

Start-ups in camouflage: the convergence of MSMEs, innovation, and Indian defense needs

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Abstract

The integration of Micro, Small, and Medium Enterprises (MSMEs), particularly start-ups, into India's defense sector is emerging as a transformative force in modernizing the country's military capabilities. As India pivots towards self-reliance through initiatives like Atmanirbhar Bharat and the Defence Innovation Organisation (DIO), start-ups are becoming critical innovation drivers in defense manufacturing, supply chains, and technological advancement. This paper investigates the current and potential convergence of start-ups and MSMEs with Indian defense needs, analyzing policy frameworks, innovation hubs, funding ecosystems, and dual-use technologies. A mixed-methods approach comprising policy analysis, case studies (e.g., Tonbo Imaging, IdeaForge), and primary interviews with defense ecosystem stakeholders is employed. The findings suggest a positive correlation between MSME innovation intensity and their integration into strategic defense functions. However, structural bottlenecks such as procurement delays, intellectual property risks, and lack of sustained funding restrict their scaling. The study proposes a techno-policy roadmap to deepen civil-military-industrial integration through innovation clusters, regulatory sandboxing, and joint development programs. The outcomes offer a blueprint for leveraging entrepreneurial vigor to meet national security imperatives while fostering indigenous defense technology capabilities.

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1. Introduction

India's defense preparedness is entering a new phase characterized by indigenous innovation, rapid digital transformation, and start-up-led disruptions. Traditionally dominated by Public Sector Undertakings (PSUs) and large corporations, the Indian defense ecosystem is now increasingly dependent on the agility and ingenuity of MSMEs and start-ups. The Ministry of Defence (MoD) has identified over 12,000 MSMEs operating as vendors for defense PSUs and ordnance factories [1]

The Defence Acquisition Procedure (DAP) 2020, Innovations for Defence Excellence (iDEX) program, and Defence India Startup Challenge (DISC) have catalyzed this paradigm shift, enabling small enterprises to

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contribute to R&D, prototyping, and the manufacture of next-gen solutions like drones, surveillance systems, AI-based situational awareness tools, and logistics support systems.

1.1 Strategic context

India's pursuit of strategic autonomy and self-reliance in defense has gained momentum in recent years, driven by evolving geopolitical dynamics and the imperative to reduce dependency on foreign military imports. The government's flagship initiatives, such as *Make in India* and *Atmanirbhar Bharat*, underscore this commitment by promoting indigenous manufacturing and fostering innovation across sectors, including defense. Central to this transformative agenda is the integration of Micro, Small, and Medium Enterprises (MSMEs) and start-ups into the defense ecosystem, leveraging their agility, innovation potential, and cost-effectiveness to meet the nation's security needs.

1.2 The role of MSMEs and start-ups in defense:

MSMEs constitute a significant segment of India's industrial landscape, contributing approximately 30% to the nation's Gross Domestic Product (GDP) and employing over 110 million people [1]. Their decentralized operations, flexibility, and sectoral diversity position them as ideal contributors to defense manufacturing, particularly in Tier-II and Tier-III cities where defense corridors are being established. Start-ups, characterized by their innovative approaches and technological prowess, complement MSMEs by introducing cutting-edge solutions in areas such as unmanned systems, artificial intelligence (AI), cybersecurity, and advanced materials.

The convergence of MSMEs and start-ups with the defense sector is facilitated by policy frameworks and initiatives designed to encourage their participation. The *Innovations for Defense Excellence (iDEX)* program, launched by the Ministry of Defense, aims to create an ecosystem that fosters innovation and technology development in defense and aerospace by engaging industries, including MSMEs and start-ups, as well as individual innovators, research and development institutes, and academia [2]. Through iDEX, the government provides financial support, mentorship, and access to testing facilities, enabling these entities to develop and commercialize defense technologies.

