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Criteria for Assessing Technology Maturity of Deep-Tech Projects for Venture Investment Decisions

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Abstract

This article addresses the criteria for evaluating the technological maturity of deep-tech ventures during venture investment screening. Relevance stems from the rising share of science-based startups whose value depends on reproducible performance, manufacturability, and adoption pathways rather than early revenue. Novelty lies in a synthesized maturity rubric linking technology readiness, manufacturing readiness, organizational preparedness, and investment readiness to investor risk allocation. The study reviews readiness frameworks, evidence on investment-readiness interventions, and diligence design practices, with attention given to translating laboratory results into scalable production and verified customer pull. The purpose is to formulate an analytical set of criteria for venture decision-making. Methods comprise structured literature analysis, comparative synthesis of readiness-level models, and conceptual mapping of evaluation signals to diligence steps. Sources include peer-reviewed studies and institutional guidance published between 2021 and 2025. The conclusion outlines a practical sequence for assessing maturity and documenting gaps for advanced-materials ventures and adjacent hardware-intensive deep-tech fields worldwide.

Keywords: *Technology Maturity, Venture Capital, Due Diligence, Technology Readiness Level, Manufacturing Readiness Level, Adoption Readiness, Investment Readiness, Deep Tech, Scale-Up, Advanced Materials.*

INTRODUCTION

Venture investors increasingly evaluate projects where scientific novelty and engineering feasibility define value more strongly than early commercial traction. In advanced-materials domains and other hardware-intensive trajectories, the distance between laboratory validation and repeatable industrial output creates uncertainty that cannot be reduced by market narratives alone; it requires structured evidence across development, production, and adoption pathways. The literature on investment readiness suggests that investor selection depends not only on a firm's intent to raise equity, but also on observable signals that reduce information asymmetry and support credible growth planning [2]. Meanwhile, programmatic interventions can raise judged readiness scores, even when longer-run outcomes remain modest [3]. In parallel, institutional readiness frameworks propose staged evidence for manufacturability and supply chain feasibility [8], while adoption-oriented constructs emphasize end-user uptake conditions beyond technical performance [7].

The goal of the article is to formulate a coherent set of criteria for assessing technology maturity that aligns deep-tech engineering evidence with venture decision processes. The study addresses three objectives:

1) to systematize maturity signals across technology validation, manufacturability, and adoption readiness;

2) to connect these signals to diligence artifacts and investor decision gates, including governance and integrity checks highlighted by recent diligence critiques [1];

3) to develop an evidence-linked rubric suitable for consulting practice at the intersection of innovation and business, with examples framed for advanced-materials projects.

Novelty is achieved through integration of heterogeneous readiness models into a single evaluation sequence that maps maturity gaps to concrete documentation requirements and risk allocation patterns.

MATERIALS AND METHODS

The literature base comprised peer-reviewed studies and institutional guidance published between 2021 and 2025 that describe readiness measurement, venture screening, and diligence design. V. Aran and N. Packin [1] analyzed structural weaknesses in venture diligence and the implications for verification practices; C. Alexakis, P. Gogas, G. Petrella, M.

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Polemis, and F. Salvadè [2] examined determinants and prediction of investment readiness using machine learning on European SME survey data; A.P. Cusolito, E. Dautovic, and D. McKenzie [3] evaluated an investment-readiness intervention via a randomized experiment; C. Eckerle and O. Terzidis [4] proposed an impact-oriented diligence design for startups; N. Gerdsri and S. Manotungvorapun [5] developed a lean readiness assessment framework for startup growth; D.C. Lowe, L. Justham, and M.J. Everitt [6] proposed a multi-index readiness approach for decision support; Sandia National Laboratories [7] presented Adoption Readiness Levels as a structured approach to uptake assessment; U.S. Department of Defense [8] detailed Manufacturing Readiness Levels and evidence expectations for production progression; United Nations Development Programme [9] summarized ecosystem conditions shaping deep-tech translation into societal and economic value; V. Uren and J.S. Edwards [10] provided empirical evidence on organizational journeys toward AI adoption, stressing multi-factor readiness beyond technology alone.

