THE EUROPEAN SOCIETY OF MEDICINE
Medical Research Archives, Volume 14 Issue 3

RESEARCH ARTICLE

Milestone-Driven Pitch Decks for Early-Stage Science

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OPEN ACCESS

PUBLISHED
31 March 2026

CITATION
York, JM., 2026. Milestone-Driven Pitch Decks for Early-Stage Science. Medical Research Archives, [online] 14(3). https://doi.org/10.18103/mra.v14i3.7292

DOI
https://doi.org/10.18103/mra.v14i3.7292

ISSN
2375-1924

ABSTRACT

Early-stage life science ventures operate under conditions of extreme biological, regulatory, and economic uncertainty. They routinely struggle to communicate decision readiness to investors and industry partners because conventional pitch decks and business plans emphasize narrative ambition, market size, and long-term upside while under-specifying scientific risk, regulatory uncertainty, and staged decision logic. Research in translational medicine, venture governance, real options theory, and stage-gate innovation governance shows that investors and organizations allocate early-stage capital to resolve dominant uncertainties through incremental, sequential learning, tying continuation decisions to predefined technical and commercial criteria rather than to persuasive vision alone. Despite this logic, early-stage pitching practices rarely operationalize explicit continuation, narrowing/redesign, or termination thresholds within their artifact design.

This paper conceptually examines early-stage pitch and planning artifacts as decision-support mechanisms under conditions of extreme biological and regulatory uncertainty. They exist as pre-contractual governance mechanisms that simulate stage-gate discipline upstream of formal portfolio review systems. Drawing on illustrative preclinical exemplars in the drug, device, drug-delivery, gene therapy, and platform domains, the analysis identifies recurring structural misalignments in scientific pitching. These include risk stacking across platform feasibility and downstream scope before anchor validation, premature commercialization framing, narrative rather than decision-relevant milestones, and the absence of explicit, predefined gate thresholds that link capital deployment to uncertainty resolution. These design failures obscure governing uncertainties, increase perceived risk, and reduce evaluability even when the underlying science is strong.

To address this gap, this work introduces an investability framework that organizes early-stage evaluation around four decision domains: problem reality, solution differentiation, de-risking path, and value capture logic. It also presents a milestone-driven, 12-slide pitching roadmap that operationalizes staged capital discipline. The framework reframes the pitch deck from persuasive narration into a governance instrument that clarifies uncertainty prioritization, learning velocity, and continuation thresholds. By translating stage-gate logic into upstream artifact design, the framework reframes pitching as a governance exercise that structures staged commitment before formal control rights exist. Rather than promising higher success rates in an inherently high-attrition domain, the model improves decision clarity, reduces governance ambiguity, and strengthens disciplined allocation of scarce translational capital. Thus, it aligns early-stage communication with the institutional capital allocation norms that govern later-stage innovation systems.

Keywords: Biomedical Innovation; Capital Allocation; Decision-Making Under Uncertainty; Life Science Startups; Milestone-Driven Development; Pitch Decks; Preclinical Entrepreneurship; Real Options Theory; Translational Medicine; Venture Governance.

1. Introduction

Preclinical life science innovation unfolds under conditions of extreme scientific uncertainty, long development timelines, and structurally high failure rates. Large-scale analyses of pharmaceutical pipelines consistently show that most therapeutic programs fail well before regulatory approval, with fewer than 10–15% of assets entering clinical testing ultimately reaching the market.[1,2] Attrition is especially severe for first-in-class mechanisms and biologically novel modalities. These outcomes reflect structural features of biomedical innovation, including biological complexity, translational fragility, and increasingly stringent evidentiary standards.

The economic implications of this uncertainty are substantial. Fully capitalized estimates of bringing a single approved drug to market reach several billion dollars once failed programs and the cost of capital are incorporated.[3] At the industry level, research documents a persistent decline in research and development productivity, often described as Eroom's Law, in which escalating investment yields proportionally fewer approvals.[4] These dynamics create a clear imperative for disciplined decision-making: ventures must invalidate weak hypotheses early, resolve uncertainty sequentially, and allocate scarce capital toward learning rather than optimism.

