stay ahead of emerging threats, and integrating defence research with civilian technological advancements can lead to cutting-edge solutions with dual-use applications.

- Resource Optimisation. Collaboration between TSIOs, AIM, and NM-ICPS can lead to efficient resource allocation. This integration can ensure that limited resources are leveraged optimally for defence and civilian innovation, maximizing the return on investment.

- Technological Synergy. Combining the expertise and capabilities of TSIOs with the interdisciplinary and innovation-driven approach of AIM and NM-ICPS can foster technological synergy. This synergy can drive advancements in areas such as cyber-physical systems, artificial intelligence, and emerging technologies.

- Global Competitiveness. Nations that excel in both defence and civilian innovation are better positioned to compete on the global stage. By aligning TSIOs with AIM and NM-ICPS, a country can enhance its competitiveness in emerging technology sectors and strengthen its global standing.

- Dual-Use Technologies. Many technological innovations have applications in both defence and civilian sectors. Integrating TSIOs with AIM and NM-ICPS can accelerate the development and deployment of dual-use technologies, benefiting both domains.

- Cyber Security and Resilience. As cyber-physical systems become increasingly critical in various domains, including defence and critical infrastructure, it is essential to enhance cyber security measures. Integration can help identify vulnerabilities and strengthen defences against cyber threats.

- National Innovation Ecosystem. The integration contributes to the overall strength of the national innovation ecosystem by fostering collaboration among government agencies, industry partners, academia, and research institutions. This interconnected ecosystem is essential for holistic and sustained innovation.

To summarise, research on the integration of TSIOs with AIM and NM-ICPS is driven by the imperative to enhance national security, optimise resources, drive innovation, and strengthen the nation's global competitiveness. This integration is not only beneficial for defence but also crucial for advancing interdisciplinary cyber-physical systems and technology for the benefit of society at large.

Research Questions

- What are the current collaborative initiatives and integration efforts within Services Innovations Organisations (SIOs), and also their present alignment with AIM, and NM-ICPS?

- What are the major challenges and barriers hindering the seamless integration of TSIOs with AIM and NM-ICPS?

- How can an effective integration framework be developed to encourage interdisciplinary collaboration while optimising resource allocation between TSIOs, AIM, and NM-ICPS?

- What would be a suggested organisation of a TSIO established under the aegis of Headquarters Integrated Defence Staff (HQ IDS)?

Scope

The scope of research on the topic is vast and multifaceted, involving various dimensions, challenges, and opportunities. Keeping the time available for research, the scope will be limited to certain key areas as given below.

- Interdisciplinary Collaboration. The research will explore how TSIOs, AIM, and NM-ICPS can collaboratively work on interdisciplinary projects and initiatives, leveraging each other's strengths and expertise to drive innovation.

- Technological Integration. This aspect includes the integration of diverse technological platforms, systems, and infrastructure across defence and civilian domains, emphasising areas like cyber-physical systems, artificial intelligence, and advanced manufacturing.

- Resource Allocation. This area will examine the financial and human resources allocation to support joint projects and initiatives.

- Stakeholder Engagement. The research will delve into strategies for engaging key stakeholders, including government agencies, industry partners, academia, and the Services, to create a collaborative and supportive ecosystem.

- Comparative Analysis. Conducting a comparative analysis of integration efforts in other countries to draw lessons and best practices for the specific national context.

Limitation of the Study

Certain technological innovations being currently pursued or being thought of by the Services may fall in the classified domain and adequate inputs with regards to these may not be available for review.

CHAPTER IV

ANALYSIS OF CURRENT STATE OF INTEGRATION

India has expended a great deal of energy and resources to set up a vast defence economy to innovate state-of-the-art weapon systems. However, the performance of the defence economy has been largely suboptimal. ***An examination of the causes of poor performance exhibits a number of shortcomings related to India's both 'hard' and 'soft' innovation capacities.*** Lack of strong support from higher political leadership, meagre research and development (R&D) and procurement budgets, inefficiency of the main R&D and manufacturing players, poor management of human resources and a weak acquisition system, among others, leave India's defence innovation in a poor state.[1]

In this chapter, we delve into the existing collaboration within the three Services Innovation Organisations (SIOs) and their interactions with various innovation policies and initiatives of tge Government of India. We assess collaborative initiatives and projects undertaken by TSIOs, explore the dynamics of collaboration between TSIOs, AIM, and NM-ICPS, and identify challenges and barriers hindering seamless integration. The analysis will aim to arrive at focussed issues which need to be addressed in a graduated manner in order to subsequently formulate an integrated tri-services organisation, in the beginning, and lay down a framework for a seamless civil – military fusion of innovation initiatives in the future.

[1] Laxman Kumar Behera (2021) Examining India's defence innovation performance, *Journal of Strategic Studies*, 44:6, 830-853, DOI: 10.1080/01402390.2021.1993829

Services Innovation Organisations (SIOs)

Service centric directorates/sections dealing with innovation have existed for some time now. However, there efforts have gained traction since the policies of '*Atmanirbharta'* and 'Make In India' have gained prominence in the national discourse. Limited or minimal collaborative mechanisms have been instituted till date to unify the individual labours of these SIOs towards a common objective.

Prior to exploring collaborative measures, it is important to understand the organisation and role of various Service specific organisations dealing with the subject of Innovation.

Army Design Bureau (ADB). The Army Design Bureau (ADB) of the Indian Army was established in August 2016, aiming to enhance the indigenous capability of the Indian Army through strategic planning, technology foresight, and collaboration with various stakeholders. The primary objective of the ADB is to facilitate the development and integration of cutting-edge technologies, systems, and solutions to meet the evolving challenges faced by the Indian Army in the contemporary security environment. One of the key roles of the Army Design Bureau is to identify technological gaps and operational requirements within the Indian Army. The Army Design Bureau also serves as a catalyst for promoting indigenous research, development, and innovation in the defence sector. By fostering collaboration with academia, research institutions, and private sector organisations, the ADB facilitates technology transfer, knowledge exchange, and joint R&D initiatives. Additionally, the ADB plays a crucial role in advocating for policy reforms and regulatory changes to

support indigenous defence production and innovation. By engaging with policymakers, industry associations, and other stakeholders, the ADB advocates for measures to streamline procurement processes, promote innovation-driven entrepreneurship, and incentivise investment in defence research and development.[2]

Naval Innovation and Indigenisation Organisation (NIIO). The Naval Innovation and Indigenisation Organisation (NIIO) is a strategic initiative launched by the Indian Navy to promote innovation, indigenisation, and self-reliance in defence technology development. Established in August 2020, NIIO serves as the apex body within the Indian Navy for driving innovation and fostering a culture of indigenous technological advancement. The primary objective of NIIO is to harness the creative potential of naval personnel and external stakeholders to address operational challenges, develop cutting-edge technologies, and enhance the Navy's operational capabilities. Overall, NIIO plays a crucial role in driving innovation and indigenization efforts within the Indian Navy, fostering collaboration, technology development, and self-reliance in defence technology.

Directorate of Aerospace Design (DAD). The Indian Air Force has created the Directorate of Aerospace Design, with the aim to synergise efforts for 'Make in India' and greater involvement of IAF in innovation, design and development. The role of the DAD is to identify niche technologies that are attainable by Indian Industry and facilitate their development for inducting into IAF to enhance the operational capabilities. The DAD, works closely with DRDO, DPSUs, CSIR labs, academia, private industries, start-ups, and individual innovators, to identify possible systems

[2] https://indianarmy.nic.in/content2/adb/introduction-adb

and technologies for IAF use. Inter-alia, the DAD plays a key role in fostering innovation and technology development within the IAF. Through research and development initiatives, the DAD explores emerging technologies, evaluates their potential applications for aerospace systems, and investigates ways to integrate them into existing platforms or develop new capabilities.

Collaborative Initiatives within SIOs

SIOs represent independent entities within their respective Services with no or minimal collaborative efforts. These organisations serve as catalysts for innovation within their respective Service, without interaction, feedback or collaboration with the other Sister Services. Collaborative initiatives within SIOs should encompass a wide range of activities, including research and development (R&D) projects, technology demonstrations, joint exercises, and knowledge-sharing platforms.

One notable collaborative initiative within SIOs is the **Defence Innovation Organisation (DIO)**, established to facilitate cross-service collaboration and accelerate innovation in defence technologies. Through the DIO, SIOs converge only at the point of system requirements of equipment being pursued by a particular Service. The DIO, primarily, deals with iDEX cases being proposed and followed up by Services, contributing in the approval, funding and final acquisition of the product. Subject Matter Expert interaction with academia, industry and the scientific community is solely at the discretion of the individual Service sponsoring the project.[3]

[3] https://idex.gov.in/about-dio

Awareness Within the Organisations

Based on the survey conducted during the course of this research, the question of collaborative efforts within the Services was posed to Serving and Retired Officers of the three Services. The distribution of these Officers (respondents) with their years of service and experience in the field of Innovation related duties is as represented below in Figure 1.

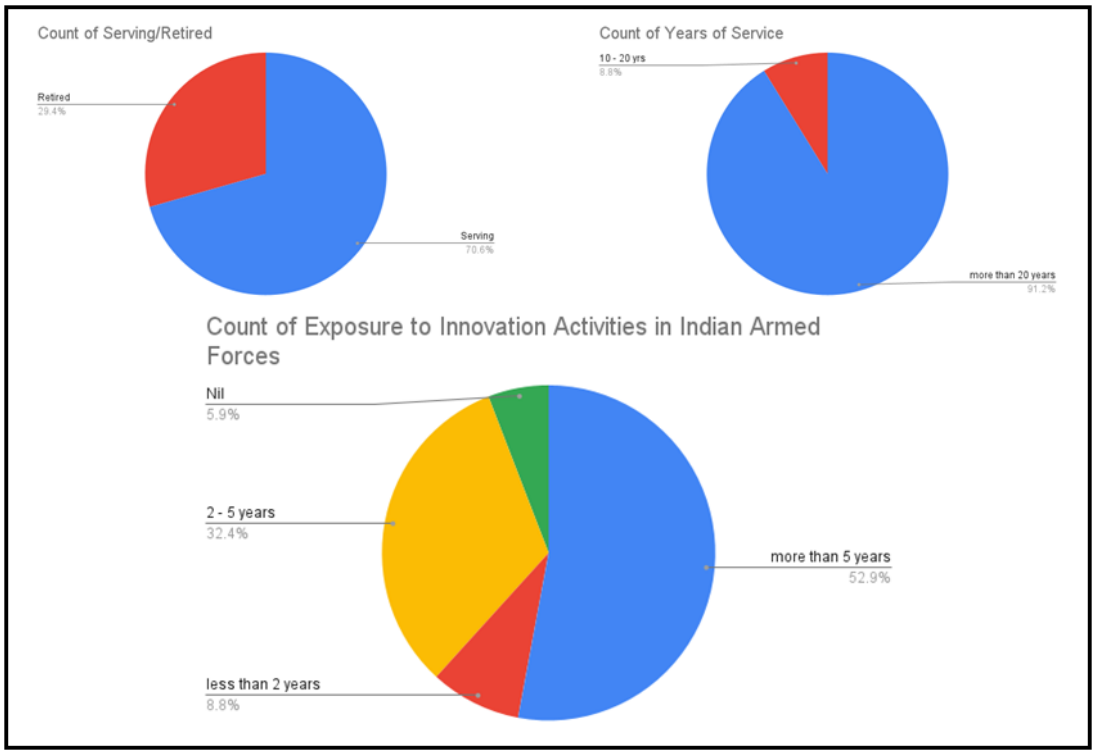

Figure 4.1: Distribution of Respondents (Refer Survey attached at Appendix 1)

Ineffective Coordination of Innovation Activities of the Three Services

HQ IDS, established to promote jointness and synergy among the three services, faces challenges in effectively coordinating innovation activities. One of the primary issues is the inherent bureaucratic structure and compartmentalisation within the Services, which can impede the sharing of resources, information, and best

practices related to innovation. Each service operates within its own silo, with its own set of priorities, procurement processes, and institutional cultures, making it difficult for HQ IDS to orchestrate a unified approach to innovation. Figure 2 below highlights the response of these samples of Officers on the 'effectiveness of HQ IDS in coordinating Innovation initiatives of the three Services'.