For writing the article, the methods comprised critical analysis of sources, comparative synthesis of readiness frameworks, and analytical mapping of maturity signals to diligence steps and documentation artifacts. No experimental study was performed; conclusions are drawn from the structured integration of published evidence and guidance.

RESULTS

Across the reviewed sources, technology maturity in venture screening emerges as a composite property, resting on proof of technical performance, reproducibility under controlled variation, manufacturability under cost and quality constraints, and credible adoption conditions. Investment readiness research supports this composite view by treating readiness as an evaluation outcome shaped by firm traits and surrounding ecosystem conditions [2]. At the same time, experimental evidence indicates that structured preparation can improve judged readiness scores in investor-style evaluations [3]. For deep-tech ventures, this implies that a maturity assessment cannot remain at the level of scientific novelty; it requires a staged dossier that anticipates investor verification and operational scaling.

A first cluster of criteria pertains to the quality of evidence for the underlying technology. Investors typically seek not a single "best result" but stability of performance under boundary conditions, traceability of test protocols, and defensible measurement chains. In advanced-materials work, this translates into documented characterization methods, repeatable synthesis routes, and clear links between microstructure, processing parameters, and functional outcomes. Without these links, later manufacturing scale decisions remain under-specified, which amplifies investor uncertainty and shifts negotiations toward harsher terms. Diligence critiques emphasize that insufficient verification creates vulnerability to misrepresentation and post-investment surprises, reinforcing the need for auditable evidence packages rather than founder narratives [1].

A second cluster concerns manufacturability and the transition to production. The Manufacturing Readiness Level framework formalizes progression from laboratory processes toward pilot and full-rate production by requiring explicit evidence on process capability, quality management, tooling, facilities, supply chain, and cost realism [8]. In venture screening, these expectations can be translated into criteria such as the existence of a process flow with measurable control points, defined critical quality attributes, preliminary yield and scrap logic grounded in known physics and process variability, and supplier qualification plans. For hardware-intensive deep tech, these criteria reduce the "scale surprise" where unit economics collapse during ramp-up despite strong lab performance. When applied to materials projects, manufacturability criteria further demand consistency of feedstock, stability of precursor quality, and reproducible deposition or synthesis at larger batch sizes, which should be supported by documented failure analyses and corrective actions aligned with production learning loops [8].

A third cluster addresses adoption and user uptake. Adoption Readiness Levels frame maturity as a function of user integration, operational fit, and the presence of enabling complements such as standards, training, and deployment pathways [7]. This perspective shifts evaluation from "works in principle" to "works for a user under real constraints." For venture screening, adoption criteria can be operationalized as evidence of a defined user segment, integration plans with existing workflows, and a credible path from pilot to recurring use. In advanced-materials settings, adoption readiness may depend on qualification cycles, certification routes, and procurement norms that constrain the speed of uptake even when performance advantages exist. Ecosystem analyses highlight that the translation of deep-tech is influenced by institutional capacity, financing instruments, and innovation infrastructure that support testing, certification, and scale-up services [9]. As a result, maturity assessment benefits from incorporating ecosystem-anchored criteria, including access to testbeds, partnerships with manufacturing integrators, and pathways to regulated markets where relevant [9].

A fourth cluster concerns organizational preparedness and execution capacity, treated in empirical adoption research as a multi-factor journey where people, processes, data, and governance interact with technology readiness [10]. Although [10] focuses on AI adoption, the underlying logic extends to deep-tech commercialization: successful translation depends on cross-functional coordination, resource allocation, and governance arrangements that prevent laboratory work from remaining isolated. For venture investors, this yields criteria centered on team competence distribution (science, engineering, production, commercialization), decision rights for technical changes, and documentation discipline sufficient for audits and partner onboarding.

The integration of these clusters benefits from a visual synthesis of staged readiness logic. Figure 1 presents readiness as a progression that aligns multiple readiness dimensions into a unified growth pathway [5]. This integration is functional for venture assessment because it encourages investors and founders to treat gaps as tractable work packages rather than vague uncertainty.

