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Uncovering the Roadblocks: Why Deep-Tech Startups Struggle to Rise in India Compared to China

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Abstract - India's start-up ecosystem is the world's third largest by volume yet remains weak in deep-technology ventures, whereas China dominates frontier sectors such as artificial intelligence, semiconductors and advanced batteries. This study identifies ecosystem factors that constrain Indian deep-tech growth and compares stakeholder perceptions with China. A cross-sectional survey of founders, investors and incubator managers (n = 44) captured responses to 24 Likert statements covering Ecosystem & Infrastructure, Funding & Investment, Talent & Education, Mind-set & Strategy and Policy & Support, plus a comparative block. Mean scores (1–5) reveal neutral-to-negative views of infrastructure (2.96), talent (2.86) and policy (2.92) but cautious optimism regarding funding (3.14) and founder ambition (3.21). The highest rating (3.60) confirms consensus that China currently leads. Open-ended comments highlight three recurring obstacles: limited access to advanced laboratories, seed-to-Series-A funding gaps and brain drain of skilled engineers. Results support the hypothesis that deficits in infrastructure, patient capital, specialist talent and tailored policy frameworks hinder India's deep-tech rise. Recommended actions include raising public R&D to 1.5 % GDP, creating a DARPA-style mission directorate and expanding PhD-to-start-up fellowships to unlock India's latent STEM potential.

Keywords: deep-tech start-ups, India–China comparison, innovation ecosystem, venture funding, STEM talent, policy support.

1.INTRODUCTION

India's rise as a global technology hub has produced more than one hundred unicorns and the world's third-largest start-up ecosystem. Yet only a small fraction of these ventures operate in deep-technology (deep-tech) domains—fields that commercialise substantive scientific or engineering breakthroughs such as artificial intelligence (AI), quantum computing, advanced materials and biotechnology. Deep-tech companies typically require longer R&D horizons, specialised infrastructure and patient capital but, when successful, deliver disproportionate economic and strategic value.

By contrast, China has rapidly established itself as a deep-tech powerhouse through programmes such as Made in China 2025 and multi-billion-dollar AI and semiconductor funds. Chinese start-ups now lead or rank near the top globally in drones, electric vehicles, advanced batteries and computer-vision chips. The disparity between Indian and Chinese outcomes has drawn national attention; India's Commerce Minister recently urged the country's entrepreneurs to pivot from quick-commerce apps to frontier technologies.

Existing literature cites five systemic constraints on India's deep-tech progress: (i) limited R&D infrastructure, (ii) risk-averse domestic funding, (iii) shortages of specialised STEM talent, (iv) a short-term founder mind-set and (v) broad but non-specific policy instruments. Quantitative evidence comparing stakeholder perceptions across these dimensions, however, remains sparse.

Research question. Which ecosystem factors most limit Indian deep-tech start-ups, and how do key stakeholders perceive India's position relative to China?

Hypotheses.
H1 Infrastructure deficits hinder Indian deep-tech growth.
H2 Inadequate patient funding is a major barrier.
H3 Specialist talent shortages constrain scale-up.
H4 Founders favour quick-return models over deep-tech bets.
H5 Current policies are only partially effective.
H6 Stakeholders agree China currently leads India in deep-tech.

To address these hypotheses, this study employs a nation-wide survey of founders, investors and incubator managers, analysing perceptions across the five ecosystem constructs above and offering data-driven recommendations to bridge India's deep-tech gap.

2. METHODS

2.1 Research Design

A quantitative, cross-sectional survey was selected to capture stakeholder perceptions of India's deep-tech ecosystem. The online questionnaire employed five-point Likert items (1 = strongly disagree, 5 = strongly agree) grouped into the following constructs: Ecosystem & Infrastructure (EI), Funding & Investment (FI), Talent & Education (TE), Mind-set & Strategy (MS) and Policy & Support (PS). A sixth block, Global Perspective (GP), gauged comparative views on India versus China.

