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Deep tech firm navigation over the "death valley": strategy and funding pathways for success

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Abstract: This study examines how funding pathway choices shape strategic development trajectories in deep tech firms. Applying event analysis to 87 ventures across Estonia, Lithuania, and Latvia over 2005–2021, the study draws on archival data, founder interviews, and €1.12 billion in funding. Four configurations emerged: accelerated venture capital (n=16, 18%), hybrid grant-then-equity (n=47, 54%), corporate partnership (n=4, 5%), and grant-dependent (n=20, 23%). Hybrid and Accelerated VC pathways achieved valley-of-death crossing rates of 47% and 44%, respectively, while the grant-dependent pathway yielded zero commercialisation successes, revealing a structural ceiling at the technology-to-market transition. Success required alignment between funding characteristics and venture-specific conditions: technology readiness, market structure, and ecosystem maturity. Findings extend Shane and Venkataraman's (2000) opportunity exploitation framework, demonstrating path-dependent strategic choices with lasting consequences for development trajectories, market entry, and partnership strategies.

Keywords: Deep technology; valley of death; funding pathways; entrepreneurial finance; innovation strategy; venture capital; government grants; strategic development; entrepreneurial ecosystems; opportunity exploitation.

1 Introduction

Deep technology ventures, built on substantial scientific or engineering breakthroughs, face extended R&D cycles, high capital intensity, and radical technological uncertainty - a commercialisation challenge widely termed the "valley of death". Spanning Technology Readiness Levels (TRL) 4-7, this transition marks the gap between proof-of-concept validation and market-ready products, where ventures exhaust early-stage research funding before generating sufficient revenue to sustain operations (Rothaermel and Thursby, 2005; Nedayvoda et. al., 2021). Unlike software startups, deep tech ventures require €5–50 million and 8–12 years to bridge this gap (Budden, Murray and

Ukuku, 2021) - a mismatch with conventional venture capital horizons of 5-7 years that deters risk-averse capital precisely when transformative innovations need it most.

Despite over €10 billion committed through Horizon Europe (2021–2027) and the European Innovation Council (European Commission, 2024), the literature has examined funding instruments largely in isolation: government grants (Lerner, 2002), venture capital (Gompers and Lerner, 2001), and corporate partnerships, without analysing how they combine or vary across contexts. Romme and Frericks (2023), Mittelmeijer et al. (2024), Romme (2022), and Muren et al. (2023) have advanced the design and contextual understanding of valley-of-death interventions, yet a critical empirical question remains: how do funding pathway configurations, rather than individual instruments, shape opportunity exploitation in deep tech ventures navigating the TRL 4-7 transition, particularly in smaller ecosystems where patient capital is structurally scarce?

This study addresses that question through longitudinal analysis of 87 deep tech ventures across Estonia, Lithuania, and Latvia, supplemented by five semi-structured founder interviews. Three contributions follow. First, the study extends Shane and Venkataraman's (2000) opportunity exploitation framework, demonstrating that valley-of-death navigation depends on strategic sequencing of capital sources, not total funding volume. Second, pathway effectiveness is domain-contingent: the Hybrid pathway dominates capital-intensive hardware sectors, while the Accelerated VC pathway is viable only where capital requirements are moderate and development cycles short. Third, a structural funding cliff specific to smaller ecosystems is identified.

2 Theoretical background and literature review

Defining the valley of death: a technology readiness perspective

The term "valley of death" has become a central metaphor in innovation and entrepreneurship literature to describe a critical funding gap that threatens the survival of technology ventures. The valley of death represents the period during which a technology venture has exhausted initial seed funding (typically supporting TRL1-3) but has not yet achieved sufficient market traction, revenue generation, or de-risked technology validation to attract substantial private investment for scaling (TRL7-9) (Auerswald & Branscomb, 2003). During the mid-TRL stages (TRL4-7), ventures face a "funding chasm" where capital requirements escalate dramatically - often from $500.000 at TRL3 to $5-50 million at TRL6-7, while traditional funding sources become scarce or inaccessible (Romme & Frericks, 2023; Nedayvoda et al., 2021).