1.3 Policy initiatives and support mechanisms:

The Indian government has implemented several policy measures to integrate MSMEs and start-ups into the defense sector:

- i. **Defense Acquisition Procedure (DAP) 2020:** Introduced to streamline procurement processes and provide greater opportunities for indigenous manufacturers, including MSMEs and start-ups, by simplifying procedures and promoting transparency [3].
- ii. **Defense Industrial Corridors (DIC):** Established in states like Uttar Pradesh and Tamil Nadu to create clusters of defense manufacturing units, providing infrastructure support and facilitating collaboration among various stakeholders [4].
- iii. **Defense India Startup Challenge (DISC):** An initiative under iDEX that invites start-ups to propose innovative solutions for specific defense requirements, offering financial grants and incubation support to selected projects [5].
- iv. **India-U.S. Defense Acceleration Ecosystem (INDUS-X):** A collaborative initiative between India and the United States aimed at fostering partnerships among defense companies, start-ups, incubators, and investors from both countries to accelerate defense innovation [6].

1.4 Emerging defense start-ups and MSMEs:

Several Indian start-ups and MSMEs have made significant contributions to the defense sector:

- i. **IdeaForge:** A leading manufacturer of unmanned aerial vehicles (UAVs) in India, IdeaForge has developed advanced drones like the NETRA V4 Pro, which are utilized for surveillance and reconnaissance missions by defense and security forces [7].

- ii. **Tonbo Imaging:** Specializes in electro-optics and image processing technologies, providing advanced imaging solutions for defense applications, including night vision and thermal imaging systems [8].
- iii. **Sagar Defence Engineering:** Focuses on developing autonomous marine systems, such as unmanned surface vehicles (USVs) and remotely operated vehicles (ROVs), for naval surveillance and reconnaissance [9].

These enterprises exemplify the innovative capabilities of Indian MSMEs and start-ups in addressing complex defense requirements through indigenous solutions.

1.5 Challenges and opportunities:

Despite the encouraging policy environment and emerging success stories, MSMEs and start-ups in the defense sector face several challenges:

- i. **Procurement hurdles:** Complex and lengthy procurement processes can deter small enterprises from participating in defense contracts, necessitating further simplification and transparency [10].
- ii. **Funding constraints:** Limited access to capital and high research and development (R&D) costs pose significant barriers to innovation and scalability for MSMEs and start-ups [11].
- iii. **Infrastructure limitations:** The lack of testing facilities, certification processes, and specialized infrastructure hampers product development and deployment [12].

Addressing these challenges requires concerted efforts from policymakers, industry stakeholders, and financial institutions to create a supportive ecosystem that nurtures innovation and facilitates the integration of MSMEs and start-ups into the defense value chain.

1.6 Research objectives:

This paper aims to explore the convergence of MSMEs and start-ups with the Indian defense sector by:

1. Assessing the strategic relevance of MSMEs and start-ups in India's defense modernization efforts.
2. Analyzing innovation trends, policy enablers, and funding mechanisms that drive this convergence.
3. Examining barriers hindering effective integration of MSMEs and start-ups into defense supply chains.
4. Proposing a techno-policy framework to enhance civil-military-industrial integration through innovation clusters, regulatory sandboxing, and joint development programs.

By addressing these objectives, the study seeks to provide insights into leveraging the entrepreneurial vigor of MSMEs and start-ups to meet national security imperatives while fostering indigenous defense technology capabilities.

2. Literature review

2.1 The strategic role of MSMEs in India's defense sector

Micro, Small, and Medium Enterprises (MSMEs) have emerged as pivotal contributors to India's defense manufacturing landscape. According to a KPMG report, the Indian defense sector is projected to witness capital expenditure of approximately USD 250 billion over the next decade, presenting substantial opportunities for MSMEs to integrate into the defense supply chain [16]. These enterprises offer agility, cost-effectiveness, and innovation, making them indispensable in achieving the nation's self-reliance goals.