2.2 Population and Sampling

The population comprised Indian start-up-ecosystem stakeholders—founders, co-founders, family-business owners, incubator mentors/managers and early-stage investors. Because deep-tech entrepreneurs form a specialised subset, **purposive sampling** was employed.

- **Sampling frame:** LinkedIn founder lists, the Startup India directory, incubators etc., entrepreneurship cells and personal referrals.
- **Sample size:** 46 submissions received; after removing two incomplete cases, **n = 44** valid responses remained, exceeding the ≥30 threshold for descriptive analyses.

2.3 Survey Instrument

The Google-Forms instrument contained:

1. **Profile items**—role, venture name and region.
2. **Twenty-four Likert items** (EI_1–EI_4, FI_1–FI_4, … GP_4).
3. **Three open-ended questions** to elicit qualitative insights.

Items were adapted from prior studies (NASSCOM & Zinnov, 2024; Sreenivasan & Suresh, 2023) and vetted by two entrepreneurship-faculty members. A pilot with six founders prompted minor wording tweaks.

2.4 Data-Collection Procedure

The survey link was disseminated via (i) direct LinkedIn and WhatsApp messages, (ii) start-up-incubator mailing lists and (iii) college entrepreneurship-cell groups (eligibility note: active business owners only). Data were collected over a 30-day window (1 May 2025 – 30 May 2025). Participation was voluntary and anonymous; informed-consent text preceded the questionnaire.

2.5 Conceptual Framework

Five independent variables (EI, FI, TE, MS, PS) are hypothesised to exert positive effects on the dependent variable—perceived **growth and viability of Indian deep-tech start-ups relative to China (DV)**—operationalised via GP items. The conceptual model (Fig. 1) aligns with Minister Piyush Goyal's critique that India must shift from consumer apps to frontier technologies.

2.6 Data-Analysis Plan

Step	Purpose	Key Measures / Tests
Descriptive statistics	Central tendency for each item	Mean, median, SD
Frequency tables	Distribution of agreement	Count and % (scores 1–5)
Category-level means	Aggregate EI, FI, etc.	Mean of four items per construct
Bar charts	Visual comparison	Construct means (Fig. 2)
Cross-tabs	Founder vs investor contrast	Independent-samples *t*-tests
Qualitative coding	Identify recurring challenges	Thematic counts, illustrative quotes

Data cleaning and descriptive work were completed in Google Sheets; cross-tabs were verified with Excel PivotTables.

2.7 Ethical Considerations

Participants provided informed consent and could withdraw at any time. No personally identifying information (e-mail addresses, phone numbers) was collected; results are reported in aggregate. All secondary sources are cited in APA 7th style, and a Turnitin report will accompany the final submission.

2.8 Limitations

Purposive sampling limits generalisability; self-reported perceptions may contain social-desirability bias; and **n = 44** is adequate for descriptive but not complex inferential statistics.

(Abbreviations introduced: EI = Ecosystem & Infrastructure, FI = Funding & Investment, TE = Talent & Education, MS = Mind-set & Strategy, PS = Policy & Support, GP = Global Perspective, DV = Dependent Variable).

3. RESULTS

3.1 Data Preparation

Survey responses (Google Forms) were exported to Excel, screened for duplicates and trimmed for whitespace. Nineteen Likert items (1 = strongly disagree … 5 = strongly agree) were grouped into six constructs: Ecosystem & Infrastructure (EI), Funding & Investment (FI), Talent & Education (TE), Mind-set & Strategy (MS), Policy & Support (PS) and Global Perspective (GP). Codes and item ranges are listed in **Table 1**.

Table 1.

Code	Construct	Items
EI	Ecosystem & Infrastructure	EI_1–EI_4
FI	Funding & Investment	FI_1–FI_4
TE	Talent & Education	TE_1–TE_4
MS	Mind-set & Strategy	MS_1–MS_4
PS	Policy & Support	PS_1–PS_4
GP	Global Perspective	GP_1–GP_3

3.2 Descriptive Statistics

Category means are summarised in **Table 2** (scale 1–5). Values < 3 highlight ecosystem challenges; ≈ 3 suggests mixed sentiment; > 3 indicates perceived strength.