Overall deep tech mortality: 60-80% of ventures fail to cross from TRL5 to TRL7, either shutting down operations or remaining perpetually undercapitalized and unable to scale (In et al., 2020)

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Table 1 Distinctive characteristics of deep tech ventures and valley of death implications

TRL stage	*Description*	*Typical funding sources*	*Valley of death status*	*References*
TRL1 Basic principles	Basic principles observed and reported; fundamental scientific research	Government grants, university research budgets	Pre-valley: funding available through academic research programs	Belz et al. (2021)
TRL2 Concept formulation	Technology concept and/or application formulated; initial feasibility studies	Government grants (NSF, NIH), early SBIR Phase I	Valley entry: projects enter programs but face selection bias toward established firms	Belz et al. (2021)
TRL3 Proof of concept	Analytical and experimental critical function and/or characteristic proof of concept	Phase II, university-industry partnerships	Early valley: transition from pure research to applied development begins	Nedayvoda et al. (2021)
TRL4 Component validation	Component and/or breadboard validation in laboratory environment	Limited public funds, scarce private investment	Deep valley: well-documented barrier; component validation achievable but system integration funding scarce	Nedayvoda et al. (2021)
TRL5 Component validation in relevant environment	Component and/or breadboard validation in relevant environment	Demonstration programs, strategic partnerships	Deepest valley: programs can reach TRL5 but funding cliff prevents progression to system integration	Belz et al. (2021); Nedayvoda et al. (2021)
TRL6 System/subsystem demonstration in relevant environment	System/subsystem model or prototype demonstration in relevant environment	Rare bridge funding, corporate partnerships	Critical barrier: risk too high for private investors, public demonstration funds limited; commercialization barrier	Romme & Frericks (2023)
TRL7 System prototype demonstration in operational environment	System prototype demonstration in operational environment	Industry procurement, venture capital (late-stage)	Valley exit: requires high capital; operational demonstration stage many projects fail to reach	Mäkivirta (2025)
TRL8 System complete	Actual system completed and qualified	Venture capital, corporate investment, strategic buyers	Post-valley: commercial financing becomes accessible with proven technology	Belz et al. (2021)
TRL9 System proven	Actual system proven through successful mission operations	Commercial revenue, growth capital, IPO/acquisition	Commercial stage: market validation achieved; traditional financing available	Nedayvoda et al. (2021)

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The valley of death in deep technology ventures

Unlike conventional technology startups that may leverage existing technologies in novel applications or business models, deep tech firms pursue breakthrough innovations that require substantial additional research and development before achieving commercial viability (Branscomb and Auerswald, 2002). Conventional growth metrics, such as the “5% growth per week” benchmark often applied to digital startups (Aulet and Murray, 2013), prove unattainable for deep tech ventures in their early stages. This temporal misalignment is exemplified by companies like Moderna and BioNTech, both founded in 2012, which required nearly a decade of patient capital investment before achieving 'unicorn' status - a timeline that would fail traditional rapid-growth tests applied to digitally-focused ventures (Aulet and Murray, 2013).

Table 2 Distinctive characteristics of deep tech ventures and valley of death implications

Characteristic	*Description*	*Valley of death implication*	*References*
Extended R&D cycles	Development timelines spanning 5-10+ to market-ready products	Sustained capital requirements before revenue generation	Branscomb and Auerswald (2002); Romme and Frericks (2023)
Capital intensity	Specialized equipment, facilities, materials, and highly skilled personnel creating significant fixed costs	Tens of millions of dollars required before achieving commercial scale	Marchenko (2023)
Radical technological uncertainty	Fundamental questions about technical feasibility, economic viability, and commercial attractiveness	Deters risk-averse capital despite potential for outsized returns	Knight (1921)
Science-based foundations	Breakthrough innovations from university or corporate R&D requiring proof of concept	Multiple validation stages before demonstrating technical feasibility	Vohora et al. (2004); Shane (2003)
Regulatory Complexity	Compliance requirements in fields such as biotechnology, medical devices, and advanced materials	Additional time and capital requirements for regulatory approval processes	Harrer and Owen (2022)

Opportunity search and exploitation framework

The opportunity search and exploitation framework provides the central theoretical lens for this study. Shane and Venkataraman (2000) conceptualise entrepreneurial opportunities as emerging through discovery, evaluation, and exploitation of new means-ends relationships, with resource configurations playing a central role in shaping which opportunities can be pursued and at what pace. In deep tech contexts, funding decisions represent critical strategic choices that influence capital availability, scope, and direction of opportunity search activities.

This perspective reframes the valley of death not merely as a capital problem but as a strategic alignment problem: ventures must match their funding pathway configuration to their technological maturity, market readiness, and competitive conditions at each development stage.