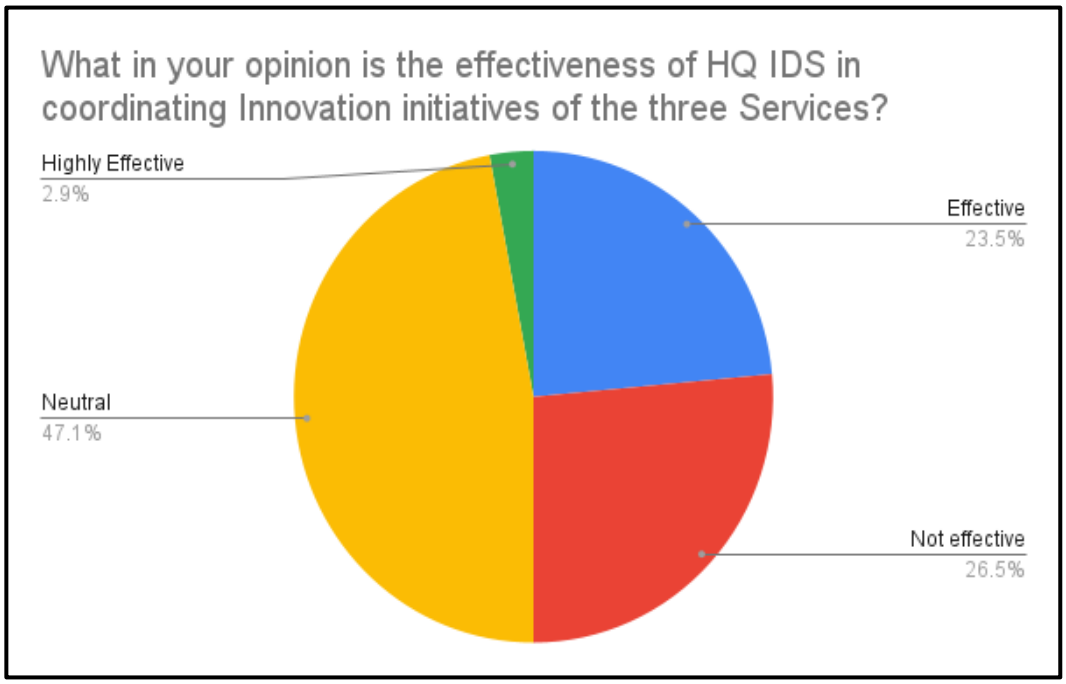

Figure 4.2: Effectiveness of HQ IDS in Coordination of Innovation Activities (Refer Survey attached at Appendix 1)

Moreover, the lack of a centralised mechanism at HQ IDS for identifying and prioritising innovation projects across the Services can lead to duplication of efforts and inefficient allocation of resources. Without clear guidelines or incentives to promote collaboration, service-specific initiatives may take precedence over joint innovation efforts, undermining the overall effectiveness of HQ IDS in coordinating innovation activities.

Additionally, limited engagement with external stakeholders, such as the private sector, academia, and research institutions, further constrains HQ IDS's ability

to leverage external expertise and resources to drive innovation. By predominantly focusing on internal capabilities and resources, HQ IDS may overlook valuable opportunities for collaboration and technology transfer that could accelerate innovation in the defence sector.[4]

Overall, the ineffectiveness of HQ IDS in coordinating innovation activities across the three services underscores the need for greater institutional reforms, cultural shifts, and incentives to promote jointness and collaboration in the pursuit of technological advancement and military modernisation.

SIOs and their Inter Service Alignment

Despite the creation of HQ IDS over two decades ago, many pertinent functions for jointmanship continue to remain *silo-ed* within each Service, with minimal sharing of information. Innovation organisations, unique to each Service (as illustrated above) continue to pursue independent projects with minimal and at times no interaction with each other. Such actions not only lead to duplication of efforts but also creates confusion in the predominantly civil based innovators pool as to the unison of effort.[5]

The integration of these independent SIOs into a dedicated Tri-Services Innovation Organisation (TSIO) within the Indian Armed Forces, therefore, becomes pertinent. Such an organisation, however, while potentially transformative, faces a

[4] Mohanty, Deba R. (2014). 'A Dismal Show Amid Pockets of Excellence: The State of Defense Innovation in India', IGCC Defense Innovation Briefs, Institute on Global Conflict and Cooperation, University of California.
[5] Behera, L K. (2014). 'Defence Innovation in India: The Fault Lines'. Occasional Paper 2014, Institute for Defence Studies and Analyses.

multitude of complex challenges and barriers that must be carefully addressed for successful implementation. These challenges can be broadly categorised into Structural and Bureaucratic Inertia, Cultural and Mindset Barriers, Resource Constraints and Talent Shortfalls, External Ecosystem and Partnership Challenges, Legal and Regulatory Hurdles, and Managing Expectations and Metrics for Success. Each of these are discussed in detail in the succeeding paragraphs.

- Structural and Bureaucratic Inertia.

    - Legacy Processes and Procurement Systems: The Indian Armed Forces have historically relied on well-established but often lengthy bureaucratic and procurement processes. These can be at odds with the agile and rapid cycles needed for successful innovation. Integrating an SIO demands streamlining these processes to support experimentation and risk-taking.

    - Siloed Structures and Inter-Service Rivalry: Each service within the Armed Forces understandably functions to maintain its domain expertise and operational priorities. Integrating an SIO requires shifting focus towards a joint, integrated approach. This necessitates building trust and changing mindsets from intra-service competition to collaboration. Joint innovation challenges, collaborative workshops, and personnel rotations across different services can help mitigate this challenge.[6]

[6] Gopal, Vivek. (2021). 'The Case for Nurturing Military Scientists in the Indian Army', Occasional Paper, Issue 320, June 2021, Observer Research Foundation.

- Hierarchical Decision-making: The Armed Forces operate on a hierarchical structure designed for command and control in high-pressure situations. While this is necessary for operations, innovation often benefits from less hierarchical, more decentralized decision-making. The SIO needs empowerment to rapidly explore ideas and learn from failures without excessive oversight in its early stages. Balancing this need for autonomy with the necessary integration into the larger force structure is key.

- Cultural and Mindset Barriers.

  - Risk Aversion: Innovation often entails calculated risk. The military environment, with its focus on operational reliability and minimizing casualties, can sometimes cultivate a risk-averse culture. Creating a psychologically safe space within the SIO to experiment, learn from failures, and embrace calculated risks is crucial. This involves clear support for such actions from the highest levels of military leadership.

  - Resistance to Change: Introducing new structures or ways of working within any large organization often faces resistance. The SIO will likely be perceived as disruptive to established routines. Addressing concerns, providing clear incentives for buy-in, and involving potential stakeholders from across the Armed Forces early in the process can build acceptance.

  - Traditional Focus on Hardware: The Armed Forces have historically focused on the acquisition and development of advanced hardware platforms. Cultivating a balanced approach that emphasizes innovation in doctrine,

tactics, operational concepts, and software-driven capabilities alongside hardware upgrades is essential in the modern context.

- Resource Constraints and Talent Shortfalls.

  - Limited Funding: While India's defense budget is significant, dedicated funding for innovation is often limited. Establishing a protected budget stream for the SIO, independent of annual procurement cycles, is key to fostering its success. This funding needs to accommodate the risk of failure inherent in any innovation effort.

  - Talent Acquisition and Retention: Attracting and retaining top talent in AI, data science, software engineering, and other cutting-edge fields is impossible when faced with competition from the private sector. Partnering with academic and research institutions to tap into broader talent pools can also prove beneficial.[7]

  - Specialised Human Capital: Building the in-house expertise necessary to manage an innovation organisation requires a new breed of talent within the military. Investing in training programs, talent exchange programs with the private sector, and creating clear career paths for "innovation professionals" within the military service are vital.

[7] Gopal, Vivek. (2021). 'The Case for Nurturing Military Scientists in the Indian Army', Occasional Paper, Issue 320, June 2021, Observer Research Foundation.

- External Ecosystem and Partnership Challenges

  - Fragmented Innovation Ecosystem: While there's increasing effort toward developing a strong defense innovation ecosystem in India, it remains relatively fragmented compared to mature ones in other countries. Fostering a stronger, more interconnected ecosystem with industry, startups, and research institutes requires a dedicated and streamlined approach from the government and defence establishment.

  - Weak Industry-Academia Linkages: Collaboration between the private sector, academic research institutions, and the Armed Forces is often limited, leading to missed opportunities and duplicated effort. Creating collaborative funding mechanisms, establishing technology transfer offices, and incentivizing joint research projects can strengthen these linkages.

  - Nascent Venture Capital Landscape: While India's startup ecosystem is growing, access to early-stage venture capital for defense-focused startups remains limited. This hinders the translation of promising ideas into full-fledged products. Government support in the form of early-stage grants, pilot projects, and initiatives to connect startups with potential investors can stimulate this space.

  - Transfer and IP Concerns: Formulating clear frameworks that ensure fair and transparent management of intellectual property rights will be crucial for fostering trust and promoting collaboration. This includes addressing

concerns regarding export control regulations and ensuring that partnerships don't compromise national security considerations.

- Legal and Regulatory Hurdles.

  - Data Security and Privacy Concerns: Collaborating with external partners and leveraging advanced technologies often involves the exchange of sensitive data. Addressing data security and privacy concerns through robust frameworks aligned with regulations like the Information Technology Act (2000) and the upcoming Personal Data Protection Bill is critical.

  - Export Control Regulations: Stringent export control regulations can inadvertently hinder collaboration with foreign partners for technology acquisition or joint research ventures. Streamlining these regulations, while ensuring national security considerations remain paramount, can facilitate access to critical expertise and technologies.

  - Inter-ministerial Coordination: Effective coordination between the Ministry of Defence (MoD), other relevant ministries (e.g., Department of Science and Technology, Department of Space), and other stakeholders is crucial for fostering a supportive environment for the SIO. Establishing clear inter-ministerial coordination mechanisms and streamlining bureaucratic processes will be essential for smooth operation.

- Managing Expectations and Metrics for Success.

    - Managing Expectations around "quick fixes": Innovation is often a slow and iterative process with potential for failures. Managing unrealistic expectations for immediate results from the SIO is crucial. Open communication with stakeholders about the inherent challenges and potential timelines is important to ensure sustainable support.

    - Developing meaningful metrics for innovation: Measuring the success of an SIO can be complex. Developing a balanced set of metrics that goes beyond just the number of "inventions" is crucial. These metrics could include measures of increased operational effectiveness, efficiency gains, improved inter-service collaboration, and fostering a culture of innovation within the Armed Forces.

Integrating a Services Innovation Organisation within the Indian Armed Forces presents a unique opportunity to propel the nation's defence capabilities into the future. However, a multitude of challenges and barriers need to be addressed for successful implementation. By acknowledging these challenges, adopting a comprehensive approach, and fostering a collaborative environment, the Armed Forces can harness the power of innovation to achieve a significant edge in the ever-evolving global security landscape.

SIOs and their Alignment to Innovation Initiatives of Government of India

In recent years, India has witnessed a surge in innovation initiatives aimed at fostering technological advancement and promoting entrepreneurship across various sectors. However, a critical challenge persists in the lack of coordination and alignment between innovation activities undertaken by the Services and Government-led initiatives such as the Atal Innovation Mission (AIM) and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS). This disconnect not only hampers the efficiency and effectiveness of innovation efforts but also undermines the nation's ability to harness its full innovative potential in defence and security domains.

- Implications of Lack of Coordination**.** The lack of coordination and alignment between service innovation activities and government initiatives has several adverse implications:-

    - Duplication of Efforts: Without proper coordination mechanisms in place, there is a risk of duplication of efforts and wastage of resources. Both the armed services and government initiatives may independently fund similar projects or initiatives, leading to inefficiencies and suboptimal utilization of funds.

    - Missed Opportunities: The absence of collaboration limits the exchange of knowledge, expertise, and best practices between the defence sector and other domains. This results in missed opportunities for leveraging

innovations and technologies developed in civilian sectors for defence applications, and vice versa.

- Slow Pace of Innovation: Inadequate coordination can impede the pace of innovation in critical defence technologies and capabilities. Delays in technology adoption and integration may undermine India's military preparedness and its ability to respond effectively to evolving security challenges.