Venture finance theory formalizes this logic. Foundational research characterizes early-stage investment as staged commitment rather than upfront conviction.[5–7] Investors deploy capital through milestone-based tranching, contingent control rights, and active monitoring to preserve optionality as information emerges.[5,8] Real options theory further clarifies that early investment purchases the right to continue once uncertainty resolves, rather than committing irrevocably to scale.[9,10] Across translational science and venture governance, disciplined uncertainty resolution defines rational capital allocation.

Despite this alignment, early-stage life science pitch materials frequently fail to reflect staged decision logic. Pitch decks and business plans often stack unresolved risks, like biological validity, delivery feasibility, safety margins, regulatory pathways, and commercialization assumptions, without clarifying which uncertainty dominates at a given stage. Many emphasize market size, platform breadth, or long-term revenue projections before establishing decisive biological or translational validation. Survey evidence suggests that investors prioritize execution discipline and milestone credibility over speculative scale.[5] However, pitch artifacts rarely operationalize explicit continuation or termination thresholds. The absence of predefined gate criteria increases perceived governance risk and undermines evaluability, even when the science is strong.

This paper argues that early-stage pitch decks function as pre-contractual governance artifacts that simulate stage-gate decision logic upstream of formal capital allocation. Long before investors negotiate financing terms or board control rights, pitch materials shape how evaluators interpret uncertainty, prioritize risk, and assess whether capital deployment will generate decision-relevant learning. When pitch artifacts privilege persuasion over disciplined uncertainty reduction, they obscure the very logic that governs staged investment in high-attrition domains.

To address this gap, the paper conceptually integrates translational risk, venture governance, and real options reasoning to examine how pitch artifacts succeed or fail as decision-support tools under extreme uncertainty. It introduces an investability model organized around four decision domains, like problem reality, solution differentiation, de-risking path, and value capture logic. This work also develops a milestone-driven 12-slide roadmap that operationalizes staged capital discipline. By reframing early-stage pitching as translational governance rather than narrative persuasion, the framework clarifies decision readiness, reduces governance ambiguity, and aligns entrepreneurial communication with established norms of staged capital allocation in biomedical innovation.

Accordingly, this paper proceeds as follows. Section 2 reviews relevant literature on translational risk, venture governance, and pitching logic. Section 3 outlines the conceptual orientation and illustrative grounding of the analysis. Section 4 synthesizes recurring misalignments in early-stage scientific pitching. Section 5 introduces the milestone-driven pitching model and situates it within existing theory. The paper concludes by discussing implications, limitations, and directions for future research.

2. Governance Logic Under Translational Uncertainty

Early-stage life science innovation operates within a governance environment shaped by extreme biological uncertainty, long development timelines, and structurally high attrition. The translational "valley of death" describes the persistent gap between scientific discovery and clinical application, where promising innovations stall due to insufficient validation, fragmented funding, or misaligned institutional incentives.[11] Empirical evidence confirms that failure is not anomalous but structural. Large-scale analyses show that fewer than 10–15% of therapeutic programs entering clinical testing ultimately achieve regulatory approval.[1,2] Attrition is particularly pronounced in neurologic, oncologic, and first-in-class programs, where uncertainty across mechanism, delivery, safety, and regulatory pathways compounds early-stage risk.

These structural realities generate a governance imperative. Translational progress depends not merely on scientific novelty but on disciplined sequencing of uncertainty resolution. Weak hypotheses must be invalidated efficiently; capital must be deployed to generate belief-changing evidence rather than to sustain narrative momentum. Although the translational literature emphasizes de-risking, it provides limited guidance on how ventures should communicate uncertainty sequencing to external capital providers at the preclinical stage. Public translational funding mechanisms similarly incorporate milestone-based continuation logic, conditioning support on predefined evidence thresholds rather than narrative ambition.[12,13]

Venture finance theory clarifies how capital is rationally deployed under such uncertainty. Foundational work conceptualizes venture capital as a governance system built on staged commitment, contingent control rights, and active monitoring.[5–7] Investors tranche capital based on milestone achievement, preserving flexibility while reallocating resources away from underperforming programs. Kaplan and Strömberg[8] demonstrate that venture contracts explicitly tie funding continuation to the resolution of technical, regulatory, and market uncertainties. These mechanisms embed decision logic into financing structures rather than relying on projected scale or aspirational narratives.