Funding sources and strategic implications

The entrepreneurial finance literature has identified multiple funding sources available to technology ventures, each providing not only capital but also complementary resources, expertise, and expectations that shape venture trajectories (Kerr and Nanda, 2015).

Government grants are a critical funding source for deep tech ventures, particularly in early stages when technological uncertainty is highest and private capital most scarce (Colombo et al., 2016). Beyond supply-side subsidies, mission-oriented innovation policies can shape market demand and de-risk private investment. The EU exemplifies this approach: Horizon Europe (2021–2027) and the European Innovation Council have committed over €10 billion to deep tech innovation (European Commission, 2024). Public-private hybrid instruments extend this logic further, with Nedayvoda et al. (2021) emphasising that managed transitions from grants to equity are critical for successful valley-of-death navigation.

The traditional venture capital model faces significant challenges in deep tech contexts. Extended timelines, capital intensity, and radical uncertainty strain conventional fund structures, driving the emergence of specialised deep tech VC funds. Mittelmeijer et al. (2024) propose fund designs combining VC discipline with early-stage technical support to bridge the gap between research breakthroughs and commercial viability. Empirical evidence on VC effectiveness remains mixed: In et al. (2020) identify commercial readiness and strong investor interactions as necessary conditions for successful exits, while Mäkivirta (2025) shows that both premature and delayed equity funding impair outcomes - underscoring that pathway design must account for not only which sources to pursue, but when.

Corporate partners provide access to distribution channels, customer relationships, and complementary assets, though at the risk of reduced strategic autonomy and IP constraints (Katila et al., 2008). Equity crowdfunding offers a complementary early-stage channel (Belz, 2020), while venture builders represent a more institutionalised solution, integrating grant sourcing, corporate in-kind support, and VC follow-on to systematically lower technological and commercialisation risk (Romme and Frericks, 2023). How ventures combine these options into coherent funding pathways remains a critical area for research and practice.

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Table 3 Funding sources for deep tech ventures: characteristics and strategic implications

Funding Source	*Capital characteristics*	*Complementary resources*	*Primary expectations*	*Strategic advantages*	*Strategic risks*	*Key references*
Government grants	Non-dilutive; Patient capital	Research infrastructure; Technical expertise	Scientific merit; Innovation potential	Supports fundamental research; Validation function	Bureaucratic requirements; IP restrictions	Colombo et al. (2016); Nedayvoda et al. (2021)
Venture Capital	Equity-based; 5-7 year horizons	Strategic guidance; Network access	Rapid growth; Clear exit pathways	Accelerates commercialization; Professional management	Pressure for rapid returns; Dilution of control	Gompers and Lerner (2001); In et al. (2020)
Specialized deep tech VC	Equity-based; Patient capital	Technical expertise; Industry connections	Technical milestones; Long-term value creation	Aligned with extended timelines; Technical evaluation capability	Limited availability; Selective criteria	Kerr and Nanda (2015); Mittelmeijer et al. (2024)
Corporate partnerships	Varies; Equity or non-equity	Market access; Distribution channels	Strategic alignment; Technology access	Accelerates market entry; Provides validation	Loss of strategic autonomy; IP concerns	Katila et al. (2008)
Angel investors	Equity-based; Flexible terms	Mentorship; Industry expertise	Growth potential; Founder commitment	More flexible than institutional VC	Limited capital; Variable expertise	Aulet and Murray (2013)
Equity crowdfunding	Equity or SAFE; Public platforms	Market validation; Customer engagement	Product delivery; Market traction	Direct market validation; Alternative to offline VC	Limited capital amounts; Public disclosure	Budden, Murray and Ukuku (2021)
Venture builders	Integrated funding + services	Technology sourcing; Ecosystem coordination; Talent	Systematic venture creation; Grand challenge alignment	Institutionalized valley-of-death solution; Combined grant/VC	Organizational complexity; Requires ecosystem maturity	Romme and Frericks (2023)
Public-Private Hybrids	Combined government and private capital	De-risking function; Market discipline	Policy goals; Commercial returns	Leverages patient public capital with private expertise	Complexity; Potential conflicts	Colombo et al. (2016); Nedayvoda et al. (2021)

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3 Research design and methodology

Research gaps and question

Despite growing recognition of the valley of death challenge, significant research gaps remain. Romme and Frericks (2023) and Mittelmeijer et al. (2024) provide actionable blueprints for institutionalising valley-of-death solutions, yet questions persist about the conditions under which these innovations succeed across different technological domains and geographic contexts. Ecosystem studies, including analysis of Eindhoven and Muren et al.'s (2023) evaluation of Slovenia, offer valuable contextual insights, but systematic cross-ecosystem comparisons remain limited.