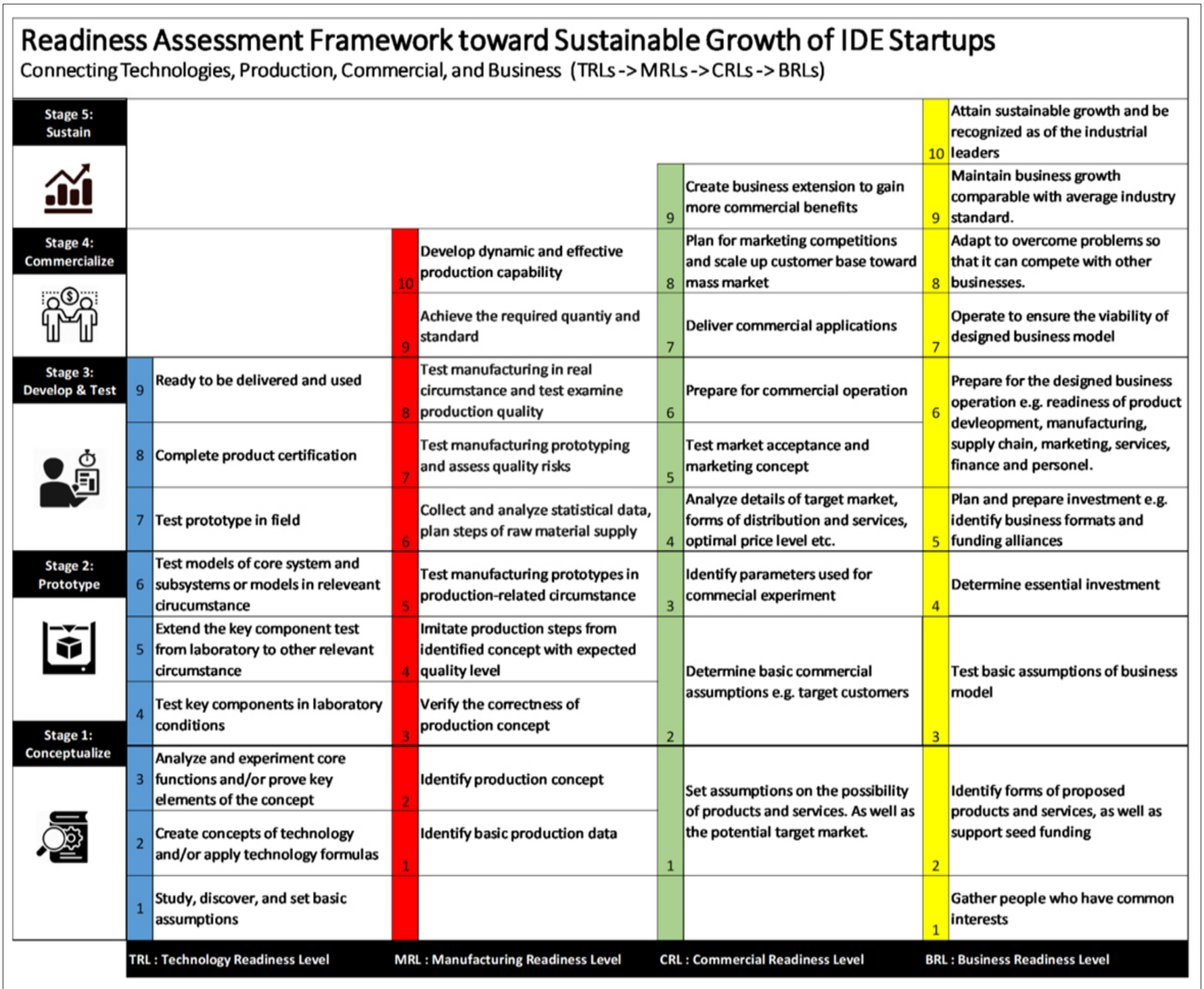

Figure 1. Readiness Assessment for Sustainable Growth of IDE Startups [5]

Taken together, the results support an evidence-linked rubric for venture decision-making. In practical diligence, criteria can be organized as a staged sequence:

i) technical evidence integrity and reproducibility;

ii) manufacturability evidence and production learning plan;

iii) adoption conditions and integration feasibility;

iv) organizational execution capacity and governance;

v) investment readiness signals and narrative coherence for equity financing [2], with explicit safeguards against weak verification practices noted in diligence critiques [1].