Strategy research reinforces this governance orientation through real options reasoning. Early investment functions as the purchase of an option to continue once uncertainty resolves, not as an irreversible commitment to expansion.[9,10] Organizations preserve flexibility by staging capital deployment and conditioning continuation on evidence. Under this logic, value emerges through disciplined learning and threshold-based commitment rather than early conviction.

Formal innovation systems institutionalize this approach through stage-gate governance structures. In stage-gate systems, development advances through defined stages separated by evaluation gates, where continuation, redirection, or termination decisions occur based on predefined technical, regulatory, and commercial criteria.[14–17] Pharmaceutical and medical technology development follows a similar logic as programs move from discovery to investigational submission and through clinical phase transitions. Each progression requires satisfaction of explicit thresholds before additional capital is committed. Stage-gate systems, therefore, operationalize real options reasoning within organizational processes, tying resource allocation to evidence generation rather than narrative aspiration. In biotechnology contexts, portfolio governance similarly emphasizes staged scientific validation prior to downstream scaling, reinforcing the structural coupling between evidence thresholds and capital deployment.[18]

Across translational science, venture governance, and stage-gate innovation systems, a common logic emerges: capital allocation depends on explicit uncertainty prioritization, sequential experimentation, and predefined continuation criteria. Yet early-stage ventures typically pitch before formal governance mechanisms exist. At this pre-contractual stage, control rights remain unallocated, portfolio oversight structures are absent, and contractual tranching has not yet been negotiated. Nevertheless, investors and business development teams evaluate opportunities through cognitive frameworks shaped by staged governance norms.

Under these conditions, pitch decks and early business plans become the first governance artifacts through which founders signal whether they understand disciplined capital deployment under uncertainty. When pitch materials fail to

articulate dominant risk, decisive experimentation, and predefined continuation thresholds, they diverge from the institutional logic that governs later-stage capital allocation. Misalignment at this upstream stage increases perceived governance risk, even when scientific credibility remains strong.

2.1 PITCHING LOGIC AND ENTREPRENEURIAL ARTIFACTS

Entrepreneurship research and accelerator practice traditionally emphasize persuasive clarity, compelling narrative structure, and large addressable markets as central components of venture communication.[19–21] Strategic entrepreneurial storytelling frameworks reinforce this orientation by foregrounding ambition, legitimacy, and visionary framing.[21,22] In digitally oriented or later-stage ventures, such narrative coherence may align with evaluative priorities.

In preclinical biomedical contexts, however, this rhetorical orientation conflicts with governance logic. Investors and pharmaceutical business development teams prioritize disciplined uncertainty resolution and staged commitment over speculative scale.[8–10] When pitch decks privilege persuasion while under-specifying risk sequencing or decision thresholds, they function as promotional artifacts rather than decision-support tools. Existing pitching research focuses primarily on signaling, impression management, and narrative effectiveness in venture financing[23,24] offering limited guidance on how pitch artifacts should encode milestone logic, learning objectives, or stopping rules in high-attrition domains.

This gap is particularly consequential in early-stage life science settings, where pitch decks may represent the primary interface between scientific programs and capital allocators. Absent a governance-oriented framework, ventures risk presenting persuasive narratives that obscure rather than clarify decision readiness.

2.2 BRIDGING GOVERNANCE LOGIC AND PITCH DESIGN

The convergence of translational risk, venture governance, and stage-gate reasoning reveals a conceptual gap at the artifact level. While existing literatures specify how uncertainty must be resolved and how capital is staged in response, it remains largely silent on how these governance logics should be encoded within early-stage entrepreneurial communication. Pitch artifacts occupy a structurally upstream position: they precede contracts, portfolio review committees, and formal development gates, yet they shape which programs receive the capital necessary to progress.

This paper addresses that gap by reframing early-stage life science pitching as a governance design problem rather than a persuasion problem. It argues that pitch decks function as pre-contractual governance artifacts that simulate stage-gate decision logic before formal capital allocation mechanisms exist. Integrating insights from translational medicine, venture governance, and real options theory, this paper develops a milestone-driven framework that operationalizes uncertainty prioritization, decision thresholds, and staged commitment within pitch design. By aligning entrepreneurial communication with established capital allocation norms, the framework clarifies decision readiness without altering the underlying biological uncertainty inherent in biomedical innovation.