Summary of the Chapter

In summation, addressing the lack of coordination within SIOs, as also alignment between Services' innovation activities and Government initiatives is essential for unlocking India's full innovative potential in defence and security domains. By fostering collaboration, sharing resources, and leveraging synergies within the Services and subsequently between the Tri-Services and Government-led programs, India can accelerate the pace of technological innovation and strengthen its defence capabilities in the face of evolving threats and challenges. Only through concerted efforts and proactive measures can India bridge the gap and emerge as a global leader in defence innovation.

CHAPTER V

MAJOR CHALLENGES AND BARRIERS HINDERING THE SEAMLESS INTEGRATION

The integration of a dedicated Tri-Services Innovation Organisation (TSIO) into the Indian Armed Forces, while potentially transformative, faces unique challenges and hindrances when aligning with broader Government of India (GoI) initiatives focused on fostering innovation across sectors.

Innovation plays a pivotal role in enhancing the operational capabilities and effectiveness of armed forces globally. The Indian Armed Forces, comprising the Army, Navy, and Air Force, recognise the significance of innovation in maintaining strategic superiority and addressing evolving security challenges. In recent years, there has been a concerted effort to promote innovation within the armed forces through the establishment of dedicated Services Innovation Organisations (SIOs).

However, despite the initiatives undertaken by the armed forces, integrating SIOs with Government of India (GoI) initiatives presents a formidable set of challenges. This chapter aims to elucidate these challenges and hindrances, offering a comprehensive analysis of the factors impeding seamless integration. Through the exploration of bureaucratic complexities, cultural disparities, technological barriers, and resource constraints, it seeks to provide a nuanced understanding of the impediments to innovation integration in the Indian Armed Forces. Case studies will

be employed to illustrate real-world examples and facilitate a deeper comprehension of the issues at hand.

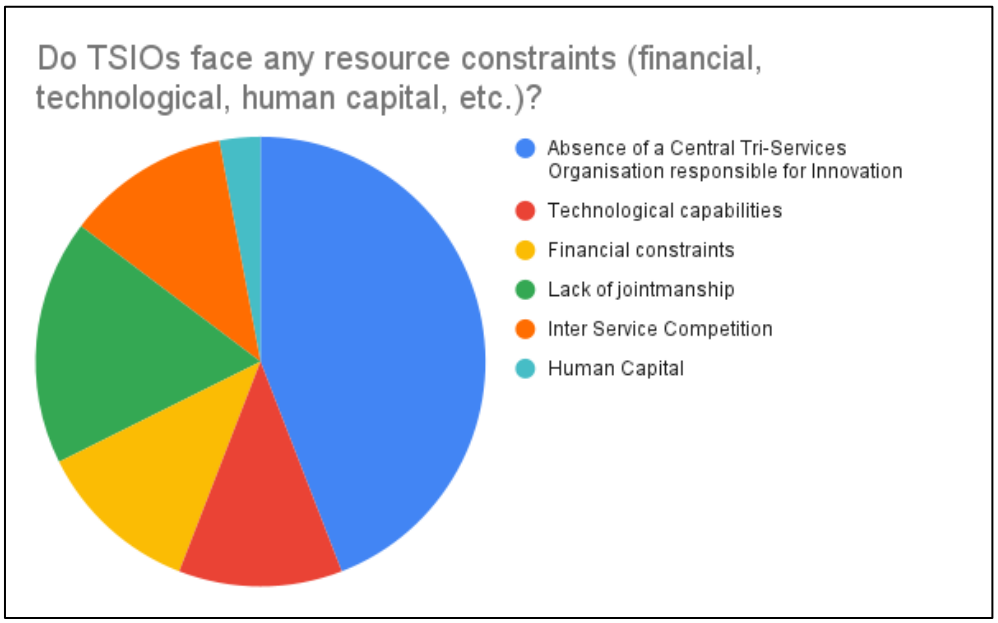

Figure 5.1: Resource Constraints Faced (Refer Survey attached at Appendix 1)

Challenge 1: Differing Goals and Priorities[1]

Narrow Operational Focus of the Armed Forces: The Armed Forces' primary mission is to defend national sovereignty and respond to immediate security threats. Their innovation efforts naturally prioritize enhancing operational capabilities, often with a short-term focus driven by evolving battlefield dynamics.

Broader Focus of GoI Initiatives: GoI innovation initiatives such as 'Startup India,' 'Atal Innovation Mission,' 'National Mission for Interdisciplinary Cyber and Physical Systems' and 'Digital India' have a broader socio-economic focus. They support

[1] Mohanty, Deba R. (2014). 'A Dismal Show Amid Pockets of Excellence: The State of Defense Innovation in India', IGCC Defense Innovation Briefs, Institute on Global Conflict and Cooperation, University of California.

innovation in diverse sectors, from healthcare and agriculture to advanced manufacturing and e-governance.

Challenge: This difference in focus can create misalignment between the specific technological needs of the Armed Forces and the general direction of GoI innovation programs. The SIO needs to clearly articulate its requirements while actively participating in broader initiatives to best leverage available resources.

Case Study: India's defence innovation ecosystem often prioritises the development and production of major platforms (e.g., aircraft carriers, fighter jets). Meanwhile, GoI initiatives tend to support smaller-scale disruptive technologies in areas like AI and cyber. Balancing focus between these two areas is a recurring challenge.

Challenge 2: Competing Bureaucratic Processes[2]

Legacy Bureaucracy within the Armed Forces: As mentioned earlier, established procurement and decision-making processes within the military structure can be slow and rigid, creating a culture of risk aversion. This contrasts with the agility often emphasized in broader GoI innovation initiatives.

Varied Pace of GoI Initiatives: Government-wide innovation initiatives are designed to be nimble but often face their own complex bureaucratic hurdles. Varying bureaucratic processes between different departments involved in such initiatives can lead to coordination challenges and delayed outcomes.

[2] Behera, L K. (2018). 'Examining India's Defense Innovation Performance', SITC Research Briefs, Series 10(2018-10)

Challenge: The TSIO must navigate this dual bureaucratic landscape, aligning with broader GoI initiatives while advocating for simplified and accelerated processes to meet its unique requirements.

Case Study: The development of indigenous unmanned aerial vehicles (UAVs) has seen promising results through collaborations between the Defence Research and Development Organisation (DRDO) and the private sector. However, lengthy procurement and approval processes often create delays in the fielding of these urgently needed capabilities compared to a more accelerated process seen in similar programs internationally.

Challenge 3: Limited Private Sector Participation in Defence Innovation[3]

Historical Reliance on PSUs: The Indian defence sector has historically relied on Defence Public Sector Undertakings (DPSUs) and Defence Research and Development Organisation (DRDO) for research, development, and production of military hardware. This has created a perception of limited opportunities for private sector innovation in the domain.

Nascent Defence Start-up Ecosystem: Though India has a vibrant overall startup culture, the defence-focused start-up ecosystem is comparatively nascent. This limits the pool of potentially innovative partners for the TSIO.

[3] Bitzinger, Richard A. (2014). 'The State of Defense Innovation in India: Can It Catch Up with Global Leaders?,' IGCC Defense Innovation Briefs, Institute on Global Conflict and Cooperation, University of California.

Challenge: The TSIO will need to actively change existing perceptions and foster a welcoming environment for private sector innovation. This involves creating transparent and accessible engagement mechanisms, streamlining procurement processes for smaller companies, and incentivising innovation in niche areas with defence applications.

Case Study: While India boasts successful examples like Tonbo Imaging (advanced surveillance systems) and idea Forge (UAVs), such companies are the exception, not the rule. Compared to more mature ecosystems like Israel, where smaller companies play a crucial role in defence technology development, India still has significant ground to cover.

Challenge 4: Gaps in Funding and Incentives

Limited Dedicated Funding for Defence Innovation: While the GoI has increased its focus on defence innovation, dedicated funding streams remain limited compared to major platform acquisitions. The TSIO must compete for resources with traditional procurement programs.

Diverse Funding Mechanisms in GoI Initiatives: National-level innovation schemes often have varied funding models, ranging from research grants to start-up seed funding and early-stage venture capital. Navigating this complex funding landscape can be difficult for the SIO.

Challenge: The SIO needs strong advocacy for dedicated innovation funding that allows for risk-taking and rapid experimentation. Simultaneously, it must identify relevant GoI funding opportunities aligned with its specific requirements.

Case Study: The Innovations for Defence Excellence (iDEX) initiative launched by the Department of Defence Production has shown promising results in engaging startups and MSMEs in defence innovation and providing seed funding. However, sustained and scaled-up funding beyond the initial stage remains a challenge for these budding innovators.

Challenge 5: Data Sharing and Intellectual Property (IP) Concerns

Sensitivity of Military Data: The Armed Forces handle vast amounts of sensitive data related to operational capabilities, platforms, and strategies. Sharing such data with external partners for innovation collaboration raises significant security and confidentiality concerns.

Complexities in GoI IP Policies: Government-wide IP policies are evolving, but challenges remain regarding ownership, licensing, and commercialisation of innovations developed through collaborations involving public and private entities. This creates uncertainty for both the TSIO and potential partners.

Challenge: The TSIO will need to develop robust data sharing protocols while exploring innovative models for collaboration that address security concerns. Additionally, the TSIO must advocate for clear and transparent IP policies tailored to

the unique needs of defence innovation, ensuring fair compensation and incentivizing participation from external partners.

Case Study: Collaborations between DRDO and private firms for developing defence technologies have faced challenges due to the complexity of data sharing and ownership of intellectual property rights. This has hindered the pace of technology transfer and commercialization of jointly developed solutions.

Challenge 6: Lack of Talent Pool and Collaboration Mechanisms

Specialised Skill Sets Required for Defence Innovation: Defence innovation requires a unique blend of technical expertise in specific engineering domains (e.g., aerospace, cyber) coupled with an understanding of military operational requirements and strategic considerations. Finding innovators/incubators with this specific skill set can be challenging.

Varying Strategies in GoI Initiatives: GoI innovation initiatives often focus on broader skill development across diverse sectors. While some aspects overlap with defence needs, there might not always be a direct alignment in the skill sets being developed.

Challenge: The TSIO will need to work towards building a dedicated talent pool of innovators through targeted training programs, attracting veterans with relevant expertise, and fostering partnerships with academic institutions and research labs focused on defence technologies. Additionally, the TSIO can play a key role in

advocating for broader GoI initiatives to incorporate specific skillsets needed for defence innovation.

Case Study: DRDO has established dedicated training programs and laboratories to develop technical expertise within its workforce. However, attracting civilian talent with complementary skill sets remains a challenge. The TSIO can bridge this gap by establishing partnerships with universities and offering attractive career paths for civilian specialists interested in contributing to defence innovation.

Challenge 7: Difficulty in Measuring and Evaluating Innovation Success

Traditional Metrics vs. Innovation Outcomes: The Armed Forces traditionally measure success through tangible outcomes like hardware acquisition and combat effectiveness. Measuring the impact of innovation efforts often involves less concrete indicators like increased operational efficiency, improved training methods, and enhanced adaptability to evolving threats.

Metrics in GoI Initiatives: GoI innovation initiatives often use diverse metrics based on the specific goals of each program. Aligning these metrics with the unique needs of the SIO can be challenging.

Challenge: The SIO needs to develop a comprehensive framework for measuring innovation success that encompasses both quantitative and qualitative indicators. This framework should consider factors like operational impact, efficiency gains,

technology readiness levels, and the fostering of a culture of innovation within the Armed Forces.

Case Study: While India has developed various defence innovation initiatives, their effectiveness at achieving intended outcomes has been questioned due to the lack of robust and transparent evaluation mechanisms. The SIO can learn from such shortcomings and prioritize the development of a comprehensive and accessible approach to measure its own success.