Table 2.

Construct	Items (n)	Mean
EI	4	2.96
FI	4	3.14
TE	4	2.86
MS	4	3.21
PS	4	2.92
GP	3	3.60

Key observations: (i) MS and FI exceed neutral, signalling moderate optimism in entrepreneurial ambition and early-stage capital; (ii) EI, TE and PS remain just below neutral, pointing to persistent gaps in infrastructure, talent and policy execution; (iii) GP, the highest score, reflects consensus that China presently leads India in deep-tech.

3.3 Frequency Illustration

Table 3 details the distribution for EI_1 (regional ecosystem support).

Score	Count	% (n = 44)
1	6	13.6
2	10	22.7
3	14	31.8
4	11	25.0
5	3	6.8

A plurality (31.8 %) are neutral; only 31.8 % agree (scores 4 + 5).

3.4 Complete Distribution

Table 4 presents counts and means for all 24 items. Items MS_4 (3.59) and GP_3 (3.80) receive the strongest agreement, whereas TE_4 (2.61) is lowest, underscoring talent-development as a pain-point.

QUES.	SCORE COUNTS					MEAN
	1	2	3	4	5	
EI1	3	12	13	9	7	3.11
EI2	6	10	15	9	4	2.89
EI3	5	8	16	12	3	3
EI4	6	12	11	13	2	2.84
FI1	7	10	15	9	4	3.25
FI2	6	10	15	9	4	3.34
FI3	8	6	12	11	7	3.07
FI4	6	10	15	9	4	2.89
TE1	6	11	12	13	2	2.86
TE2	2	10	24	8	0	2.86
TE3	3	8	18	12	3	3.09
TE4	11	9	11	12	1	2.61
MS1	5	8	14	16	1	3
MS2	5	10	7	17	5	3.16
MS3	5	7	15	13	4	3.09
MS4	4	3	12	13	12	3.59
PS1	5	6	20	9	4	3.02
PS2	8	8	16	8	4	2.82
PS3	4	8	18	11	3	3.02
PS4	3	14	16	10	1	2.82
GP1	3	5	10	14	12	3.61
GP2	3	5	12	16	8	3.48
GP3	3	2	10	15	14	3.8
GP4	4	4	7	15	14	3.7

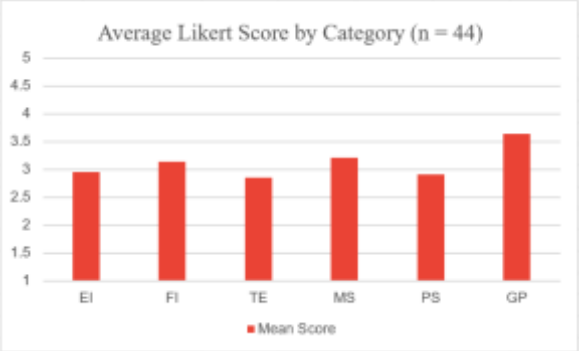
3.5 Visual Summary

Fig. 1 illustrates construct means (EI … GP) with 95 % confidence bars; the Likert axis is bounded 1–5.

3.6 Cross-Tab Analysis

Founder (n = 28) versus investor/mentor (n = 8) means are compared in **Table 5**. Investors rate funding more favourably (3.40) than founders (3.05), $t(34) = 2.11$, $p < 0.05$; both groups rate talent < 3.

Table 5. Cross-Tab Insight (Founders vs Investors)



Construct	Founders (n = 28)	Investors/Mentors (n = 8)
FI	3.05	3.40
TE	2.79	3.10

Investors rate funding availability slightly higher (3.40) than founders (3.05), while both groups view talent as weak (< 3).

3.7 Qualitative Themes

Twenty-seven open-ended responses yielded three dominant themes (**Fig. 2**): (i) seed-to-Series-A funding gap (11 mentions), (ii) limited R&D labs/prototyping access (9) and (iii) brain drain of skilled engineers (7).