3. Methods: Conceptual Orientation and Illustrative Grounding

This paper adopts a conceptual synthesis and design-oriented analytic approach to examine how early-stage life science pitch decks and business plans function as decision-support and governance artifacts under conditions of extreme uncertainty. Rather than testing hypotheses or estimating population-level effects, the analysis seeks to explain why conventional pitching practices systematically misalign with translational risk and staged capital allocation and to develop a conceptual model that addresses this misalignment. The analytic focus centers on the design and function of pitch and planning artifacts themselves, which operate upstream of formal contracts, regulatory submissions, and development plans yet play a decisive role in shaping early-stage investment and partnership decisions. Accordingly, the paper treats pitch decks and business plans not as marketing materials, but as governance mechanisms that encode assumptions about learning, risk sequencing, and capital discipline.

To ground this conceptual development in translational practice, the analysis draws on illustrative exemplars from early-stage, preclinical life science ventures within university-affiliated translational

and accelerator environments. The evaluation utilized preset scaffolding for business plan and pitch deck assessment (Tables 1 and 2). Accompanying these scaffolds is an investability model (Table 3), which synthesizes these decision domains into a structured evaluation lens. Rather than functioning as a scoring instrument, the model clarifies which dimensions must be addressed explicitly for early-stage programs to be evaluable under conditions of extreme uncertainty.

Table 1. Business Plan Analytic Scaffolding (Investor & Translational Lens)

Purpose: To assess whether an early-stage life science business plan functions as a *decision-support document* for staged capital allocation rather than as a purely narrative or aspirational artifact.

Evaluation Domain	Key Criteria Assessed	Decision-Relevant Signal
A. Structure & Executive Readiness	Executive summary clarity, organization, investor orientation; concision	Can an investor understand *what decision is being asked* within minutes?
B. Industry & Market Understanding	Market segmentation (TAM/SAM/SOM); PESTLE; Five Forces; strategic insight	Does the team understand *where power, risk, and timing sit* in the industry?
C. Company & Team Credibility	Founder–market fit; team completeness; traction realism	Is this the *right team* to run the next experiment?
D. Product & Value Proposition	Problem–solution fit; differentiation; customer validation	Is the value proposition *specific, defensible, and testable*?
E. Revenue Model & Pricing	Pricing logic; unit economics; willingness-to-pay assumptions; sensitivity analysis	Are economics *grounded in behavior* rather than projections?
F. Go-to-Market Strategy	Channel prioritization; customer journey; partners; positioning	Is there a *credible path* from validation to adoption?
G. Operations, Development & Risk	Product roadmap; risk identification; mitigation plans	Are risks *acknowledged, sequenced, and managed*?
H. Financials & Investment Readiness	Financial coherence; use of funds; capital efficiency	Does capital clearly map to *learning and value inflection points*?

Scoring Scale:
1 = Major gaps / not investor-ready
3 = Adequate but underdeveloped
5 = Investor-ready / best-in-class

Interpretive Use: This rubric emphasizes *decision clarity* over completeness. High scores indicate that a plan enables staged funding or partnering decisions under uncertainty. PESTLE: Political, Economic, Social, Technological, Legal, and Environmental; SAM: Serviceable addressable market; SOM: Serviceable obtainable market, TAM: Total addressable market

Table 2. Pitch Deck Analytic Scaffolding (Investor & Business Development Decision Lens)

Purpose: To evaluate whether a pitch deck enables *go/no-go* decisions at the preclinical or early translational stage.

Section	Evaluation Focus	Key Decision Question
I. Customer, Problem, Market	ICP clarity; urgency; market framing	Is the problem *real, painful, and specific*?
II. Solution & Differentiation	Mechanistic logic; competitive realism; moat	Why *this solution* versus all substitutes?
III. Execution Logic & Inflection Point	Dominant risk; next milestone; assumptions	What *uncertainty is resolved next*?
IV. Business Model & Ask	Revenue logic; valuation logic; capital use	Why fund or partner *now*?
V. Evidence & Story Flow	Data support; narrative coherence	Can the evaluator *retell the decision logic*?

Inflection-Point Emphasis: This rubric weights Section III more heavily for preclinical ventures, reflecting investor and BD prioritization of risk reduction over scale narratives. ICP: Ideal customer profile.