A study by Chopade and Lad at IIM Bangalore underscores that over 8,600 MSMEs are actively engaged in defense manufacturing, supplying components ranging from electronics to mechanical parts [17]. Their involvement not only enhances domestic production capabilities but also fosters employment and technological advancement.

2.2 Policy frameworks facilitating MSME participation

The Indian government has instituted several policies to bolster MSME involvement in defense. The 'Make in India' initiative and the Defense Procurement Procedure (DPP) have been instrumental in promoting indigenous

manufacturing. Furthermore, the Defense Offset Policy mandates foreign vendors to source a percentage of their contracts from Indian companies, thereby opening avenues for MSMEs [18].

The Innovations for Defence Excellence (iDEX) program, launched in 2018, aims to create an ecosystem fostering innovation and technology development in the defense and aerospace sectors by engaging industries, including MSMEs and start-ups [19]. Through iDEX, the government provides financial support and incubation facilities, enabling MSMEs to develop cutting-edge defense technologies.

2.3 Emergence of Defense start-ups and innovation hubs

India's defense sector has witnessed a surge in start-ups focusing on advanced technologies such as unmanned systems, artificial intelligence, and cybersecurity. For instance, ideaForge, a Mumbai-based start-up, has developed indigenous unmanned aerial vehicles (UAVs) utilized by the Indian armed forces [20]. Similarly, Tonbo Imaging specializes in advanced imaging systems for defense applications [21].

The establishment of defense corridors in states like Uttar Pradesh and Tamil Nadu has further catalyzed the growth of defense start-ups. These corridors provide infrastructure, testing facilities, and incentives, creating a conducive environment for innovation and collaboration [22].

2.4 International collaborations and the INDUS-X initiative

Recognizing the importance of international cooperation, India and the United States launched the India-U.S. Defense Acceleration Ecosystem (INDUS-X) in 2023. This initiative aims to facilitate collaboration between defense start-ups, MSMEs, and academic institutions from both countries, focusing on co-development and co-production of defense technologies [23]. INDUS-X serves as a platform for sharing best practices, fostering innovation, and enhancing interoperability between the two nations' defense industries.

2.5 Challenges faced by MSMEs and start-ups in defense

Despite supportive policies, MSMEs and start-ups encounter several challenges in the defense sector. Complex procurement procedures, limited access to capital, and stringent quality standards often hinder their growth. A report by the Department of Scientific and Industrial Research highlights that many technology-based start-ups struggle with scaling their innovations due to inadequate funding and market access [24].

Furthermore, a study published in the Global Journal for Research Analysis points out that MSMEs often lack the necessary certifications and infrastructure to meet defense production requirements, limiting their participation in large-scale projects [25].

2.6 Strategies for enhancing MSME and start-up integration

To address these challenges, experts suggest several strategies. Simplifying procurement processes, providing dedicated funding mechanisms, and establishing mentorship programs can significantly aid MSMEs and start-ups. The Defense Innovation Organization (DIO) has initiated partnerships with incubators across India to support entrepreneurs in navigating the defense sector's complexities [26].

Moreover, fostering collaborations between established defense public sector undertakings (DPSUs) and MSMEs can facilitate knowledge transfer and capacity building. Such partnerships can enable MSMEs to participate in larger projects and contribute to the development of sophisticated defense systems [27].

3. Research methodology

This study adopts a mixed-methods approach, integrating both qualitative and quantitative techniques to comprehensively examine the role and challenges of MSMEs and start-ups in India's defense sector. The rationale behind employing a mixed-methods framework lies in its ability to capture nuanced perspectives from industry stakeholders while simultaneously validating patterns through empirical data.

3.1 Research design

The research was structured into three sequential phases:

1. **Exploratory phase** – Qualitative interviews with stakeholders.
2. **Descriptive phase** – Survey-based analysis of innovation outcomes.
3. **Analytical phase** – Secondary data analysis and policy mapping.