Challenge 8: Varied Stakeholders

The more effective 'innovation ecosystems' involve active participation from five main stakeholder groups, each with a role to perform. This paradigm extends beyond the classic 'dyad' of huge 'public-private', 'government-corporate', or'military-industrial complex' ties, as well as the popular 'triple helix', which merely included the 'entrepreneurial' University. MIT believes that in order to fully comprehend today's innovation and its eco-systems, it is crucial to take into account both the entrepreneurial community, which is responsible for establishing the businesses of the future, and the "risk capital" providers, who evaluate and finance these new endeavors. As such, this goes beyond just developing the ‘entrepreneurial university’, and adds these two additional stakeholders, as represented in the MIT figure 5.1 below[4]:

[4] Budden, P. & Murray, F. (2019), An MIT Approach to Innovation: eco/systems, capacities & stakeholders, *Working Paper, MIT Innovation Initiative, pg 11, Oct 2019*

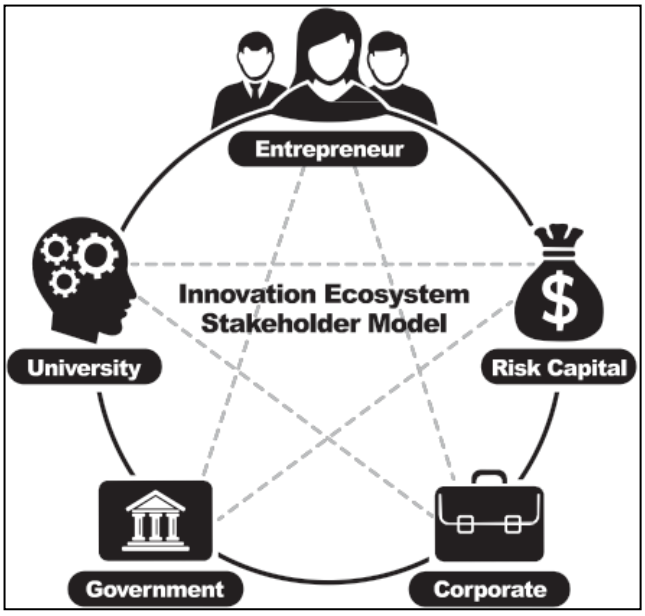

Figure 5.1 Innovation Ecosystem Stakeholder Model (Budden, P. & Murray, F. (2019), An MIT Approach to Innovation: eco/systems, capacities & stakeholders, Working Paper, MIT Innovation Initiative, pg 11, Oct 2019

Within innovation ecosystems, most stakeholders will have their own formal arrangements and systems for driving innovation. In the case of a Government, it will have a formal (and more or less rational) state 'system' of units and agencies which is designed to deliver innovation (eg for security/safety) and engage with a larger and more organic 'ecosystem' of non-state actors.

Challenge 9: Lack of a Central Tri-Services Organisation[5]

The absence of a Tri-Services Innovation Organisation (TSIO) in India has significant implications for the country's defense innovation ecosystem. The succeeding paragraphs explore the effects of this absence and discuss potential remedies.

[5] https://nationaldefenceinstitute.in/article/indigenisation-of-indian-defence-sector

Fragmented Approach to Innovation: Without a centralised TSIO, each branch of the Indian Armed Forces (Army, Navy, and Air Force) operates independently in terms of innovation. This fragmentation leads to redundancy, inefficiency, and missed opportunities.

Duplication of Efforts: Currently, the lack of coordination often results in multiple branches working on similar projects simultaneously. This duplication of efforts wastes time, money, and human resources.

Missed Synergies: The absence of a TSIO prevents synergies between different branches. For instance, technologies developed for the Navy might have applications in the Air Force or Army.

Lack of Interdisciplinary Approach: Defence innovation often requires expertise from various domains—engineering, data science, materials science, etc. A TSIO could bring together experts from diverse fields, fostering a holistic approach to problem-solving. It would encourage innovation beyond traditional boundaries.

Inadequate Funding Allocation: Currently, each service allocates its budget for innovation independently. This decentralised approach may lead to unequal funding distribution. Centralised funding decisions, ensuring equitable allocation based on strategic priorities. It would prioritise high-impact projects and allocate resources accordingly.

Lack of Industry Engagement: A TSIO could serve as a bridge between the armed forces and the private sector. It would facilitate partnerships with defence contractors, startups, and research institutions.

Summary of the Chapter

Integrating the TSIO with broader GoI innovation initiatives involves navigating a complex landscape of differing goals, bureaucratic hurdles, and limited resources. However, by understanding these challenges and adopting a strategic approach, the TSIO can foster a more effective and collaborative ecosystem for innovation in the Indian Armed Forces. This requires strong leadership, continuous communication, and a commitment from all stakeholders involved to build a robust and sustainable defence innovation framework for the nation's future security needs.

CHAPTER VI

DEVELOPING AN EFFECTIVE INTEGRATED FRAMEWORK

Innovation in the public sector requires not only creativity, but the successful planning, and implementation of ideas into an existing operational system.[1]

- ***Bekkers & Tummers, 2018; The Auditor General, 2009***

Nations allocate special funds for defence focused on the growth of innovation. A core component of innovation is the generation of ideas through diversity, collaboration and unexpected connections.[2] Innovation is the cornerstone of military superiority in the contemporary strategic landscape. The Indian Armed Forces, recognising the imperative of innovation, have been striving to institutionalize mechanisms to drive innovation across all branches. However, the fragmented nature of innovation initiatives and the lack of alignment with broader government initiatives pose significant challenges. The Atal Innovation Mission (AIM) and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) are flagship initiatives of the Government of India aimed at fostering innovation and research. Integrating the innovation efforts of the Armed Forces with these initiatives is essential to leverage synergies and enhance innovation outcomes.

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[1] Bekkers, V., & Tummers, L. (2018). Innovation in the public sector: Towards an open and collaborative approach. *International Review of Administrative Sciences, 84(2)*, 209-213. doi:10.1177/0020852318761797

[2] Silverberg, G., Dosi, G., & Orsenigo, L. (1988). Innovation, diversity and diffusion - a self-organisation model. *Economic Journal, 98*, 1032-1054

In this chapter, I propose an integrated framework for establishment of Higher Defence Organisations which will oversee the Innovation Strategy and Policy of the Armed Forces, to include a Tri-Services Innovation Organisation (TSIO). This framework aims to streamline innovation efforts, promote collaboration, and align with government initiatives such as AIM and NM-ICPS. The framework delineates the roles, scope, organogram, and duties of various sub-parts of the organisation, ensuring a coherent approach to innovation across the armed forces.

With the system itself, the Government and its agencies need to consider the division of labour within and among the various constituent parts: a system that simply evolved may no longer be optimally fit for service today, requiring changes both within existing units and also among their roles and responsibilities. This is further complicated by the need for the state system of agencies to be configured so as to best engage with the wider ecosystem. It will be hard for the non-state innovators to support the Government if its own agencies do not have a clear, shared understanding of their division of labour, and who is best placed to engage whom on what.[3] Thus, in order to achieve innovation maturity, defence organisations mostly rely on encouraging idea generation and cross-agency collaboration across departments and agencies as well as interacting with industry.

National Defence Innovation

Innovation within a nation can be said to exist as a combination of technology, institutions, and organisations. This is the so-called "innovation system." From this

[3] Budden, P. & Murray, F. (2019), An MIT Approach to Innovation: eco/systems, capacities & stakeholders, *Working Paper, MIT Innovation Initiative, pg 11, Oct 2019*

perspective, innovation and technological change can be considered as sources of continuous development. Innovation is usually a new combination of existing elements. This process is characterised by complex feedback mechanisms and interrelationships between science, technology, learning, production, policy, and demand. The 'triple helix' perspective points out and further enhances the importance of synergies in the relationships between academia, industry and government. The university sector plays a central role in national innovation6. The problem associated with technology transfer and military capability development is that of ``absorptive capacity". The extent to which a company or organisation has the technology and its operational use and exploitation capabilities. To analyse military innovation and how a nation's military capabilities should be developed, we can use the three-component military innovation triad perspective. Conditions of military innovation: technology, doctrine, organisation. States pursuing new military capabilities need to consider the technology absorption capacity of domestic companies, affected organisations (such as procurement and research), and, most importantly, the military. If a country's defence technology infrastructure is not sufficiently sophisticated and adaptable, it can be very difficult to carry out intended capacity expansions. Ideally, synergy should be achieved through a triple helix effect that combines the contributions of academia, industry, and government. In the previous paragraphs, we focused on different focuses when analyzing innovations. namely, the innovation systems model, which sees the state as the leading role, and the triple helix model, which sees science as the central enabler of innovation. The most obvious perspective would be to view defence enterprises as hubs of innovation.[4]

[4] Lundmark, M. (2013) Acquiring and Absorbing New Military Capabilities:: Defence Technology Acquisition for Defence-Aspiring Asia Pacific Nations Through Technology Policy and Bilateral Partnering, *S. Rajaratnam School of International Studies (2013) Stable URL: http://www.jstor.com/stable/resrep05789*

To oversee and manage these kinds of initiatives, governments frequently establish new departments, divisions, or teams. According to Denti and Hemlin (2012), Jon Freeman et al. (2015), p. xiv, and Larédo and Mustar (2004), the programs create alliances between academia and business, aiding in the growth of startups and promoting an atmosphere that encourages creativity. (Bason, 2010, p. 19; Budden & Murray, 2019) This has been referred to as the 'Military Innovation Ecosystem'. These ecosystems are regionally distributed and concentrate on certain tactical advantages.

Defence Innovation Ecosystems

Most regions have strategic approaches to the management and organisation of innovation for defence, and each are therefore an innovation ecosystem (Adner, 2006). Governments fund agencies that sit outside the bureaucratic hierarchy and who maintain relationships, as well as private partnerships, with industry. Some innovation ecosystems may also include alliances with defence organisations across several member countries. A list of international organisations and programs are shown in Table 1.[5]

[5] Langham,J and Wrigley, C. Defence Innovation: The Role of Design-Led Innovation in Disrupting the Conservative Paradigm, *Academy of Management Annual Meeting Proceedings · August 2020 DOI: 10.5465/AMBPP.2020.21494abstract*

Table 1. List of International Organisations and Programs

(Langham,J and Wrigley, C. Defence Innovation: The Role of Design-Led Innovation in Disrupting the Conservative Paradigm, *Academy of Management Annual Meeting Proceedings · August 2020DOI: 10.5465/AMBPP.2020.21494abstract*)

Country or Region	**Programs and Agencies**
Australia	The Next Generation Technologies Fund; Defence Innovation Hub
US	Strategic Capabilities Office (SCO); Defence Innovation Unit (DIU); MD5 or National Security Innovation Network (NSIN); Defence Advanced Research Projects Agency (DARPA); Special Operations Command (SOCOM); Special Operations Forces Works (SOFWERX);
Canada	Innovation for Defence Excellence and Security Program (IDEaS)
New Zealand	Defence Technology Agency (DTA)
UK	Defence and Security Accelerator (DASA); Defence Innovation Unit (DIU); : the Royal Navy Discovery, Assessment and Rapid Exploitation (DARE); The Army Innovation team; the RAF Innovation Exchange (RIX); the Joint Forces Command (jHub); Information Systems and Services (ISS); Defence Science and Technology Laboratory (Dstl)
European Union/NATO	European Defence Agency; CapTech Program

Country or Region	**Programs and Agencies**
Singapore	Future System and Technology Directorate, Strategic Planning Office
China	Central Military Commission (CMC): The Scientific Research Steering Committee, Strategic Committee of Science, Technology, and Industry Development for National Defence; Central Commission for Integrated Military and Civilian Development
Israel	Israel Innovation Authority, Unit 8200; National Cyber Bureau; Liberated Ventures Israel
France	Direction générale de l'armement (DGA), Defence Innovation Agency, Definvest

The nature of the defence innovation ecosystem is also shifting from the domination of large corporations controlling the majority of R&D budgets to smaller, more agile, specialized companies focused on developing specific solution areas. The goal of these programs is for the Department to benefit from innovation and potentially disruptive ideas from partnerships with small businesses and academic institutions that often fail through traditional bureaucratic procurement processes. Through funding sharing and collaboration, new ideas can mature based on the strengths of different organisations and institutions. Additionally, the changing innovation landscape means that more and more industry and academic institutions are collaborating with the Ministry of Defence, requiring new and innovative approaches to funding management and collaboration. Defence innovation takes place

in an environment where the global economy supports increased interest in research and development.

Macro Policy Orientation

Prior to establishing a Defence Innovation Ecosystem in the Indian Armed Forces, it is pertinent that overarching government policies and guidelines get incorporated at the macro levels itself which will ensure smooth alignment with initiatives subsequently. The GoI has recently released the 5th National Science, Technology, and Innovation Policy (STIP), which marks a significant milestone in the nation's aspirations within the realm of scientific and technological progress. This forward-thinking policy aims to address contemporary challenges by fostering a vibrant innovation ecosystem, positioning India as a global leader in science, technology, and innovation (STI).