Scoring Scale:
1 = Major gaps / not investor-ready
3 = Adequate but underdeveloped
5 = Investor-ready / best-in-class

Table 3. Investability Model for Early-Stage Translational Ventures

1. Problem & Customer Reality	2. Solution & Differentiation	3. De-Risking Path & Evidence	4. Value Capture & Scale Logic
Key question: Is the problem real, painful, and owned by a clear economic buyer?	**Key question:** Does the solution plausibly change outcomes vs. alternatives?	**Key question:** Is there a believable path from uncertainty to proof?	**Key question:** If it works, does value actually accrue to the venture?
Clearly defined customer and use context.	Clear value mechanism (why this works)	Dominant uncertainty explicitly named	Business model logic articulated
Evidence of unmet need (not assumed interest)	Meaningful differentiation vs. status quo	Milestones tied to learning, not activity	Pricing, reimbursement, or revenue path is credible
Economic buyer is identifiable and credible.	Competitive landscape acknowledged	OKRs aligned to de-risking logic	Partners, regulators, or gate keepers acknowledged
⚠ *Common failure:* Vague "users" or proxy buyers	⚠ *Common failure:* Feature novelty without comparative logic	⚠ *Common failure:* Parallel progress on everything	⚠ *Common failure:* Market size without capture mechanics

The analysis selected illustrative exemplars purposively based on theoretical relevance rather than representativeness.[25–27] Among these exemplars, the analysis examines a pre-company academic platform developing a polyphenol-based intracellular delivery system designed to enable delivery of diverse biologics across multiple disease areas. This effort chose this exemplar because it combines strong scientific credibility with persistent ambiguity in decision readiness, allowing evaluability failures to be surfaced independent of data quality. The analysis uses these exemplars to surface recurring design failures in early-stage scientific pitching and to illustrate how alternative framing improves decision relevance. It does not treat these as empirical cases in a causal or statistical sense. Instead, they function as worked examples consistent with theory-building and analytic generalization traditions,[25–30] in which concrete instances clarify mechanisms and boundary conditions rather than establish statistical prevalence.[29,30] Each exemplar operated at a discovery or preclinical stage where biological, translational, or regulatory uncertainty dominated commercial uncertainty, addressed a clearly articulated unmet medical or clinical need, and produced formal pitch decks, and in selected instances complementary business plans, used in evaluative settings involving investor- or industry-facing decision criteria. The final set of explicit exemplars spans multiple translational pathways, including therapeutic, gene-based, medical device, drug–device, and drug delivery combination development contexts. Drug–device exemplars are particularly informative for examining decision misalignment because clinical workflow fit may be clear, while buyer identity, regulatory responsibility, and deal structure remain ambiguous. This diversity enables conceptual contrast across regulatory regimes, development logics, and adoption dynamics while preserving a common decision environment characterized by high uncertainty and staged capital deployment.

In addition to these explicit exemplars, the analysis incorporates recurring patterns drawn from other early-stage translational contexts encountered during instructional and evaluative practice. It references these patterns analytically where relevant, but they are not treated as discrete cases, thereby avoiding over-specification of indication- or modality-specific details that are not central to the conceptual argument. The analytic focus is therefore not venture outcome or performance, but the pitch and planning artifacts themselves as mediators between scientific uncertainty and capital allocation decisions.

The primary analytic material consists of pitch decks produced by the illustrative exemplar ventures and evaluated by them. For selected exemplars, full business plans were also reviewed as complementary artifacts that extend and operationalize pitch-level assumptions. The analysis examined these materials using structured, investor-grade evaluation criteria (Tables 1 and 2) designed to reflect how investors and pharmaceutical business development teams reason about early-stage opportunities under uncertainty. The analytic lens emphasized decision-critical dimensions rather than completeness or polish, including how ventures articulated and prioritized dominant translational uncertainties, specified and operationalized milestones, aligned capital use with uncertainty reduction, sequenced regulatory considerations,

and addressed the presence or absence of explicit kill, pivot, or continuation criteria. Supporting materials such as written evaluation memoranda, rubric-based frameworks, and structured feedback generated during formal pitch reviews informed conceptual pattern identification but were not treated as independent data sources or quantitative measures.