Two research questions follow:

- What distinct funding pathways do deep tech ventures pursue in navigating the valley of death?
- How do these pathways shape strategic development trajectories?

These questions are addressed through event analysis of 87 deep tech ventures across Estonia, Lithuania, and Latvia, contributing to the understanding of funding strategies as path-dependent strategic choices with significant implications for venture development and success.

Event analysis approach and data collection

The study employs event analysis methodology to examine how deep technology ventures navigate the valley of death through different funding pathway configurations for identifying temporal patterns and causal sequences in organisational development (Van de Ven and Poole, 1995). Events are defined as discrete, observable occurrences marking significant venture milestones, with particular focus on two categories: funding events (grants, equity rounds, corporate investments) and strategic events (patent filings, market entry decisions, partnership formations, and product launches).

Data were constructed from three primary sources. Structured database analysis drew on Dealroom, PitchBook, and national business registries (Startup Lithuania, Startup Estonia, LIAA) to capture funding events and company characteristics. Five semi-structured interviews with founders and R&D managers provided qualitative data on strategic decision-making, funding pathway choices, and the relationships between funding decisions and venture development trajectories. Interviews lasted 30-45 minutes and covered funding strategy evolution, key strategic turning points, investor and partner relationships, and reflections on success factors and challenges encountered.

Sample selection

This study examines 87 deep tech ventures founded between 2005 and 2021 across Estonia (n=45, 52%), Lithuania (n=24, 28%), and Latvia (n=18, 21%). This distribution aligns with verified ecosystem data from the Baltics Deep Tech Report 2024 (Dealroom and Iron Wolf Capital, 2024): Estonia leads in funded startups (920+, 47.2% of the Baltic total) and VC investment (€334 million, 47.4%); Lithuania reflects strong academic foundations in biotechnology, life sciences, and laser technologies (590+ startups, 30.3%); Latvia represents the most nascent ecosystem (400+ startups, 20.5%, €73 million in 2023 VC investment).

The sample was constructed through purposeful selection to ensure venture maturity, archival record availability, and outcome variation. Included ventures are technology-intensive, grounded in novel scientific or engineering breakthroughs, and had secured at least one round of external financing. Founding between 2005 and 2021 ensures a minimum of five years of operational history by the 2025-2026 data collection period. The sample encompasses ventures with diverse outcomes: successful commercialisation, ongoing pre-commercial operations, strategic acquisitions, and discontinued operations.

The 87 ventures span eight deep tech clusters: biotechnology and life sciences (n=20, 23%); robotics, AI and software (n=16, 18%); industrial and transportation technology (n=12, 14%); aerospace, defence and space (n=11, 13%); advanced materials and manufacturing (n=10, 11%); cleantech and energy (n=8, 9%); cybersecurity and digital (n=6, 7%); and other (n=4, 5%).

Data coding and analysis

Four funding pathways were through a six-step classification logic: (1) count rounds by source type; (2) calculate equity vs. non-dilutive capital share; (3) identify temporal sequencing relative to TRL stage; (4) identify dominant investor type; (5) apply pathway criteria (≥2 must be satisfied); and (6) apply domain context adjustment.

1. Hybrid pathway combines government grants or non-dilutive public funding with private VC, sequenced to match TRL stages. Criteria (≥2): at least one grant/EIC instrument AND one VC round; evidence of temporal sequencing; EIC blended finance qualifies as hybrid; mixed equity/non-equity across ≥3 rounds.
2. Grant-dependent pathway relies primarily or exclusively on government grants, EU programme funding (Horizon Europe, EIC Pathfinder), or non-dilutive accelerator support, with private equity absent or negligible. Criteria (≥2): ≥60% of rounds are non-dilutive instruments; no VC round above €500K; private equity <20% of total disclosed funding; TRL ≤6 at classification.
3. Accelerated VC pathway is funded primarily through successive private equity rounds (seed through Series A/B/C) with minimal grant dependency. Criteria (≥2): ≥70% of rounds are VC equity; no grant >15% of total disclosed funding; sequential VC round progression; technology domain enables faster TRL progression (AI/software, SaaS, biotech tools).
4. Corporate partnership pathway is dominated by strategic corporate investors, CVC, or PE growth funds, with technology validation occurring through corporate relationships rather than independent market entry. Criteria (≥2): corporate lead investor in ≥1 major round; M&A documented as primary exit

mechanism; single PE round ≥50% of total disclosed funding; crowdfunding followed by corporate acquisition.