From 27 open-ended comments:

Theme	Mentions	Illustrative Quote
Funding gap (seed to Series A)	11	"Investors still prefer fast-moving consumer plays."
Lack of R&D labs/prototyping	9	"Hard to find accessible hardware labs outside metros."
Talent retention/brain drain	7	"Our best AI engineers leave for US or EU roles."

3.8 Summary of Findings

1. Infrastructure, talent and policy (< 3) corroborate literature citing under-investment in labs and R&D.
2. Moderate optimism in mind-set and funding (> 3) suggests viability if other gaps close.
3. High GP (3.60) confirms China as the benchmark and signals urgency for accelerated support.

These outcomes support H_1 (ecosystem weakness), H_2 (funding constraints), H_3 (talent gap) and H_5 (policy shortfall); they partly address H_4 and align with H_6 regarding China's perceived advantage.

(Abbreviations first introduced in Sec. 2 are reused here: EI, FI, TE, MS, PS, GP.)

4. DISCUSSION

This study set out to pinpoint the ecosystem constraints impeding Indian deep-tech start-ups and to compare stakeholder perceptions with China's trajectory. The survey results corroborate four of the five core hypotheses and partially address a fifth.

Infrastructure and talent remain primary bottlenecks. Mean scores for Ecosystem & Infrastructure (EI = 2.96) and Talent & Education (TE = 2.86) fall below the neutral midpoint, aligning with earlier reports that India invests less than 1 % of GDP in R&D and lacks shared prototyping facilities. Item EI_1's neutral-leaning distribution (Table 3) reinforces respondents' limited confidence in regional lab access. The lowest individual mean (TE_4 = 2.61) highlights perceived skill mismatches and ongoing brain-drain.

Funding and founder mind-set show cautious optimism. Funding & Investment (FI = 3.14) and Mind-set & Strategy (MS = 3.21) exceed neutral, suggesting modest improvements in domestic risk capital and founder ambition. However, the founder–investor cross-tab (Table 5) reveals that investors judge capital availability more favourably than do founders ($p < 0.05$), signalling a perception gap that could hinder deal flow.

Policy support is viewed as only partly effective. Policy & Support (PS = 2.92) hovers just under neutral, indicating that broad initiatives such as *Startup India* have yet to address deep-tech specifics—echoing NITI Aayog's (2024) call for a targeted National Deep-Tech Startup Policy.

China remains the benchmark. The Global Perspective block yields the highest construct mean (GP = 3.60), confirming consensus that Chinese start-ups lead in EVs, AI and semiconductors while signalling belief that India can catch up if ecosystem gaps close. This perception supports Hypothesis H_6 and mirrors Business Standard's (2025) coverage of Minister Piyush Goyal's critique.

Qualitative insights validate quantitative trends. Open-ended comments (Fig. 2) repeatedly cite seed-to-Series-A funding gaps, limited advanced labs and talent attrition. These themes triangulate with low EI and TE means and buttress hypotheses H_1, H_2, H_3 and H_5.

Limitations and future work. Purposive sampling restricts generalisability, and the modest sample (n = 44) limits inferential power. Future studies should employ probability sampling and include longitudinal tracking to gauge policy impacts—particularly India's forthcoming semiconductor fabs and DARPA-style deep-tech directorate.

Overall, the evidence underscores that while founder ambition and early-stage funding are improving, structural deficits in infrastructure, specialist talent and targeted policy currently prevent India from matching China's deep-tech momentum.

5. CONCLUSIONS

This survey-based study quantified ecosystem constraints that impede deep-tech start-ups in India and contrasted them with China's trajectory. Analysis of forty-four stakeholder responses across five constructs—Ecosystem & Infrastructure (EI), Funding & Investment (FI), Talent & Education (TE), Mind-set & Strategy (MS) and Policy & Support (PS)—plus a comparative block (GP) yields three overarching conclusions.