The analysis proceeded through iterative comparison between conceptual expectations derived from the literature and patterns evident in pitch and planning artifacts. It first examined individual exemplars to assess how uncertainty was framed, sequenced, or deferred across scientific, regulatory, and commercial dimensions. Cross-exemplar synthesis then highlighted recurring misalignments between conventional pitch logic and investor or business development decision logic. Structured evaluation rubrics, presented in Tables 1 and 2, served as analytic scaffolding rather than measurement instruments. Although the rubrics employ ordinal scales across decision-relevant dimensions, the analysis does not interpret scores quantitatively. Instead, the rubrics support systematic comparison and help surface design failures related to risk stacking, narrative milestones, and absent decision thresholds.

This synthesis informed the development of the milestone-driven pitching model presented in subsequent sections. Consistent with conceptual research norms, the analysis prioritizes analytic generalization and explanatory coherence rather than statistical inference. The objective is not to predict venture outcomes, but to explain why early-stage pitch artifacts frequently fail as governance tools and how alternative design principles can improve decision quality under extreme uncertainty.

4. Conceptual Misalignments in Early-Stage Scientific Pitching

This section synthesizes recurring conceptual misalignments evident in early-stage, preclinical life science pitch decks and business plans when evaluated as decision-support and governance artifacts. Rather than reporting empirical results or venture outcomes, the analysis examines how pitch and planning artifacts encode, or fail to encode, decision logic under conditions of extreme scientific, regulatory, and translational uncertainty. Drawing on illustrative exemplars spanning therapeutic, gene therapy, and medical device contexts, the section identifies structural weaknesses in early-stage pitching that systematically undermine evaluability, capital efficiency, and governance alignment.

Across illustrative contexts, the analysis highlights a consistent misalignment between how founders frame opportunity and how investors and pharmaceutical business development teams assess decision readiness. Founders commonly articulate ambition, novelty, and long-term value, yet pitch materials frequently fail to make uncertainty reduction, milestone logic, and decision discipline explicit. The synthesis proceeds by examining exemplar characteristics and dominant limitations, recurring failure modes in pitch design, the effects of milestone-driven reframing, contrasting pitching logics, and the implications of these patterns for early-stage decision-making.

4.1 ILLUSTRATIVE EXEMPLARS AND DOMINANT DESIGN LIMITATIONS

Table 4 summarizes the illustrative translational contexts, development stages, primary artifacts reviewed, and dominant decision misalignments. Although these programs differ in regulatory pathway and commercialization trajectory, they share a common structural weakness: pitch and planning artifacts emphasize downstream value creation before establishing near-term decision clarity. The issue is not scientific quality but governance signaling.

In the neurological therapeutic exemplar, pitch materials foreground platform potential, market size, and future indication expansion despite the absence of decisive *in vivo* validation of the core biological hypothesis. The deck does not specify which single experiment most efficiently validates or invalidates the mechanism, nor does it define what outcome would materially alter the investment thesis. As a result, evaluators cannot determine whether capital deployment will generate belief-changing evidence or extend exploratory activity. The dominant uncertainty–biological validity–remains embedded within a broader narrative of scale rather than isolated as a decision gate.

Table 4. Illustrative Exemplar Translational Contexts and Dominant Decision Misalignments

Translational Context	Development Stage	Primary Decision Artifact	Dominant Decision Misalignment
Neurological therapeutic program	Discovery	Pitch deck	Market-first framing prior to decisive biological validation
Gene-based programs with staged population expansion	Preclinical	Pitch deck	Stacked delivery, durability, and regulatory uncertainty
Implantable medical device	Preclinical	Business plan and pitch deck	Under-specified procurement dynamics and buyer power
Gene-based programs targeting chronic indications	Discovery	Business plan and pitch deck	Premature partnership framing before biological proof
Drug–device combination adjunct therapies in acute care	Preclinical/early translational	Pitch deck (often supplemented by partnering narrative)	Assumed workflow fit implies commercial pull; under-specified who pays, who decides, reimbursement logic, and partner decision gates. Underplays intellectual property runway relative to development pathway.
Platform-stage intracellular drug delivery technology	Discovery too early preclinical	Platform-focused pitch deck	Platform breadth and downstream market narratives emphasized before anchoring to a single payload–indication pair capable of generating a decisive biological or translational readout, obscuring which uncertainty governs continuation or abandonment decisions.