STIP's Focus Areas. The new policy identifies key focus areas for research, innovation, and capability development:-

- STI Governance: The policy emphasises streamlined governance, aiming to reduce bureaucratic hurdles, simplify processes, and promote collaboration across various government departments, research institutions, and the private sector.
- Fundamental Research: Recognising the importance of basic research, the STIP aims to increase investment and support in fundamental

scientific inquiry to expand our knowledge base and lay the foundation for future breakthroughs.

- Translational Research and Technology Development: It highlights the need to bridge the gap between research and real-world applications. STIP encourages focused initiatives for translating research into commercially viable technologies and solutions.

- Industry-Academia Linkages: The policy emphasises building stronger connections between academic institutions and industry. Collaboration is promoted to align research with industry needs and accelerate the transfer of knowledge and technology.

- Traditional Knowledge Systems: STIP uniquely recognises the value of traditional knowledge systems. It aims to integrate this knowledge with modern scientific methods, exploring potential applications for healthcare, agriculture, and sustainable development.

- STI Diplomacy: The policy underscores the importance of engaging with global scientific communities. It promotes joint research projects, technology transfer, and collaborations to address shared global challenges.

- Science Communication and Public Engagement: Aiming to increase science literacy and awareness of STI initiatives, the policy encourages greater

public engagement through science communication, outreach programs, and citizen science initiatives.

STIP and Defence Innovation. India's 5th National Science, Technology and Innovation Policy (STIP), therefore, provides a strong framework for aligning and accelerating defence innovation initiatives within the larger national innovation ecosystem. Certain key STIP principles and focus areas that can directly enhance India's defence innovation efforts:-

- Openness and Inclusivity for Collaboration.
    - Breaking Down Silos: STIP's emphasis on openness facilitates knowledge sharing between the traditionally siloed defence sector and the broader scientific community. This can enable better integration between the Indian Armed Forces, DRDO, defence PSUs, private industry, and academic institutions, promoting collaboration and knowledge sharing.
    - Attracting Diverse Talent: The inclusivity focus promotes participation from previously underutilized talent pools, like women and researchers from marginalized communities, bringing fresh perspectives and broader expertise to the defence innovation landscape.

- Decentralisation and Evidence-Based Decision Making for Flexibility.

    - Empowering Frontline Innovators: A decentralised approach fosters greater autonomy at the Armed Forces' operational level, encouraging unit-driven innovation aimed at addressing immediate tactical challenges. This allows for localised solutions and faster decision-making.

    - Data-Driven Experimentation: Evidence-based decision-making allows for better assessment of the efficacy of experimental technologies and innovation projects. This ensures efficient resource allocation and prioritises projects with the highest potential impact.

- Focus on Fundamental and Translational Research

    - Long-Term Strategic Investments: STIP's commitment to fundamental research provides a basis for developing defence-specific foundational technologies, such as advanced materials, quantum computing, and AI algorithms that offer long-term strategic advantages.

    - Solution-Oriented Research: The focus on translational research aligns with defence needs, emphasizing the development of solutions rooted in scientific principles. This accelerates technology transfer from the lab to the battlefield.

- Focus Areas and Their Alignment with Defence Innovation

  - STI Governance for Defence Needs: Streamlined governance structures advocated by the STIP help reduce hurdles in defence procurement and collaboration processes. This enables faster development and deployment of indigenous military solutions.

  - Strengthening Industry-Academia Linkages: Increased focus on industry-academia partnerships offers the Armed Forces access to cutting-edge research and technologies. It also provides opportunities to collaborate on developing solutions catering specifically to military requirements.

  - Leveraging Traditional Knowledge Systems: Integrating traditional knowledge into defence innovation can offer unique insights into areas like battlefield medicine, material science, or navigation, potentially leading to novel solutions.

  - STI Diplomacy for Strategic Partnerships: Global collaborations fostered by STI diplomacy facilitate access to advanced technologies, enabling knowledge exchange and joint ventures on critical defence projects.

  - Public Engagement and Awareness: Increased public engagement and awareness surrounding defence innovation can help

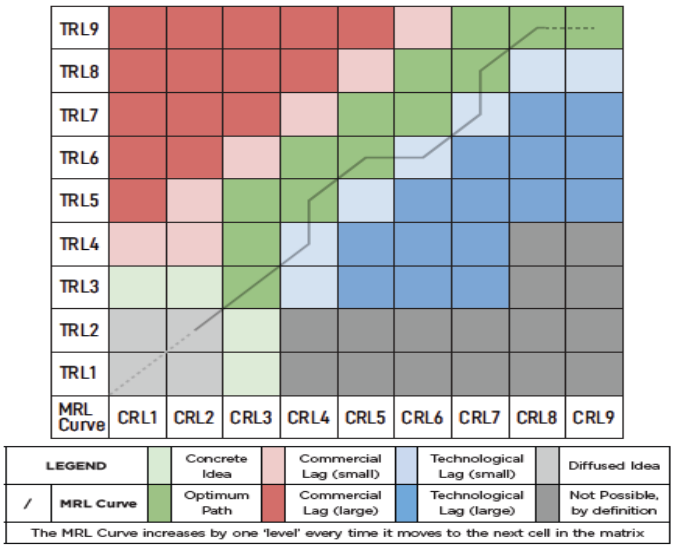
attract skilled talent, inspire a wider pool of innovators, and create a broader support base for defence innovation initiatives.

NITI Aayog's Techno-Commercial Readiness and Market Maturity (TCR-MM) Matrix and Defence Innovation

The NITI Aayog has introduced the Techno-Commercial Readiness and Market Maturity (TCR-MM) Matrix as a tool to assess and guide innovation across various sectors. There in immense significance in aligning Indian defence innovation ecosystem with the TCR-MM Matrix and formulate strategies for alignment towards techno-commercial readiness and market maturity in the defence sector.

Understanding the TCR-MM Matrix.[6] The TCR-MM Matrix developed by NITI Aayog is a comprehensive framework that evaluates innovations based on their technological readiness and commercial potential. It categorises innovations into

Table 6.1: Techno-Commercial Readiness and Market Maturity Matrix
(NITI Aayog, A New Lens For Innovation in New India - Introducing The Techno-Commercial Readiness and Market Maturity Matrix)



[6] NITI Aayog, A New Lens For Innovation in New India - Introducing The Techno-Commercial Readiness and Market Maturity Matrix

four quadrants: nascent, emergent, accelerating, and mature, based on their level of technological development and market readiness. Each quadrant represents a different stage of the innovation lifecycle, ranging from early-stage research to widespread commercialisation. By assessing innovations across these dimensions, the TCR-MM Matrix provides insights into their readiness for scaling up and market penetration.

Benefits to be Accrued. Aligning Indian defence innovation with NITI Aayog's Techno-Commercial Readiness and Market Maturity Matrix is essential for enhancing the competitiveness and effectiveness of defence capabilities by focusing on technology readiness enhancement, commercialisation support, and market access and expansion.

Summary of the Chapter

The alignment of the Tri-Services Innovation Organisation (TSIO) with Government of India policies such as the Science, Technology, and Innovation Policy (STIP), and innovation initiatives like Atal Innovation Mission (AIM) and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) is crucial for fostering a robust ecosystem of innovation and technological advancement in our nation.

STIP and the Research Ecosystem: STIP aims to create a fit-for-purpose, accountable research ecosystem that promotes both translational and foundational research in India, aligning with global standards. By integrating TSIO with STIP, we can leverage the organization’s expertise to address critical defence challenges

through cutting-edge research and development. This alignment ensures that defence innovations are not isolated but contribute to the broader scientific community.

AIM: Cultivating an Innovative Mindset: Atal Innovation Mission (AIM) is the flagship initiative of the Indian government, designed to nurture innovation and entrepreneurship across the country. TSIO's alignment with AIM allows it to tap into a vast network of Atal Tinkering Labs (ATLs) established in schools across districts. These labs foster a problem-solving mindset among students, encouraging them to think innovatively from an early age. Collaborating with AIM also provides TSIO access to mentors, incubation centers, and startups, creating a fertile ground for cross-disciplinary innovation.

NM-ICPS: Bridging Disciplines: The NM-ICPS focuses on interdisciplinary cyber-physical systems, bridging domains like electronics, computing, and mechanical engineering. TSIO's alignment with NM-ICPS enables cross-pollination of ideas and technologies. For instance, innovations in autonomous systems, sensor networks, and data analytics developed by NM-ICPS can find applications in defense. By collaborating with NM-ICPS, TSIO can accelerate the adoption of emerging technologies, enhancing the capabilities of our armed forces.

Strategic Imperatives: National security demands agility, adaptability, and foresight. TSIO's alignment with these policies and initiatives ensures that our defence forces stay ahead in the technological race. Resource optimisation is another benefit. Leveraging existing platforms and networks reduces redundancy and maximizes impact. Innovation diffusion occurs when defence innovations spill over

into civilian applications, benefiting society at large. Alignment facilitates this diffusion.

In summary, the alignment of TSIO with government policies and initiatives is not merely administrative; it is a strategic imperative. It empowers our defence forces, fuels technological progress, and positions India as a global innovation hub. Let us envision a future where defense innovation seamlessly integrates with national development, creating a safer, smarter, and more prosperous India.

CHAPTER VII

SUGGESTED ORGANISATION OF A TSIO

Optimising the defence ecosystem for innovation will be difficult, challenging the organisational cultures of both the user and producers of technology.[1]

- Taylor, T. and Louth, J. (2013), The Challenge of Change: Acquiring Technologies for Defence in the UK

The MIT, in a study, has developed a systematic way to examine and assess how that region experiences and delivers 'innovation' (see the diagram below), for any such geographical region (such as a nation/state), allowing for some global comparison (at least with country-level data). This matters to our understanding of the ability of the public sector to deliver on innovation' because decisions about any state's system of agencies which it establishes to accelerate such innovation (whether for civilian, security or dual purposes) will be informed by this understanding of where and why innovation thrives in certain ecosystems. In the MIT model, the core elements to such innovation are – at the base – foundations and institutions (e.g. rule of law) upon which much else rests.[2]

[1] Taylor, T. and Louth, J. (2013), The Challenge of Change: Acquiring Technologies for Defence in the UK, https://www.jstor.org/stable/resrep40330.6

[2] Budden, P. & Murray, F. (2019), An MIT Approach to Innovation: eco/systems, capacities & stakeholders, *Working Paper, MIT Innovation Initiative, pg 4, Oct 2019*

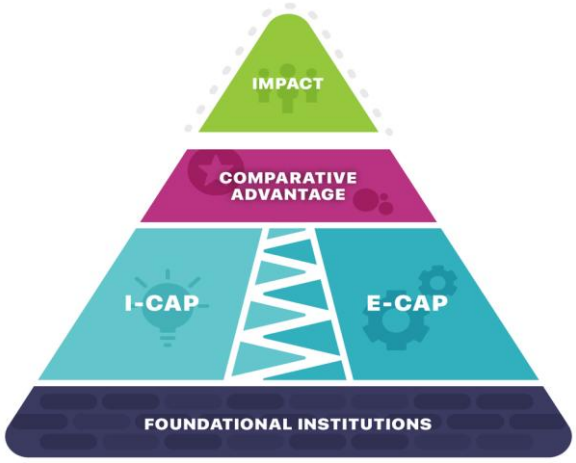


Figure 7.1: MIT Model (Budden, P. & Murray, F. (2019), An MIT Approach to Innovation: eco/systems, capacities & stakeholders, Working Paper, MIT Innovation Initiative, pg 4, Oct 2019

The above study report makes it abundantly clear that any innovation activity requires stable and robust foundational institutions to provide this highly volatile and unpredictable activity sound support and hand holding. Thus, emerges the need for a centralised, empowered, adequately funded and enabled organisation which can integrate the requirements and efforts of the Armed Forces to support Defence Innovation. The Armed Forces, being the main stakeholders and Users, need to take lead in establishing an organisation capable of such responsibilities.

In the survey conducted as part of this research, the same has also emerged quite evidently as given in the figure below.