The sequence reduces ambiguity by clarifying what documentation resolves which uncertainty class, allowing founders and consultants to build maturity dossiers that match investor verification behavior.

DISCUSSION

The integrated view of maturity clarifies why deep-tech ventures often face evaluation friction: investors compress heterogeneous uncertainties into a single "risk" label, while engineering teams distribute uncertainty across measurement, process, supply chain, and qualification cycles. A structured rubric helps convert this mismatch into explicit diligence artifacts and staged commitments. Evidence from investment-readiness studies suggests that evaluation outcomes improve when firms receive structured preparation for investor-style assessments [3]. That readiness correlates with ecosystem conditions and firm structural traits that are measurable at scale [2]. This suggests that maturity criteria should not be limited to laboratory achievements; instead, they should incorporate organizational and ecosystem signals that influence the execution probability.

Before detailing the mapping, Table 1 consolidates the maturity dimensions, observable signals, and diligence artifacts, which are grounded in the reviewed sources. The table is designed for analytical screening and consulting diagnostics rather than compliance checklists; each signal is linked to a document or proof object that investors can verify.

Table 1. Evidence-linked maturity criteria for venture screening of deep-tech projects [1–3; 5; 7–10]

Maturity dimension	Observable signal in practice	Typical diligence artifact
Technical reproducibility	Performance stability under parameter variation; traceable test protocols	Test reports, protocol repository, metrology traceability notes
Process definition	Documented process flow with control points and critical variables	Process map, control plan, and early SPC outline
Quality and yield logic	Defined quality attributes and failure modes linked to process steps	FMEA / cause analysis notes, yield model assumptions
Supply chain feasibility	Identified materials inputs and supplier qualification approach	Supplier list, qualification plan, risk register
Adoption pathway	User integration plan, pilot design tied to operational constraints	Pilot plan, integration requirements, training outline
Organizational execution	Cross-functional coordination plan, governance for technical change control	Org chart, decision rights matrix, documentation workflow
Investment readiness	Coherent equity story aligned with growth planning and ecosystem capacity	Pitch deck with evidence annex, milestone budget logic

A second analytical layer concerns how maturity gaps are translated into investor terms: staged financing, covenants, liquidation preferences, and board control often serve as substitutes for missing evidence. Diligence critiques highlight systemic weaknesses when verification is underfunded or rushed, which increases tail risk and fosters reactive governance [1]. For founders and consultants, a maturity rubric creates a more defensible negotiation position by pre-empting these governance substitutions with credible documentation.

Table 2 maps recurring maturity gaps to mitigation actions and the evidence base that supports each linkage. The intention is to convert abstract uncertainty into time-bounded work packages that can be priced into milestones.

Table 2. Mapping maturity gaps to mitigation actions and verification logic [1–3; 5; 7–10]

Typical gap observed in deep-tech ventures	Investor concern translated from the gap	Mitigation action framed as a work package
"Lab result without repeatability envelope"	Performance collapses under scale or environmental variation	Replication plan, sensitivity analysis, standardized protocol set
"Prototype works, production path unclear"	Unit economics and delivery risk during ramp-up	MRL-aligned manufacturing plan, pilot tooling roadmap, and early quality system
"Pilot interest, weak uptake conversion"	Adoption stalls after trials	ARL-aligned integration plan, user workflow validation, and enablement materials
"Team strong in R&D, thin in operations"	Execution failure during scale transition	Governance redesign, hiring plan tied to milestones, documentation discipline
"Investor pitch detached from ecosystem constraints."	Unrealistic timelines for certification, partnerships, and infrastructure	Partnership strategy, testbed access plan, staged market entry
"Preparedness for investor evaluation is low."	Mispriced risk and weak credibility in committees	Structured investment-readiness preparation and evidence annexing