The implantable medical device exemplar presents a contrasting but structurally similar misalignment. The venture demonstrates functional prototypes, clinician engagement, and preliminary reimbursement alignment. However, early pitch and planning materials under-specify procurement dynamics, buyer authority within consolidated delivery systems, and commercialization sequencing. Clinical enthusiasm appears as implicit validation, yet the artifact does not clarify which milestone de-risks institutional purchasing decisions or how evidence translates into contracted revenue. Here, the dominant uncertainty lies not in the mechanism but in buyer behavior and organizational adoption. Without explicit linkage between development milestones and purchasing thresholds, evaluators struggle to assess capital efficiency.

The platform-stage intracellular delivery exemplar further illustrates how breadth can obscure decision logic. The technology demonstrates promising early data across multiple payload classes and indications, with favorable preliminary safety signals. Pitch materials emphasize platform extensibility and theoretical applicability across therapeutic areas. However, they defer specification of a single anchor payload–indication pairing capable of generating a decisive biological or translational readout. By expanding the scope before anchoring validation, the artifact amplifies uncertainty rather than sequencing it. Evaluators cannot identify which experiment governs continuation or abandonment decisions at the present stage.

Additional contexts reinforce this structural pattern without altering its logic. Gene-based programs, for example, often stack vector performance, durability of expression, regulatory feasibility, and market expansion without prioritizing which uncertainty dominates at entry.[1,2] Drug–device combination programs frequently assume that workflow fit or mechanistic plausibility implies commercial pull, while leaving reimbursement responsibility and partner decision gates implicit. Across modalities, the surface details differ, but the governance failure remains consistent: founders stack risk rather than sequence it.

Across exemplars, credibility limitations do not arise from weak science, inadequate teams, or poor intent. They arise from insufficient articulation of decision inflection points and from the absence of explicit linkage between evidence generation and capital allocation. When pitch artifacts fail to clarify which uncertainty governs continuation and what outcome triggers redirection or termination, they deviate from the staged decision logic that characterizes translational governance. By contrast, when artifacts isolate a dominant uncertainty, specify a decisive experiment, and define interpretable

thresholds, evaluators can map the opportunity onto established capital allocation frameworks.

4.2 RECURRING PITCH DESIGN FAILURE MODES

Cross-exemplar synthesis highlights a set of recurring pitch design failure modes that systematically undermine investor and business development confidence. These patterns appear consistently across translational contexts, indicating structural rather than idiosyncratic weaknesses.

First, pitch materials routinely overstate developmental maturity. Founders employ language more appropriate for late preclinical or early clinical assets, like platform readiness, pipeline expansion, or commercial scalability, despite unresolved upstream uncertainty. This mismatch signals insufficient risk awareness rather than ambition and leads evaluators to discount downstream claims.

Second, pitch artifacts stack multiple high-uncertainty elements simultaneously rather than sequencing risk. Founders frequently present novel biology, delivery challenges, safety assumptions, regulatory pathways, and adoption logic in parallel, without clarifying which uncertainty dominates decision-making at the current stage. This risk stacking obscures accountability and prevents evaluators from assessing option value or capital efficiency.

Third, pitches frame milestones narratively rather than operationally. Pitch materials often describe progress using aspirational statements such as advancing toward the clinic or demonstrating efficacy, rather than defining testable experiments with interpretable readouts and predefined thresholds. Without explicit success and failure criteria (i.e., continuation or termination thresholds), milestones cannot function as governance inflection points. A milestone becomes a decision gate only when predefined quantitative or qualitative thresholds determine whether capital continues, narrows/redesigns, or terminates. In high-uncertainty translational contexts, evaluators prioritize threshold-defined gates over narrative advancement. This pattern is especially pronounced in adjunctive drug–device therapies, where teams may assume that strong clinical fit will naturally attract partners despite unresolved uncertainty regarding value capture, reimbursement, and regulatory responsibility. When pitch artifacts articulate milestones without specifying decision consequences, evaluators cannot determine whether capital deployment will generate decision-relevant learning or merely extend activity, thereby increasing perceived governance risk.

Finally, pitch decks frequently introduce commercial framing prematurely. Ventures emphasize partnerships, licensing opportunities, or market expansion before resolving dominant scientific or translational uncertainties. In therapeutic contexts, this appears as early discussion of blockbuster potential or deal economics; in device contexts, it appears as optimistic adoption narratives without procurement realism. Premature commercialization framing amplifies perceived risk across evaluative contexts.