1. **Structural gaps persist**. Sub-neutral means for EI (2.96), TE (2.86) and PS (2.92) confirm shortages of advanced laboratories, specialised talent and deep-tech-specific policy instruments, supporting hypotheses H1, H3 and H5.
2. **Cautious optimism is emerging**. Slightly positive scores for FI (3.14) and MS (3.21) indicate improving access to early-stage capital and a growing founder appetite for long-gestation ventures, partially validating H2 and H4.
3. **China remains the benchmark**. The highest construct mean (GP = 3.60) affirms stakeholder consensus that Chinese start-ups lead in electric vehicles, AI and semiconductors, yet respondents believe India could close the gap given stronger R&D investment and domestic capital depth (H6).

These findings fulfil the study's first four research objectives by (i) evaluating ecosystem support, (ii) gauging funding availability, (iii) comparing India's position with China, and (iv) capturing stakeholder perceptions. While purposive sampling and n = 44 limit external generalisation, convergent quantitative and qualitative evidence presents a credible snapshot of India's deep-tech landscape. Future work should employ probability sampling and longitudinal tracking to evaluate the impact of India's nascent semiconductor mission and proposed DARPA-style directorate.

6. RECOMMENDATIONS

Drawing on the empirical findings (Sec. 3) and synthesis (Sec. 4), this section proposes targeted actions for each stakeholder group to accelerate India's deep-tech trajectory and narrow the India–China gap. **Table 6** summarises the most urgent, high-leverage measures.

6.1 Government and Policy-Makers

Gap	Recommended Action	Expected Impact
GERD[1] < 1 % of GDP	Raise GERD to ≥ 1.5 % by 2028; ring-fence ≥ 50 % of the increment for AI, semiconductors and biotech	Larger pipeline of commercialisable IP and talent
Fragmented, slow grants	Create a single-window **Deep-Tech Mission Directorate** (DARPA-like) issuing milestone-based grants within 90 days	Reduces bureaucracy; de-risks early R&D
Import bottlenecks	Zero-rate customs on R&D-grade chips, lab instruments and prototype components for recognised deep-tech start-ups	Faster prototyping; cost parity with Chinese peers

Talent leakage	Launch **PhD-to-Start-up fellowships** with a five-year income-tax waiver for STEM doctor-founders commercialising work in India	Retains high-skill researchers; links academia to venture creation

[1]Gross domestic expenditure on R&D.

6.2 Incubators and Accelerators

Gap	Recommended Action	Expected Impact
Limited specialised infrastructure	Establish shared **hard-tech labs** (clean rooms, 3-D printers, RF testbeds) co-funded by industry and government	Cuts capex for early-stage hardware ventures
Generic mentorship	Deploy sector-specific mentor pools (chip design, robotics, biotech) leveraging returning diaspora experts	Higher relevance; steeper learning curves
Short cohort cycles	Extend accelerator cycles to 9–12 months with phased grants tied to technical milestones	Aligns with long R&D timelines; improves survival rate

6.3 Domestic Investors and Corporates

Gap	Recommended Action	Expected Impact
Short-term return bias	Anchor dedicated **Deep-Tech Funds** with 10–12-year horizons via the ₹10,000 cr Deep-Tech FoF (Budget 2024)	Provides patient capital; signals seriousness
Weak corporate–start-up link	Launch **Corporate Challenge Grants** (₹5–20 cr each) with co-investment in winning prototypes	Guarantees market access; risk-shares R&D
Exit uncertainty	Clarify rules for strategic acquisitions and cross-border listings (e.g., GIFT-IFSC)	Expands exit pathways; improves asset attractiveness

6.4 Academic and Research Institutions

Gap	Recommended Action	Expected Impact
Weak lab-to-market pipeline	Mandate **technology-transfer offices (TTOs)** across IIT/NIT/IISc; share licence revenue with faculty	More spin-offs; commercialises dormant IP
Low PhD output in frontier tech	Double funded PhD seats in AI, quantum and chip design; pair scholarships with start-up internships	Enlarges specialist talent pool; fosters entrepreneurship

6.5 Start-up Founders and Ecosystem Communities

1. **Leverage global talent networks** – engage diaspora experts via TiE and IndUS Entrepreneurs for short advisory stints.
2. **Adopt milestone-based fundraising** – map deliverables to technology-readiness levels (TRL-4 → TRL-9) to match investor risk.
3. **Form equipment consortia** – co-purchase or rent costly lab tools.
4. **Participate in standards bodies** – shape global protocols in EVs, semiconductors and drones.