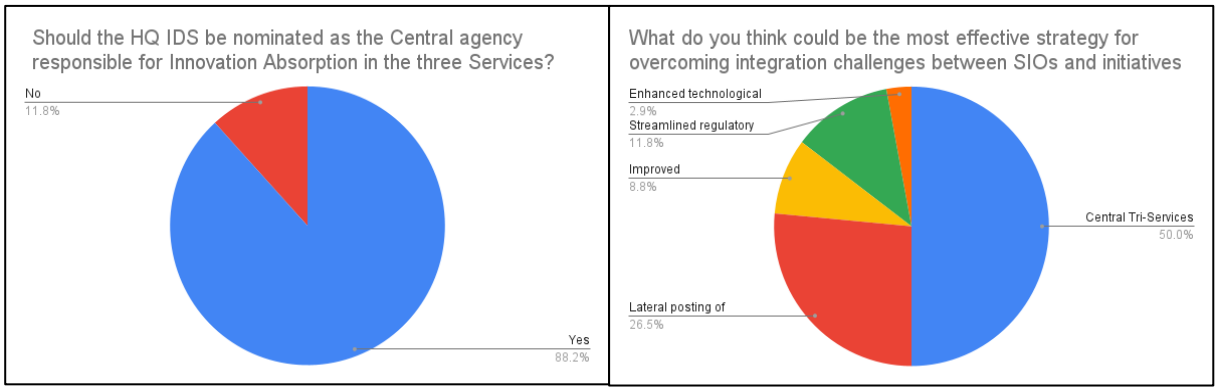


Figure 7.2: Requirement of a Central Tri-Services Organisation
(Refer Questionnaire of the Survey conducted)

RECOMMENDED TRI-SERVICES INNOVATION ORGANISATION

The Indian Armed Forces stand at the forefront of safeguarding the nation's security interests, facing evolving threats and challenges in an increasingly complex geopolitical landscape. In this dynamic environment, innovation emerges as a key enabler for maintaining military superiority, enhancing operational effectiveness, and adapting to emerging threats. Recognizing the imperative of fostering a culture of innovation across all branches of the armed forces, there arises a need for a dedicated Tri-Service Innovation Organisation (TSIO). The TSIO will serve as the apex body responsible for driving innovation initiatives, facilitating collaboration, and harnessing the collective ingenuity of the Army, Navy, and Air Force. By providing a centralised platform for identifying, incubating, and scaling innovative solutions, the TSIO will aim to address operational gaps, promote technological advancements, and enhance the overall combat readiness of the Indian Armed Forces.

This proposed organisation represents a strategic imperative in ensuring India's defence preparedness in the 21st century, aligning with global trends in military innovation and technology adoption.

Role and Scope of the Tri-Services Innovation Organisation (TSIO):

The TSIO will serve as the apex body responsible for driving innovation across the Indian Armed Forces. Its primary role will be to identify, prioritise, and facilitate the development and adoption of innovative solutions to address operational

challenges and enhance capabilities. The scope of TSIO will encompass the following key areas:-

- Technology Scouting and Assessment: TSIO is tasked with scouting emerging technologies relevant to defence and assessing their potential for application in military operations. This involves monitoring global trends, engaging with industry and academia, and conducting technology evaluations.

- Research and Development: TSIO oversees research and development (R&D) activities aimed at advancing military technology and capabilities. It collaborates with research institutions, defence laboratories, and private sector entities to fund and coordinate R&D projects aligned with defence requirements.

- Innovation Ecosystem Development: TSIO works towards nurturing an innovation ecosystem within the armed forces by fostering a culture of creativity, entrepreneurship, and risk-taking. This includes establishing innovation hubs, organizing hackathons, and providing support to innovators and startups.

- Technology Transfer and Commercialisation: TSIO facilitates the transfer of technology from research institutions to the armed forces and promotes the commercialization of defence technologies through partnerships with industry and startups.

HIGHER DEFENCE ORGANISATION FOR INNOVATION

The Allocation of Business Rules for the Department of Military Affairs (DMA) or *Sainya Karya Vibhag* has laid down 'promoting jointness in procurement, training and staffing for the Services through joint planning and integration of their requirements', 'facilitation of restructuring of Military Commands for optimal utilisation of resources by bringing about jointness in operations, including through establishment of joint / theatre commands' and 'promoting use of indigenous equipment by the Services' as some of the responsibilities for the DMA. Headquarters Integrated Defence Staff is the direct HQ working under the DMA for implementation of the same. The TSIO is therefore ideally suited to be established under the aegis of HQ IDS with a Higher Defence Organisation named Integrated Defence Innovation Council (IDIC) overseeing its functioning.

Integrated Defence Innovation Council (IDIC)

The establishment of an Integrated Defence Innovation Council (IDIC) in India can significantly bolster the nation's ability to address the complex security challenges of the 21st century. By providing a centralised, nimble, and well-structured body focused on collaborative defence innovation, India can move a step closer to building a self-reliant and technologically advanced military, equipped to address both conventional and asymmetric threats of the future.

The IDIC will serve as the apex body providing strategic direction and oversight for the TSIO. It is crucial to compose the council with experienced and forward-thinking individuals. The proposed composition of the IDIC is as under:

- Chairperson: Chief of Defence Staff (CDS)

- Members:

    - Service Chiefs (Army, Navy, Air Force)
    - Scientific Advisor to the Defence Minister (SADM)
    - Secretary, Research and Development
    - Eminent experts from industry, academia, and security think tanks (with a rotating membership for broader perspectives)

Functions of the IDIC. The IDIC would perform the primary functions as follows:-

- Define the overall innovation vision and policy for the Armed Forces.
- Identify and prioritise strategic technology areas for focused research and development efforts.
- Set performance metrics and guide resource allocation for the TSIO.
- Foster collaboration and knowledge sharing across the tri-services and broader innovation ecosystem.
- Oversee the implementation of the TSIO's strategy and advise on its effectiveness.

Organogram of the Tri-Services Innovation Organisation (TSIO)

The organogram of the proposed TSIO, named ***Directorate of Innovation Strategy and Policy (DISP)***, reflects a hierarchical structure designed to ensure efficient coordination and execution of innovation initiatives across the armed forces. The organisation will comprise of several key components, each with specific roles and responsibilities as explained below:-

- Directorate of Innovation Strategy and Policy (DISP): DISP will be responsible for formulating innovation strategies, policies, and frameworks to guide TSIO's activities. It will conduct policy analysis, benchmarks best practices, and ensures alignment with government policies such as STIP and initiatives such as AIM and NM-ICPS.

- Chief Innovation Officer (CIO): The CIO, a Major General/equivalent rank Officer, will serve as the head of DISP and is responsible for providing strategic direction, leadership, and oversight. The CIO reports directly to the Chief of Defence Staff (CDS) through the CISC, and liaises with senior military leadership, government agencies, and external stakeholders. He/She will head the Directorate of Innovation Strategy and Policy (DISP) established under the aegis of HQ IDS.

- Technology Assessment Cell (TAC): TAC will be tasked with scouting, evaluating, and prioritising emerging technologies for adoption by the armed forces. It will conduct technology assessments, feasibility studies,

and risk analyses to inform decision-making on technology acquisition and development.

- Research and Development Cell (RDC): RDC will oversee the planning, funding, and execution of R&D projects being pursued by the three Services through various schemes like iDEX, Technology Development Fund (TDF) of the DRDO, Make projects and all other Services funded ongoing, aimed at enhancing military capabilities. It will be the single point contact with defence research organisations, academic institutions, and industry partners to advance technology development in priority areas.

- Innovation Incubation Cell (IIC): IIC will serve as a platform for nurturing innovation and entrepreneurship within the armed forces. It will provide support to in-service innovators, facilitates prototyping and experimentation, and connects these innovators with mentors, investors, and industry collaborators. The Center will also liaise with all other incubators established under the AIM and NM-ICPS initiatives.

- Technology Transfer Cell (TTC): TTC facilitates the transfer of technology from research institutions to the armed forces through licensing agreements, technology demonstrations, and joint development programs. It also supports the commercialization of defence technologies through partnerships with industry.

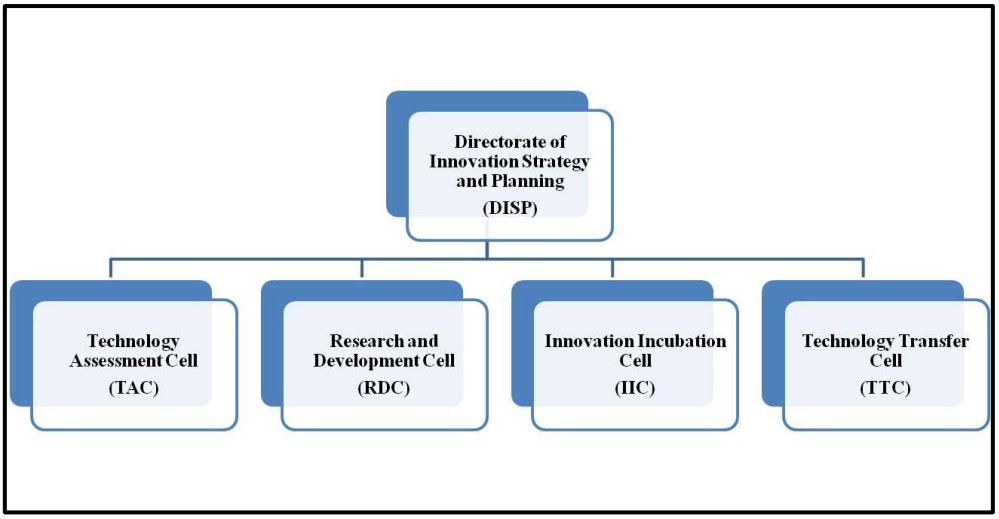


Figure 7.3: Proposed Organogram of the Directorate of Innovation Strategy and Planning (DISP)

Summary of the Chapter

The main road block here is to look at weapon technology purely from a scientific point of view. Scientists and engineers come into play only at the 'last mile' as it's called to provide a technical solution to the stated problem. Therefore, stating the problem is the first step. So here thinkers need to come in, analyse what's changing in war, give out a prognosis and translate the same into desired deliverables which in turn will help focus on essentials, channel scarce resources in the right direction and derive maximum 'bang for the buck.' [3]

The proposed integrated framework for a Tri-Services Innovation Organisation (TSIO) in the Indian Armed Forces represents a comprehensive approach to driving innovation and collaboration aligned with government initiatives such as AIM and NM-ICPS. By establishing clear roles, responsibilities, and mechanisms for coordination, TSIO aims to enhance the armed forces' innovation

[3] Srivastava, Samir. (2021). 'Innovation: Key to become 'atmanirbhar' in the defence sector'. Warfare, Observer Research Foundation

capabilities and contribute to India's strategic objectives in defence technology and security. Through strategic partnerships with industry, academia, and government agencies, TSIO seeks to leverage emerging technologies, nurture a culture of innovation, and address the evolving challenges faced by the armed forces in the 21st century.

CHAPTER VIII

CONCLUSION AND RECOMMENDATIONS

The integration of Tri-Services Innovations Organisations (TSIOs) with a focus on alignment with the Atal Innovation Mission (AIM) and the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS) presents a formidable challenge but also holds immense potential for driving innovation, enhancing defense capabilities, and fostering socio-economic development. As we conclude our exploration of this critical issue, it is imperative to assess the progress made thus far, offer recommendations for improvement, and propose innovative solutions to address the challenges inherent in this integration process.

Assessment of Progress

The journey towards integrating TSIOs with AIM and NM-ICPS has seen significant strides, albeit with certain challenges. Collaborative initiatives and projects have been initiated, fostering cross-disciplinary partnerships and knowledge exchange. TSIOs have leveraged opportunities provided by AIM and NM-ICPS to access additional funding streams and enhance resource utilization. Furthermore, there has been a growing recognition of the importance of interdisciplinary collaboration and stakeholder engagement in driving innovation and addressing complex challenges. However, despite these advancements, several challenges persist, hindering seamless integration and collaboration. These challenges include

bureaucratic hurdles, resource constraints, technological silos, and regulatory complexities.

RECOMMENDATIONS

To address the challenges and maximise the potential of integrating TSIOs with AIM and NM-ICPS, the following recommendations are proposed, with a special focus on the establishment of an integrated Tri-Services Innovation Organisation called the Directorate of Innovation Strategy and Planning (DISP):-

- **Streamlining Regulatory Frameworks**: There is a need to streamline regulatory frameworks governing defense innovation and technology transfer to facilitate seamless collaboration between TSIOs, AIM, and NM-ICPS. Clear guidelines and streamlined processes will expedite decision-making and enhance the ease of doing business.