The discussion supports a practical implication: maturity assessment becomes more credible when it treats verification, manufacturability, and adoption as co-evolving tracks with explicit artifacts. For advanced-materials ventures, this approach reduces friction between scientific novelty and investor expectations by reframing maturity as documented engineering progress coupled with verifiable execution capacity. A consultant working at the innovation–business interface gains leverage when maturity criteria are expressed in investor language (risk allocation, milestone gating), while remaining grounded in engineering evidence standards [8]. This dual framing prevents performative storytelling from replacing verification.

CONCLUSION

The article developed an evidence-linked set of criteria for assessing technology maturity in deep-tech venture screening by integrating four maturity tracks: reproducible technical evidence, manufacturability progression, adoption readiness, and organizational preparedness.

The systematization objective was met by consolidating readiness frameworks and readiness-related empirical findings into a single rubric that specifies which proof objects reduce each uncertainty class. The linkage objective was addressed by mapping criteria to diligence artifacts and by highlighting verification weaknesses that motivate stricter investor governance when evidence is thin. The applied objective was fulfilled through two analytical tables that translate maturity gaps into mitigation work packages, and through a figure-based synthesis that helps structure maturity documentation for advanced materials and related deep-tech ventures. The resulting sequence supports more disciplined venture decision-making and more defensible founder preparation for equity financing under conditions of asymmetric information.

REFERENCES

1. Aran, Y., & Packin, N. G. (2024, May 1). *Due diligence dilemma* (University of Illinois Law Review, Vol. 2025; European Corporate Governance Institute—Law Working Paper No. 849/2025). SSRN. https://doi.org/10.2139/ssrn.5273659
2. Alexakis, C., Gogas, P., Petrella, G., Polemis, M., Salvadè, F., & Salvadè, F. (2025). Investigating the investment readiness of European SMEs: A machine learning approach. *International Review of Financial Analysis, 105*, 104439. https://doi.org/10.1016/j.irfa.2025.104439
3. Cusolito, A. P., Dautovic, E., & McKenzie, D. (2021). Can government intervention make firms more investment ready? A randomized experiment in the Western Balkans. *The Review of Economics and Statistics, 103*(3), 428–442.
4. Eckerle, C., & Terzidis, O. (2024). Designing impact due diligence for startups. *Journal of Business Venturing Design, 3*, 100020. https://doi.org/10.1016/j.jbvd.2024.100020
5. Gerdsri, N., & Manotungvorapun, N. (2021). Readiness assessment for IDE startups: A pathway toward sustainable growth. *Sustainability, 13*(24), 13687. https://doi.org/10.3390/su132413687
6. Lowe, D. C., Justham, L., & Everitt, M. J. (2024). Multi-index analysis with readiness levels for decision support in product design. *Technological Forecasting and Social Change, 206*, 123559. https://doi.org/10.1016/j.techfore.2024.123559
7. Sandia National Laboratories. (2024). *Using Adoption Readiness Levels (ARLs) to assess your technology* [Slide deck]. https://www.sandia.gov/app/uploads/sites/256/2024/09/ARL-Slides.pdf
8. U.S. Department of Defense. (2025). *Manufacturing Readiness Level (MRL) deskbook* (May 2025). https://www.dodmrl.com/MRL_Deskbook_2025.pdf
9. United Nations Development Programme. (2025). *Global deep tech ecosystems*. https://www.undp.org/sites/g/files/zskgke326/files/2025-06/undp-global-deep-tech-ecosystems.pdf
10. Uren, V., & Edwards, J. S. (2023). Technology readiness and the organizational journey towards AI adoption: An empirical study. *International Journal of Information Management, 68*, 102588. https://doi.org/10.1016/j.ijinfomgt.2022.102588