Outcomes were determined by applying seven data sources in strict priority order, consulting the next source only if the previous was unavailable or ambiguous: (1) PitchBook VC Exit Predictor "Success Class" - primary signal, overrides all lower priorities; (2) PitchBook "Revenue Growth (%)", supplementary traction modifier, does not override Priority 1; (3) TRL stage; (4) funding round type and total raised; (5) employee count; (6) commercialisation evidence (product launch, regulatory clearance, revenue); (7) archival records and national business registry. When PitchBook data were unavailable, Priorities 3–7 were applied in sequence.

Four outcome categories were defined:

1. Successful commercialisation (n = 25, 29%) requires all of: commercially available product to paying customers; documented revenue ≥€100K in year 2 for ≥2 consecutive fiscal years; repeatable sales process (≥3 customers across ≥2 organisations, or recurring/subscription revenue, or positive unit economics); and TRL ≥8.
2. No exit - active pre-commercial (n = 46, 53%) captures ventures continuing operations without yet achieving full commercialisation; classified as right-censored in survival analysis.
3. Acquired (n = 8, 9%) classifies acquisitions as successful when ≥2 of three criteria are met: acquisition price exceeded total capital invested; founding team characterised the outcome as successful; or acquirer integrated the technology within 24 months.
4. Discontinued (n = 8, 9%) covers ventures that formally dissolved, ceased active development for >18 consecutive months, or pivoted entirely from their original deep tech focus.

4 Results

Funding pathway distribution and characteristics

The Hybrid pathway emerged as the dominant funding configuration, accounting for 54% of the sample (n=47). This pathway was characterized by the strategic sequencing of non-dilutive grants in early stages (TRL 3-5) followed by equity investment as ventures approached market readiness. The Grant-dependent pathway represented 23% of ventures (n=20), with these firms relying almost exclusively on public funding mechanisms throughout their development trajectory. The Accelerated VC pathway accounted for 18.4% of ventures (n=16), characterized by early equity investment and rapid scaling ambitions. The Corporate partnership pathway was the least common (4.6%, n=4), involving strategic corporate investors or acquisition-oriented funding structures.

Table 4 Funding pathway distribution and characteristics

Funding pathway	*n*	*%*	*Characteristics*
Hybrid pathway	47	54.0%	Strategic combination of grants, public-private VC, impact investors, and angel networks; staged de-risking approach
Grant-Dependent Pathway	20	23.0%	Predominant reliance on non-dilutive public funding (EU Horizon, national innovation agencies, Seal of Excellence); minimal equity investment
Accelerated VC Pathway	16	18.4%	Early-stage equity investment from venture capital; rapid scaling trajectory; minimal grant funding
Corporate Partnership Pathway	4	4.6%	Strategic corporate investment or acquisition-oriented funding; industry-specific validation

Sectoral patterns emerged in pathway selection. Aerospace and Defence ventures exhibited a strong association with the Hybrid pathway (n=6 of 9 total) and Grant-dependent pathway (n=2), reflecting the capital-intensive nature and regulatory requirements of the sector. MedTech ventures similarly concentrated in the Hybrid pathway (n=6 of 8 total), consistent with extended regulatory validation timelines. Cybersecurity ventures showed greater representation in the Accelerated VC Pathway (n=3 of 4 total), reflecting the sector's compatibility with traditional venture capital investment models. Biotechnology ventures were distributed across Hybrid (n=3), Grant-dependent (n=2), and Accelerated VC (n=2) pathways, suggesting heterogeneity in funding strategies within the sector.

Outcome distribution and combined success rate

Following established entrepreneurship research conventions, the analysis employed a combined success measure that aggregated Successful commercialization and Acquired outcomes. This approach recognizes that acquisition represents a legitimate exit strategy for deep tech ventures, particularly in sectors where strategic corporate buyers seek to internalize novel technologies. The combined success rate across the full sample was 36.8% (n=32 of 87 ventures).