- **Enhancing Resource Allocation and Funding**: Efforts should be made to enhance resource allocation and funding mechanisms for TSIOs, AIM, and NM-ICPS. This can be achieved through increased budgetary allocations, innovative financing models, and strategic partnerships with industry and academia.

- **Promoting Interdisciplinary Collaboration**: Initiatives should be undertaken to promote interdisciplinary collaboration within TSIOs and between TSIOs, AIM, and NM-ICPS. This can be facilitated through joint

research programs, technology exchange platforms, and collaborative innovation hubs.

- **Fostering Technology Transfer and Dual-Use Technologies**: Efforts should be made to foster technology transfer and promote the development of dual-use technologies that can benefit both defense and civilian sectors. This can be achieved through technology scouting, matchmaking, and licensing initiatives.

- **Strengthening Stakeholder Engagement**: Stakeholder engagement should be strengthened to ensure inclusive decision-making and foster a sense of ownership and commitment towards shared objectives. This can be achieved through regular stakeholder consultations, participatory decision-making processes, and transparent communication channels.

Establishment of Directorate of Innovation Strategy and Planning (DISP)

As a transformative solution to address the challenges of integrating TSIOs with AIM and NM-ICPS, the establishment of DISP under HQ Integrated Defence Staff (IDS) is proposed. DISP will serve as a centralized agency responsible for coordinating and overseeing innovation strategy and planning across the tri-services. It will facilitate collaboration between TSIOs, AIM, and NM-ICPS, streamline resource allocation and funding, promote interdisciplinary collaboration, and drive technology transfer and innovation diffusion. DISP will also serve as a focal point for

stakeholder engagement, ensuring alignment of innovation initiatives with strategic defense priorities and national development goals.

In conclusion, the integration of TSIOs with AIM and NM-ICPS represents a critical imperative in the contemporary landscape of defense and technological advancement. While significant progress has been made, challenges persist, necessitating concerted efforts and innovative solutions. By implementing the recommendations outlined above and establishing DISP as a centralized agency for innovation strategy and planning, stakeholders can unlock the full potential of collaborative innovation, driving transformative advancements in defense capabilities, technological innovation, and socio-economic development.

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Appendix 1 – Questionnaire for the Survey

iDEX: INTEGRATION OF INTERDISCIPLINARY INNOVATION

INTEGRATION OF INTERDISCIPLINARY INNOVATION : STUDY OF TRI SERVICES, ATAL INNOVATION MISSION (AIM) AND NATIONAL MISSION ON INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (NM-ICPS)

Dear Sir/Madam, At the outset, let me thank you for being part of my academic journey. This study is being undertaken as part of my dissertation on the 'INTEGRATION OF INTERDISCIPLINARY INNOVATION : STUDY OF TRI SERVICES, ATAL INNOVATION MISSION(AIM) AND NATIONAL MISSION ON INTERDISCIPLINARY CYBER PHYSICAL SYSTEMS (NM-ICPS)' as part of the curriculum of the APPPA Course at IIPA, New Delhi.

For the purposes of analysis, the questionnaire has been divided into the following sections:-

1. Your profile
2. General Perceptions - current collaborative initiatives and integration efforts between Tri-Services Innovations Organisations (TSIOs), and their present alignment with AIM, and NM-ICPS
3. Major challenges and barriers hindering the seamless integration of TSIOs with AIM and NM-ICPS
4. Suggested organisation and role of a Central TSIO under HQ IDS
5. Concluding Remarks

Thank you for sparing your valuable time and inputs. Please feel free to share as much (or as little) as you want to. Please feel free to incorporate any additional data, case studies you feel relevant to the study in your concluding remarks. The data collated will be used only for academic purposes. The finding of the study will be shared with the concerned Department/ Service HQs.

Regards
Brigadier Marut Shukla, SM
Attending 49th APPPA Course
Indian Institute of Public Administration

* Indicates required question

1. Email *

2. Military/Non-Military Officer * 5 points

Mark only one oval.

- ◯ Military
- ◯ Non-military

3. Serving/Retired * 5 points

Mark only one oval.

- ◯ Serving
- ◯ Retired

4. Rank/Designation (Serving/Last on retirement) * 5 points

_____

5. Name

_____

6. Years of Service * 5 points

Mark only one oval.

- ◯ less than 10 years
- ◯ 10 - 20 yrs
- ◯ more than 20 years

7. Exposure to Innovation Activities in Indian Armed Forces * 5 points

Mark only one oval.

- ◯ Nil
- ◯ less than 2 years
- ◯ 2 - 5 years
- ◯ more than 5 years

8. Primary Department/Sector/Industry of work * 5 points

General Perspective

Current collaborative initiatives and integration efforts between Tri-Services Innovations Organisations (TSIOs), and their present alignment with AIM, and NM-ICPS

9. Do you believe different initiatives are required for significant advancements in innovation absorption and technological integration within services? * 5 points

Mark only one oval.

- ◯ Yes
- ◯ No

10. Are you aware of any initiatives being undertaken for better innovation absorption in the Indian Armed Forces? * 5 points

Mark only one oval.

- ◯ Yes
- ◯ No

11. If your answer to the previous question is Yes, please list out the initiatives that you know of 5 points

12. Have you heard about the Atal Innovation Mission (AIM)? * 5 points

Mark only one oval.

- Yes
- No

13. If yes, briefly describe what you know about AIM 5 points

14. Have you heard about the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS)? * 5 points

Mark only one oval.

- Yes
- No

15. If yes, briefly describe what you know about NM-ICPS 5 points

16. Do you think initiatives like AIM and NM-ICPS contribute to fostering innovation in services? * 5 points

Mark only one oval.

- ◯ Yes
- ◯ No

Major challenges and barriers hindering the seamless integration of TSIOs with AIM and NM-ICPS

17. Do TSIOs face any resource constraints (financial, technological, human capital, etc.)? * 5 points

Mark only one oval.

- ◯ Financial constraints
- ◯ Human Capital
- ◯ Technological capabilities
- ◯ Inter Service Competition
- ◯ Lack of jointmanship
- ◯ Absence of a Central Tri-Services Organisation responsible for Innovation

18. What in your opinion is the effectiveness of HQ IDS in coordinating Innovation initiatives of the three Services? * 5 points

Mark only one oval.

- ◯ Highly Effective
- ◯ Effective
- ◯ Neutral
- ◯ Not effective

19. Should the HQ IDS be nominated as the Central agency responsible for Innovation Absorption in the three Services? * 5 points

Mark only one oval.

- ◯ Yes
- ◯ No

20. Please rate the following challenges on a scale of 1(most challenging) to 5(least challenging) which inhibit Innovation absorption in the Services * 25 points

Mark only one oval per row.

	1	2	3	4	5
Technological competence of Innovators	◯	◯	◯	◯	◯
Complicated procedures for absorption	◯	◯	◯	◯	◯
Budgetary constraints for R & D	◯	◯	◯	◯	◯
Lack of knowledge within Services	◯	◯	◯	◯	◯
Integration with ongoing civil initiatives	◯	◯	◯	◯	◯

21. How would you rate the level of communication and collaboration between TSIOs and initiatives like AIM and NM-ICPS? * 5 points

Mark only one oval.

	1	2	3	4	5	
High	◯	◯	◯	◯	◯	Non existent

22. In your opinion, what regulatory or policy hurdle poses the biggest obstacle to TSIOs integrating with initiatives like AIM and NM-ICPS? * 5 points

Mark only one oval.

- ◯ Intellectual property rights
- ◯ Compliance regulations
- ◯ Licensing requirements
- ◯ Export/import regulations
- ◯ Other (please specify)
- ◯ Other: _____

23. Which factor do you believe contributes most to communication barriers between TSIOs and AIM/NM-ICPS initiatives? * 5 points

Mark only one oval.

- ◯ Lack of clear communication channels
- ◯ Differences in organisational culture
- ◯ Bureaucratical issues
- ◯ Diverse Service organisations dealing with the same issue
- ◯ Lack of unified central agency in the Services

24. How do you perceive the current level of collaboration between TSIOs and initiatives like AIM and NM-ICPS? * 5 points

Mark only one oval.

- ◯ Very collaborative
- ◯ Somewhat collaborative
- ◯ Not collaborative at all

25. What do you think could be the most effective strategy for overcoming integration challenges between TSIOs and initiatives like AIM/NM-ICPS? * 5 points

Mark only one oval.

- ◯ Central Tri-Services Agency to interact with other Government initiatives
- ◯ Streamlined regulatory processes
- ◯ Enhanced technological compatibility measures
- ◯ Improved communication channels
- ◯ Lateral posting of Officers with other initiatives

Suggested organisation and role of a Central TSIO under HQ IDS Section

26. Are you in agreement with the concept of a Central TSIO under HQ Integrated Defence Staff (IDS)? * 5 points

Mark only one oval.

- ◯ Agree
- ◯ Neutral
- ◯ Do not agree

27. In your opinion, what should be the primary role of a Central TSIO under HQ IDS? * 5 points

Mark only one oval.

- ◯ Research and development of advanced defense technologies
- ◯ Innovation management and fostering a culture of innovation within the military
- ◯ Technology scouting and assessment of emerging technologies
- ◯ Collaboration facilitation between different branches of the military and external stakeholders
- ◯ Other (please specify)

28. Which of the following organizational structures do you think would best suit a Central TSIO under HQ IDS? * 5 points

Mark only one oval.

- ◯ Hierarchical structure with clear chains of command
- ◯ Flat organisational structure with decentralised decision-making as per stream
- ◯ Matrix structure with cross-functional teams
- ◯ Network structure with strong external partnerships
- ◯ Other (please specify)

29. How do you believe a Central TSIO should prioritise its research and innovation efforts? * 5 points

Mark only one oval.

- ◯ Focus on developing cutting-edge weaponry and defense systems
- ◯ Emphasise technologies for enhancing military readiness and operational efficiency
- ◯ Prioritise dual-use technologies with civilian applications
- ◯ Address emerging threats
- ◯ Other (please specify)

30. What impact do you believe a well-functioning Central TSIO could have on the overall defense capabilities of the country? Rate as 1(Most impactful) to 5 (Least Impactful) * 5 points

Mark only one oval per row.

	1	2	3	4	5
Significantly enhance technological superiority and military strength	◯	◯	◯	◯	◯
Foster innovation ecosystem benefiting both defense and civilian sectors	◯	◯	◯	◯	◯
Strengthen national security and defense preparedness	◯	◯	◯	◯	◯
Improve interoperability and coordination among different branches of the military	◯	◯	◯	◯	◯
Optimal utilisation of resources	◯	◯	◯	◯	◯

31. Overall, how optimistic are you about the potential effectiveness of a Central TSIO under HQ IDS in driving innovation and technological advancement in the defense sector? * 5 points

Mark only one oval.

- ◯ Very optimistic
- ◯ Somewhat optimistic
- ◯ Neutral
- ◯ Somewhat pessimistic
- ◯ Very pessimistic

Concluding Remarks

32. Based on your experience, briefly suggest any relevant inputs for Integration of Interdisciplinary Innovation 5 points

Appendix 2 – ATAL INNOVATION MISSION (Extracts)

Overview of Atal Innovation Mission (AIM)

The Atal Innovation Mission (AIM) is a flagship initiative set up by the NITI Aayog to promote innovation and entrepreneurship in the country.

Its objective is to create a facilitating environment for transformation of ideas into innovative and impactful solutions at schools, universities, research institutions, MSME and industry levels across the country.

Our Programs


Innovation Ecosystem Development
Initiatives of Atal Innovation Mission
Innovation Cycle
Idea & research
Problem identification & design thinking
Solution tech development & POC
Pilot implementation
Production startup
Large scale deployment
Encouraging innovation at institute level
Atal Tinkering Labs/ Mentor India
Supporting tech development, deployment and commercialisation in important sectors
Atal/ Established Incubation Centres
Atal New India Challenge
Building a robust innovation ecosystem in unserved/ undeserved regions of India
Atal Community Innovation Centres
Supporting research and innovation in MSME sector
Atal Research & Innovation for small Enterprises

AIM Incubators

Atal Incubation Centres (AICs)

Setting up world class incubation facilities across the country with state-of-the-art infrastructure, that will support next gen startups in terms of labs, coupled with the availability of sectoral experts for mentoring. Apart from this, business planning support, access to seed capital, industry partnerships, training and other relevant components required.