Such triangulation ensures data reliability, as recommended in defense-oriented entrepreneurship research [28].

3.2 Data collection methods

Primary data was collected through 225 semi-structured interviews with:

- i. MSME founders operating in defense manufacturing.
- ii. Start-up executives with defense innovations.
- iii. Policy advisors and defense procurement analysts.

The interviews focused on the following themes:

- i. Ease of access to defense procurement frameworks.
- ii. Key bottlenecks in scale-up and IP protection.

Data was coded using NVivo 14 for thematic analysis, which enabled efficient pattern recognition [29].

Secondary sources included:

- i. Annual reports from the Ministry of Defence and iDEX [30].
- ii. Publications from Invest India [31].
- iii. White papers from SIDBI [32].
- iv. Policy documents like the Defence Acquisition Procedure (DAP) 2020 [33].
- v. Research articles on innovation in Indian MSMEs [34].

The integration of policy-level data with entrepreneurial case studies created a multidimensional analytical framework [35].

3.3 Sampling and selection criteria

Purposive sampling was used to identify relevant participants from defense innovation clusters, including Bengaluru, Pune, Hyderabad, and Coimbatore.

The following criteria were used:

- MSMEs/start-ups engaged with DRDO, iDEX, or DIO programs.
- Companies operational for a minimum of 3 years.

This approach ensured focused insights from actors directly contributing to the defense value chain [36][42]. Table 1 shows variables and analytical techniques used.

Table 1. Variables and analytical techniques [32][33][34][35]

Category	Indicators
Innovation capacity	Patents filed, TRL scores, new product launches
Defense integration	Number of tenders awarded, offset contracts
Funding access	Venture capital raised, government grants
Policy engagement	Participation in iDEX, Start-up India ranking

Statistical techniques employed included descriptive statistics, correlation matrices, and cross-tabulation analysis. For qualitative data, thematic clustering and content validation were implemented [37][43]. All interviews were conducted following ethical guidelines outlined by the Indian Council of Social Science Research (ICSSR). Participants signed informed consent forms, and anonymity was preserved [38][42].

3.4 Limitations of the methodology

While the study attempts a holistic understanding, limitations include

- a. Geographical concentration of respondents.
- b. Potential recall bias in qualitative interviews.
- c. Limited public access to sensitive procurement data.

Nevertheless, the combination of primary and secondary data mitigates most of these issues and enhances result reliability [39].

3.5 Research validity and reliability

To ensure internal validity, multiple coders reviewed interview transcripts. Triangulation of findings was used to enhance construct validity. External reliability was maintained through pilot interviews and replicable data collection instruments [40].

4. Results

4.1 Research design recap

The research followed a triangulated design comprising three core phases:

1. Exploratory Phase: Conducted qualitative interviews with 225 stakeholders, gathering firsthand insights on MSME and start-up participation in the defense ecosystem.
2. Descriptive Phase: Executed a structured survey to analyze patterns in innovation outcomes, funding access, and procurement engagement.
3. Analytical Phase: Integrated secondary data sources, including policy documents, public databases, and academic literature, to triangulate findings.

This triangulated approach was instrumental in achieving research depth and data validation, as proposed by Eisenhardt [28][43].

4.1.1 Primary data findings

Stakeholder profiles

Interviews were conducted with:

- 180 MSME founders in defense manufacturing, and
- 45 policy advisors and procurement analysts at MoD, DDP, and SIDBI.

Key thematic patterns (NVivo analysis)

Using NVivo 14, the qualitative dataset was thematically coded, revealing the following from Table 2.

Table 2. Secondary Data Highlights [32][33][34][35]

Theme	Frequency (%)
Procurement complexity	78%
IP & Scale-up constraints	64%
Positive perception of iDEX	70%
Funding gaps (Post-prototype stage)	58%
Regional disparity in support	42%

These findings highlight the systemic barriers hindering wider integration despite strong innovation capabilities among MSMEs/start-ups [29].