Table 5 Outcome distribution and country-level success rates

Outcome category	*Total sample (n=87)*	*Estonia (n=45)*	*Lithuania (n=24)*	*Latvia (n=18)*
Successful commercialization	25 (28.7%)	13 (28.9%)	9 (37.5%)	3 (16.7%)
Acquired	7 (8.0%)	2 (4.4%)	3 (12.5%)	2 (11.1%)
Combined success	**32 (36.8%)**	**15 (33.3%)**	**12 (50.0%)**	**5 (27.8%)**
No exit – active pre-commercial	47 (54.0%)	26 (57.8%)	10 (41.7%)	11 (61.1%)
Discontinued	8 (9.2%)	4 (8.9%)	2 (8.3%)	2 (11.1%)

Geographic variation in success rates was substantial. Lithuanian ventures achieved the highest success rate at 50.0% (n=12 of 24), followed by Estonian ventures at 33.3% (n=15 of 45) and Latvian ventures at 27.8% (n=5 of 18). The majority of ventures (54.0%, n=47) remained in active pre-commercial status at the time of data collection, indicating ongoing development efforts without yet achieving commercial viability or exit. The discontinuation rate was 9.2% (n=8), representing ventures that ceased operations during the observation period.

Sectoral success rates varied considerably. MedTech ventures achieved a 50.0% success rate (n=4 of 8), while Advanced Materials ventures also reached 50.0% (n=2 of 4). Aerospace and Defence ventures achieved 44.4% success (n=4 of 9), and Biotechnology ventures reached 42.9% success (n=3 of 7). Manufacturing and Robotics & AI ventures exhibited lower success rates at 20.0% (n=1 of 5 for each sector). Electronic, Cybersecurity, and Cleantech ventures each achieved 25.0% success rates.

Funding pathway and success outcomes

The corporate partnership pathway achieved the highest success rate at 75.0% (n=3 of 4 ventures), though the small sample size limits generalizability. The Hybrid pathway demonstrated a 46.8% success rate (n=22 of 47), representing the largest absolute number of successful ventures. The Accelerated VC pathway achieved a 43.8% success rate (n=7 of 16). The Grant-dependent pathway produced zero successful outcomes (0.0%, n=0 of 20 ventures), with 90% of these ventures (n=18) remaining in active pre-commercial status and 10% (n=2) discontinued.

Table 6 Outcome distribution by funding pathway

Funding Pathway	*Successful*	*Acquired*	*No Exit (Active)*	*Discontinued*	*Total*
Hybrid Pathway	18	4	22	3	47
Grant-Dependent Pathway	0	0	18	2	20
Accelerated VC Pathway	6	1	6	3	16
Corporate Partnership Pathway	1	2	1	0	4
Total	25	7	47	8	87

The outcome distribution matrix reveals distinct patterns across pathways. The Hybrid pathway produced the most balanced distribution, with 38.3% achieving successful commercialization (n=18), 8.5% acquired (n=4), 46.8% remaining active pre-commercial (n=22), and 6.4% discontinued (n=3). The Grant-dependent pathway exhibited a concentration in the active pre-commercial category (90%, n=18), with no ventures progressing to successful commercialization or acquisition. The Accelerated VC pathway showed a trimodal distribution, with equal proportions achieving successful commercialization (37.5%, n=6) and remaining active pre-commercial (37.5%, n=6), while 18.8% (n=3) discontinued operations. The Corporate partnership pathway demonstrated the highest acquisition rate (50%, n=2 of 4), consistent with its strategic corporate investor orientation.

Capital mobilization patterns

The Accelerated VC pathway mobilized the highest mean funding at €37.6 million, though the median of €5.4 million indicated substantial right-skew driven by a small number of highly-capitalized ventures. The Corporate partnership pathway exhibited a mean funding level of €24.2 million with a median of €15.0 million, reflecting more consistent capital-intensive trajectories. The Hybrid pathway demonstrated intermediate funding levels (mean €10.9 million, median €2.8 million), while the Grant-dependent Pathway mobilized dramatically lower capital (mean €333,715, median €50,000), representing a funding gap of two orders of magnitude compared to equity-backed pathways.

Ventures achieving successful commercialization mobilized mean funding of €37.1 million (median €4.9 million), while acquired ventures raised €19.2 million on average (median €9.4 million). Active pre-commercial ventures had mobilized only €2.7 million on average (median €727,500), suggesting insufficient capital to complete commercialization. Discontinued ventures had raised €4.6 million on average (median €180,000), indicating that failure occurred across a range of funding levels.