Established Incubation Centres (EICs)

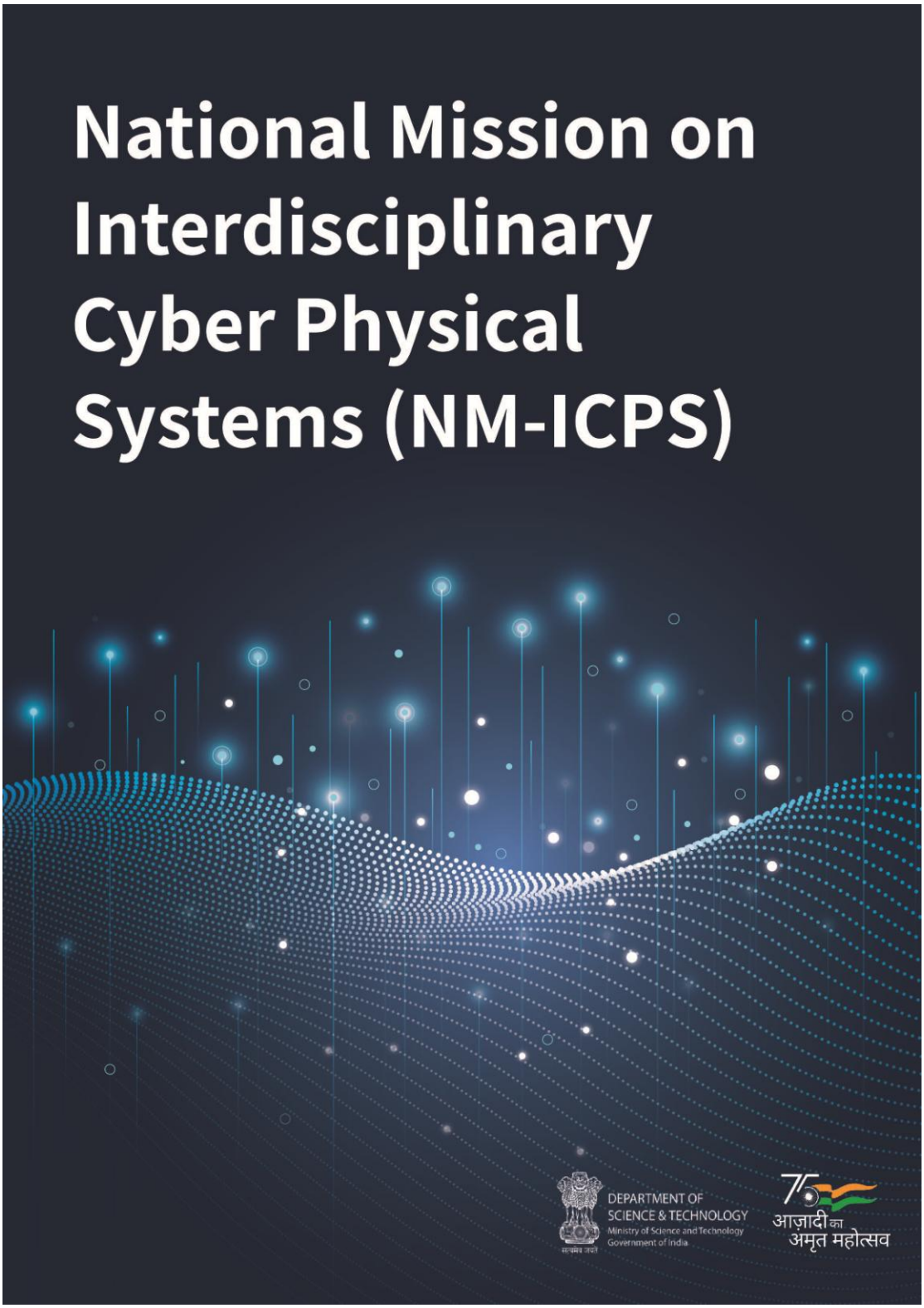
Scale-up support and upgrading well-performing Incubation Centres to world-class standards. This is done with a view to augment, enhance and upgrade their incubation capacity manifold and develop a conducive innovation and entrepreneurship ecosystem by strengthening linkages with various national and international stakeholders

#WorldClassIncubators

Objectives:

- **Promote and establish world-class incubation centres**
- **Support, nurture innovative technology-based start-ups**
- **Guidance on business planning, go-to-market & financial advisory**
- **Facilitate access to labs, investors, innovators, market access and other resources**

Appendix 2 – NM-ICPS (Extracts)



Mission:

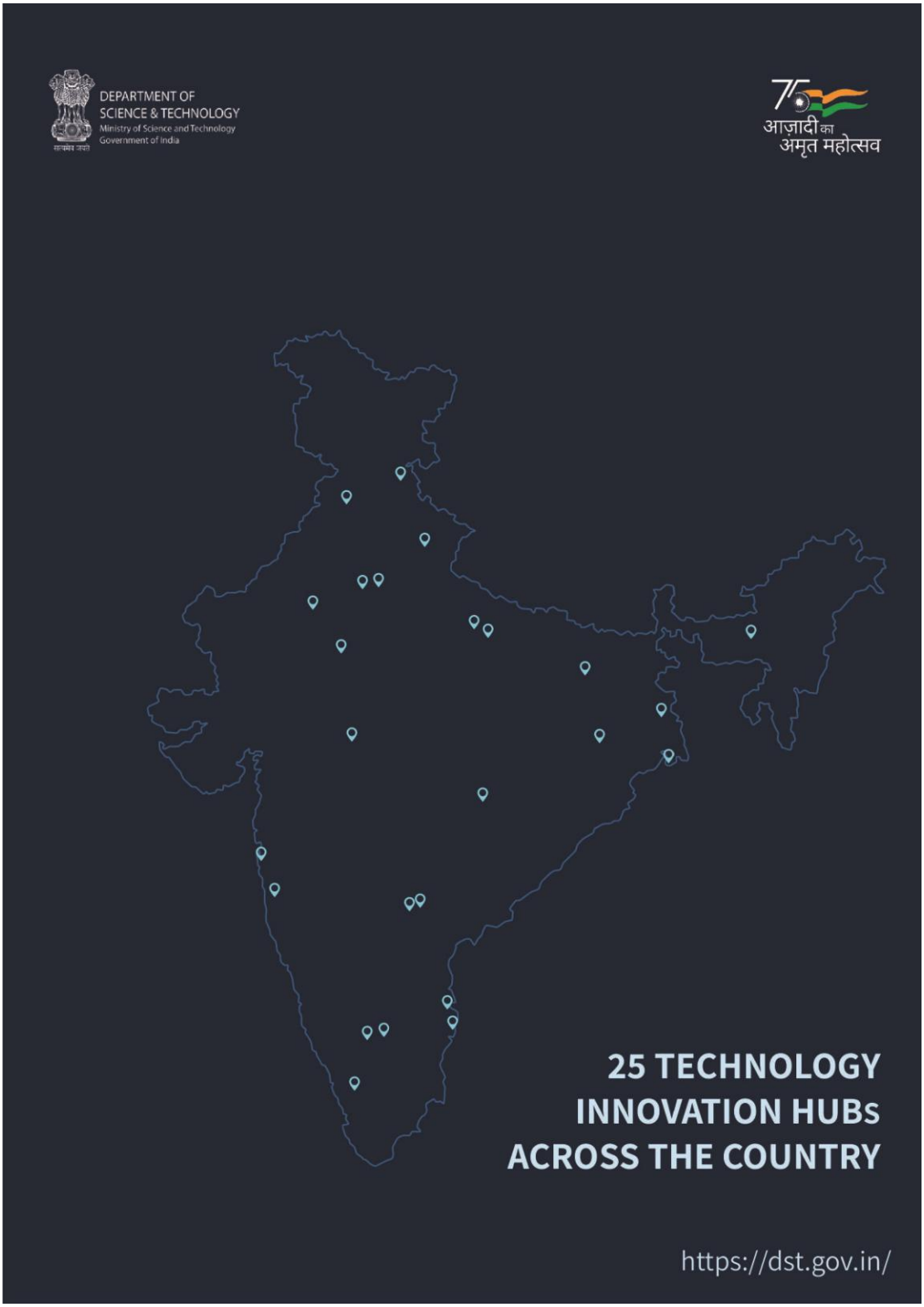
Various CPS and its associated technology verticals have been considered under NM-ICPS which includes: Artificial Intelligence and Machine Learning, Technologies for Internet of Things & Internet of Everything, Data Banks & Data Services, Data Analysis, Robotics & Autonomous Systems, etc. The Mission aims at development of technology platforms to carry out R&D, Translation Research, Product Development, Start-ups and as well as Commercialization. NM-ICPS is a comprehensive Mission aimed at complete convergence with all stakeholders by establishing strong linkages between academia, industry, Government and International Organizations. The Mission working with all the concerned Ministries/ Departments to identify their technology needs, develop solutions and technical support. The Mission is implemented through 25 number of Technology Innovation Hubs (TIHs) already established as part of the Mission in the top academic and National R&D Institutes. Hubs will be the platform for executing all Mission activities.

Hubs architecture: Each is created as a Section-8 Company with industry as Members in co-development, partnerships and for commercialization. The Industry - Academic-Govt collaborations are the main focus of the Hubs.

The list of 25 TIHs

S.NO	INNOVATION HUB	TECHNOLOGY VERTICAL
1	AI4ICPS I-Hub Foundation (TIH) at IIT Kharagpur	Artificial Intelligence and Machine Learning
2	TIH Foundation For IoT And IoE at IIT Bombay	Technologies for IoT & IoE
3	IIIT-H Data I-Hub Foundation at IIIT Hyderabad	Data Banks & Data Services, Data Analysis
4	I-HUB for Robotics & Autonomous Systems Innovation Foundation at IISc Bengaluru	Robotics and Autonomous Systems
5	IHUB NTIHAC Foundation at IIT Kanpur	Cyber Security and Cyber Security for Physical Infrastructure
6	IHUB Drishti Foundation at IIT Jodhpur	Computer Vision, AR & VR
7	Divyasampark IHUB Roorkee for Devices Materials and Technology Foundation at IIT Roorkee	Device Technology and Materials
8	IIT Patna Vishlesan I-hub Foundation at IIT Patna	Speech, Video & Text Analytics
9	IITM Pravartak Technologies Foundation at IIT Madras	Sensors, Networking, Actuator & controls
10	NMICPS Technology Innovation Hub on Autonomous Navigation Foundation (TiHAN) at IIT Hyderabad	Autonomous Navigation & Data Acquisition systems
11	I-DAPT-HUB Foundation at IIT (BHU) Varanasi	Data Analytics & Predictive Technologies
12	IIT Guwahati Technology Innovation and Development Foundation at IIT Guwahati	Technologies for Under water exploration

S.NO	INNOVATION HUB	TECHNOLOGY VERTICAL
13	IIT Mandi IHub and HCI Foundation at IIT Mandi	Human Computer Interaction
14	I-Hub Foundation for Cobotics (IHFC) at IIT Delhi	Cobotics
15	IIT Ropar Technology & Innovation Foundation at IIT Ropar	Technologies for Agriculture & Water
16	Technology Innovation in Exploration & Mining Foundation at IIT(ISM) Dhanbad	Technologies for Mining
17	IIT Palakkad Technology Ihub Foundation at IIT Palakkad	Intelligent Collaborative Systems
18	IIITB Comet Foundation at IIIT Bangalore	Advanced Communication System
19	BITS BioCYTiH Foundation at Birla Institute of Technology & Science, Pilani	Bio-CPS
20	IDEAS- Institute of Data Engineering, Analytics and Science Foundation at Indian Statistical Institute, Kolkata	Data Science, Big Data Analytics & Data curation etc.
21	IITI Drishti CPS Foundation at IIT Indore	System Simulation, Modeling & Visualization
22	IHUB Anubhuti-IIITD Foundation at IIIT Delhi	Cognitive Computing and Social Sensing
23	I-Hub Quantum Technology Foundation at IISER Pune	Quantum Technologies
24	IIT Tirupati Navavishkar I-Hub Foundation at IIT Tirupati	Positioning & Precision Technologies
25	IIT Bhilai Innovation & Technology Foundation at IIT Bhilai	Technologies for financial sector (Fintech)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