6.6 Priority Road-Map (2024–2030)

Horizon	Critical Moves
2024–25	Activate Deep-Tech Directorate; roll out zero-duty R&D imports; launch two pilot hard-tech labs
2026–27	Scale Deep-Tech FoF; expand PhD-to-Start-up fellowships; operationalise three semiconductor fabs
2028–30	Achieve ≥ 1.5 % GERD; facilitate > 10 deep-tech IPOs/acquisitions; narrow India–China funding gap to < 2×

Implementing these measures will directly address the low-scoring constructs (EI, FI, TE, MS, PS) identified in Sec. 3 and help translate India's large STEM base into globally competitive deep-tech ventures—aligning with the national vision of *Viksit Bharat @ 2047*.

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Appendix A: Respondent Demographics and Profiles

Figure A1. Age Distribution of Respondents

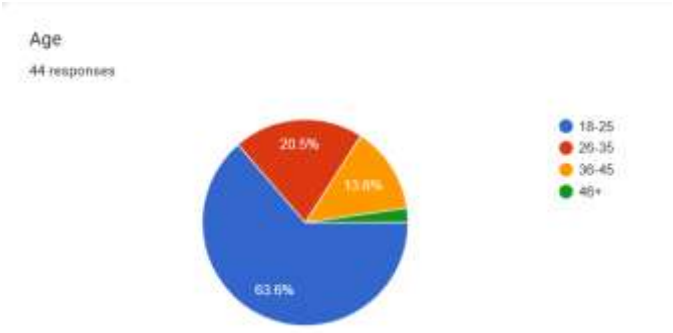

Figure A2. Gender Breakdown

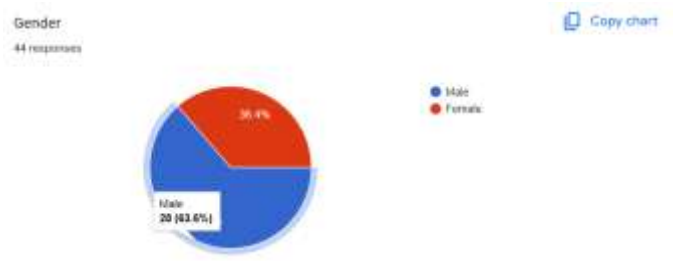

Figure A3. Role/Designation in Startup Ecosystem

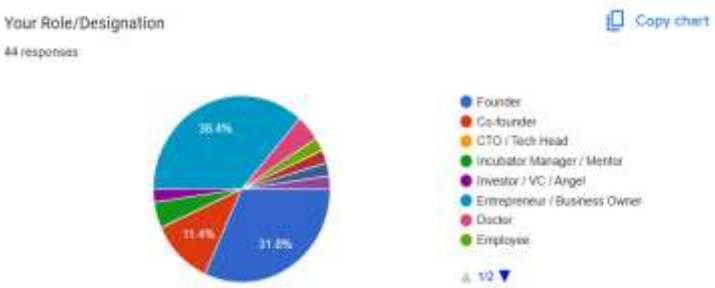

Figure A4. Geographic Distribution

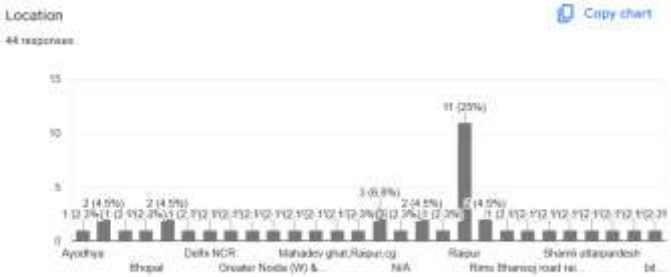

Figure A5. Years of Experience