The 480 total funding rounds across the sample exhibited the following distribution by round type: Accelerator/Incubator programs (38.5%, n=185), Grant funding (15.8%, n=76), Seed round equity (12.3%, n=59), Later stage VC (6.9%, n=33), Early stage VC (4.8%, n=23), Angel investment (1.9%, n=9), and Merger/Acquisition events (1.5%, n=7). The classification of rounds into equity versus non-equity categories revealed an approximately balanced distribution, with 231 equity rounds (48.1%) and 203 non-equity rounds (42.3%), indicating that deep tech ventures in the Baltic region employed mixed capital structures combining dilutive and non-dilutive funding sources.

Qualitative findings: strategic themes from interviews

Grant-VC structural tension

Interviewees described a structural tension between grant-based funding and subsequent equity investment. A founder from a discontinued cleantech venture that had raised €8 million in grants over seven years and achieved TRL 6 pilot production articulated the challenge: "*We proved the technology worked. But there's a funding cliff at the production stage that no amount of scientific excellence can overcome*". The venture required €25-30 million for commercial-scale production infrastructure but encountered a funding gap where venture capital investors considered the venture "*too early*" while grant programs excluded production infrastructure from eligible expenses.

This signalling problem was explicitly recognized by interviewees: "*Investors need to see that you're building a company, not just a research project*", also "*Grant dependence creates path dependencies that are hard to escape*". These qualitative accounts suggest that prolonged reliance on grant funding may signal research orientation rather than commercial viability to equity investors, creating a structural barrier to pathway transition at critical scaling stages.

The structural challenges collaborating in the Horizon Europe consortium was noted, referring to example: "*Out of eight partners in the specific field, only two include* *companies, with the rest being purely academic consortiums not oriented toward commercialization*". Despite receiving a Seal of Excellence designation, the venture's national funding was discontinued after two years, forcing reliance on international grant programs with academic consortium structures that did not support commercial objectives.

Hybrid pathway strategic logic

Interviews with ventures that successfully navigated the Hybrid pathway revealed a deliberate strategic logic underlying the combination of funding sources. A MedTech venture founder explained: "*The strategic combination of grants, public-private VC, impact investors, and angel networks enabled us to progress through extended development cycles while maintaining strategic flexibility and capital efficiency*". This venture had completed seven funding rounds totaling €6.9 million, combining EU Horizon grants, national innovation agency funding, impact investment, and angel capital to reach TRL 8 and achieve successful commercialization.

The founder emphasized that success depended on "*alignment between funding characteristics: patient capital, impact focus, ecosystem support and venture-specific conditions, such as regulatory requirements, clinical validation needs, market adoption timelines".* This statement confirms that the Hybrid pathway functions as a staged de-risking strategy, where non-dilutive grants fund early-stage technical validation (TRL 3-5), reducing technological uncertainty before equity investors enter at later stages (TRL 6-8) when commercial risk becomes the primary concern.

The double valley of death in biotechnology

A biotechnology spin-off founder described sector-specific challenges that differentiate biotechnology from other deep tech domains: "*Creating a laboratory-scale solution doesn't directly translate to larger scales because laboratory conditions are controlled, but conditions change at each scaling stage*". This "*double valley of death*" phenomenon reflects the fact that biological systems require additional research and validation at each scaling increment, unlike digital or software-based technologies where minimum viable products can be deployed at small scale and scaled incrementally.

Ecosystem maturity and Acceleration gaps

Multiple Lithuanian interviewees identified ecosystem infrastructure gaps that constrained venture development. One founder noted: *"The closest international acceleration opportunities are in Estonia and Poland. Existing programs lack the financial component necessary to compete and scale internationally".*

5 Discussion and conclusions

The 36.8% combined success rate (n=32 of 87) demonstrates that crossing the valley of death is achievable through the strategic sequencing of funding sources not the aggregate amount raised. This finding extends Shane and Venkataraman's (2000) opportunity exploitation framework by demonstrating how early funding decisions constitute path-dependent strategic choices with lasting consequences for technological development trajectories, market entry timing, and partnership strategies.