Integrated observations

- 1) Innovation outcomes
 - a) A 65% of start-ups reported completing technology readiness levels (TRL) 6–8 within 18 months.

- b) 58% successfully deployed dual-use technologies (e.g., surveillance UAVs).

2) Policy engagement

- a) 72% of surveyed entities engaged with at least one MoD scheme (iDEX, Make-II, TDF).
- b) However, only 38% transitioned to sustained procurement.

3) Geographic concentration

- a) 60% of successful defense MSMEs/start-ups were concentrated in Bengaluru, Pune, Hyderabad, and Chennai.
- b) Respondents from tier-2 cities expressed lower exposure to DRDO labs and defense corridors.

5. Discussion

The findings from this study underscore the dynamic yet constrained role of MSMEs and start-ups within India's defense innovation landscape. Thematic coding from interviews with 225 stakeholders revealed dominant issues around procurement complexity (78%) and IP protection (64%), highlighting systemic frictions in transitioning innovation to scalable solutions. These frictions are consistent with concerns raised in the Defence Acquisition Procedure (DAP) 2020 regarding documentation burdens and slow vendor onboarding processes [33]. The positive engagement with iDEX, evidenced by 70% of respondents, aligns with Ministry of Defence data indicating rapid acceleration in start-up participation [30]. However, the gap between prototype completion and commercialization is evident—only 38% of start-ups transitioned to sustained procurement, signaling limitations in downstream integration. This finding supports earlier observations by Sharma and Mishra [34], who noted that while MSMEs show strong innovation potential, institutional inertia often restricts broader deployment.

The role of regional ecosystems also emerged as critical. Over 60% of successful MSMEs/start-ups were concentrated in innovation hubs like Bengaluru, Pune, and Hyderabad, whereas firms in tier-2 cities reported a lack of access to DRDO labs and defense corridor benefits. This spatial disparity suggests a need for decentralizing defense innovation infrastructure, echoing recommendations from SIDBI's white papers on inclusive regional development [32]. Secondary data confirmed a vibrant innovation environment—65% of start-ups reached TRL 6–8, and 58% deployed dual-use technologies[43]. Yet, only 35% received follow-on growth funding, affirming the need for a more robust defense venture capital framework. The India-U.S. INDUS-X initiative may offer valuable insights here, as it integrates capital support with co-development pathways [23].

In summary, the discussion reveals a high ceiling for MSMEs and start-ups in defense, currently limited by structural barriers and asymmetric support access. Policy reforms should focus on simplifying procurement, establishing regional innovation nodes, and enabling sustained funding to realize the full potential of these agile innovators.

6. Conclusions

This study concludes that while MSMEs and start-ups represent a highly innovative and agile segment of India's industrial base, their potential within the defense sector remains only partially realized. The convergence of these entities with national security needs, supported by programs like iDEX and Make in India, has laid the groundwork for indigenous technological advancements. However, systemic inefficiencies—especially in procurement, funding access, and IP protection—continue to hinder their scalability and sustainability. The research findings indicate that although 65% of start-ups reached significant technology readiness levels and 58% reported dual-use technology deployment, only 38% transitioned to consistent defense procurement. This gap illustrates a need for institutional mechanisms that can better translate innovation into operational deployments. Furthermore, geographic concentration in a few metro cities has excluded many high-potential enterprises from tier-2 and tier-3 locations, highlighting the importance of regional inclusivity in defense innovation ecosystems.

In conclusion, a multifaceted strategy—focusing on decentralized support infrastructure, procurement reforms, and targeted financial instruments—is required to elevate the role of MSMEs and start-ups from peripheral contributors to core enablers of India’s defense capabilities. Future research could further explore longitudinal outcomes of iDEX-funded ventures and assess the scalability of public-private defense partnerships across various states.

Declaration of competing interest

"The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper."

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