Hybrid and Accelerated VC pathways as valley of death navigation strategies

The Hybrid pathway (n=47, 54%) achieved a 46.8% success rate by sequencing non-dilutive public capital at early TRL stages (4-6) with equity investment at later stages (TRL 7–9). This staged de-risking logic aligns with Nedayvoda et al.'s (2021) argument that sequential financing reduces information asymmetry and signals technological credibility to subsequent investors. Founder interviews corroborated this mechanism: one MedTech entrepreneur described grant funding as "*the only way to reach the point where investors could even evaluate us"* before securing Series A capital. The Hybrid pathway is particularly suited to capital-intensive hardware and life sciences domains where development cycles are long and proof-of-concept milestones are costly, consistent with Mittelmeijer et al.'s (2024) analysis of blended finance instruments for deep tech.

The Accelerated VC pathway (n=16, 18%) achieved a comparable 43.8% success rate but through a fundamentally different mechanism: speed. By bypassing extended grant cycles and accessing equity capital early, these ventures compressed their development timelines, reducing exposure to the valley of death rather than systematically de-risking it. This approach is viable primarily in capital-efficient software-adjacent domains where TRL progression is faster and market feedback loops are tighter, consistent with Auerswald and Branscomb's (2003) characterisation of the valley of death as a time-bounded resource gap. The mean capital mobilised by Accelerated VC ventures (€37.6M) reflects the higher risk premium demanded by investors who absorb technological uncertainty at earlier stages.

Grant-dependent pathway: structural ceiling, not stepping stone

The Grant-dependent pathway (n=20, 23%) yielded a 0% commercialisation success rate. This is not attributable to technological failure: ventures on this pathway reached a mean TRL of 6.2, indicating substantive technical progress. Rather, the structural ceiling arises from a mismatch between grant programme design and the capital requirements of the TRL 6–8 transition. Grant instruments are typically calibrated for research and proof-of-concept activities, leaving a systematic funding gap at the production-readiness and market-entry stages (Lerner, 2002; Mäkivirta, 2025). Interview evidence reinforced this interpretation: a robotics/AI founder noted that repeated grant success paradoxically "*trained us to write proposals, not to sell*", thus creating an organisational capability misalignment that impeded investor engagement. A discontinued cleantech venture further illustrated how grant-dependent signalling actively deterred equity investors, who interpreted the absence of private co-investment as a negative quality signal. These findings suggest that grant instruments, absent deliberate transition mechanisms toward equity, function as a trap rather than a bridge across the valley of death, with direct implications for the design of public-private blended finance programmes (Mittelmeijer et al., 2024).

Corporate partnership pathway and sectoral variation

The Corporate Partnership pathway (n=4, 4.6%) achieved the highest success rate (75%), primarily through acquisition exits. This pathway is structurally distinct: corporate partners absorb valley of death risk through strategic interest rather than financial return expectations, compressing the timeline to commercial deployment.

Theoretical contributions and limitations

By framing research findings within Shane and Venkataraman's (2000) opportunity exploitation framework, the study offers two theoretical insights: suggesting that funding pathway configuration, rather than capital volume that may serve as a key determinant of valley-of-death navigation success, and indicating that the grant-dependent pathway can function as a structural constraint within current public innovation finance architecture that, absent deliberate transition mechanisms toward equity, may limit rather than support commercialisation.

This study establishes a foundational understanding of deep tech funding pathways in the Baltic region using archival longitudinal methods, which naturally introduce scope constraints that future research can productively address. The qualitative component (n=5 interviews) and archival databases with systematic gaps in early-stage capital rounds represent an opportunity to deploy larger-scale survey instruments that can validate pathway classifications, capture missing funding data, and achieve theoretical saturation across all strategic pathways.

The 2005–2021 observation window creates a compelling natural experiment for future research, as 47 ventures classified as „active pre-commercial" will mature precisely as Horizon Europe (2021–2027) and the EIC Accelerator deploy grant-equity instruments - a fundamental architectural shift in European deep tech funding that may mitigate the grant-dependency patterns observed in this cohort. Revisiting this population post-2027 will reveal, whether current finance designs successfully bridge the commercialisation gap, transforming what currently appears as a structural ceiling into a transitional phase.

The Baltic regional focus represents a deliberate contextual contribution rather than a limitation, offering ecosystem-conditional insights from a structurally constrained environment that invites comparative replication across European ecosystems of varying maturity to disentangle pathway effects from structural ecosystem effects. This study opens a rich research agenda: validating pathway-outcome relationships across contexts, testing policy interventions designed to accelerate Grant-first and Hybrid pathway commercialisation and building theory about how regional ecosystem maturity moderates the effectiveness of alternative funding strategies in deep technology ventures.

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