4.3 EFFECTS OF MILESTONE-DRIVEN REFRAMING

Reframing pitch artifacts around milestone-driven decision logic increases evaluator confidence because it demonstrates discipline, not just developmental motion. Articulating predefined gate thresholds signals governance maturity rather than pessimism. By defining continuation criteria in advance, founders align with staged capital allocation norms used in venture finance and corporate research and development (R&D) systems. Clear gate conditions reduce ambiguity about capital stewardship even when underlying biological uncertainty remains unchanged.

Investors and business development evaluators respond more favorably when founders identify which uncertainty the next tranche of capital addresses, specify what outcome would meaningfully change belief, acknowledge plausible failure modes, and link capital use directly to uncertainty resolution. This effect occurs even without new data because evaluators can map the opportunity onto their staged capital allocation frameworks. This reframing transforms pitch decks from persuasive narratives into decision-support tools and repositions capital as a mechanism for purchasing defined answers to dominant uncertainties. In the delivery platform exemplars, milestone-driven reframing clarifies whether the asset should be treated as a scalable platform or a narrower tool, enabling earlier, lower-cost resolution of strategic ambiguity for both founders and evaluators. Notably, explicit acknowledgment of downside scenarios functions as a signal of governance maturity rather than weakness. By clarifying stopping rules and decision consequences, milestone-driven framing reduces perceived risk even when objective uncertainty remains unchanged. In essence, capital becomes a

tool for purchasing answers to defined questions rather than fuel for speculative growth.

4.4 TRADITIONAL PITCH LOGIC VERSUS MILESTONE-DRIVEN PITCH LOGIC

The contrast between conventional pitch framing and milestone-driven (i.e., gate) framing is sufficiently consistent to warrant formal articulation. Within the milestone-driven framework, this analysis defines kill criteria as predefined belief thresholds that determine whether continued investment remains justified. Kill criteria operationalize decision readiness; they define when capital stops, not just when it continues. Consistent with real options reasoning, early-stage ventures deploy capital to resolve a dominant uncertainty, while predefined stopping rules specify the conditions under which evidence fails to support continuation or resolves uncertainty unfavorably. These rules trigger abandonment or strategic redesign rather than escalation. By making kill criteria explicit, the framework preserves ambition while strengthening decision discipline, clarifying how decision makers interpret evidence and identifying the point at which additional capital no longer improves the expected value of continuation. Table 5 synthesizes the dimensions along which traditional pitch logic diverges from milestone-driven pitch logic.

Table 5. Traditional Pitch Logic vs Milestone-Driven Pitch Logic

Dimension	Traditional Pitch Logic	Milestone-Driven Pitch Logic
The primary purpose of capital	Fund vision, growth, and scale	Buy answers to specific uncertainties
The primary goal of the pitch	Persuade through ambition and upside	Enable staged decision-making
Core narrative structure	Big market + compelling story	Sequential uncertainty reduction
Treatment of risk	Implicit, minimized, or deferred	Explicit, prioritized, and sequenced
Milestone definition	High-level, narrative, aspirational	Testable, time-bound, decision-relevant
Link between milestones and decisions	Weak or assumed	Explicit kill/continue logic
Failure criteria	Rarely articulated or avoided	Explicit stopping or pivot thresholds
Financial projections	Static, long-term projections	Scenario-based and milestone-linked
Use of market size	Primary justification for investment	Contextual and downstream consideration
Investor question addressed	"How big could this be?"	"What will we know next?"
Partner/BD question addressed	"Is this exciting?"	"Why fund or partner *now*?"
Governance function of the pitch	Promotional artifact	Decision-support and governance tool

Under traditional pitch logic, capital functions as fuel for growth and scale, risk remains implicit or minimized, milestones are aspirational, and failure criteria remain unstated. Financial projections emphasize long-term outcomes and remain weakly connected to development risk. The central question addressed is how large the opportunity could become.

Milestone-driven pitch logic reframes capital as a means to resolve specific uncertainties. Risk is explicit, prioritized, and sequenced; milestones are testable, time-bound, and decision-relevant. Predefined gate thresholds specify continuation, narrowing/redesign, or termination conditions. Failure criteria are explicit, and financials are scenario-based and linked to development gates. The central questions shift to what will be known next and why funding or partnering is justified at the present stage.

This shift repositions the pitch deck itself as a governance mechanism rather than a promotional artifact, aligning pitch content with how investors and business development teams allocate capital under uncertainty.

While Table 5 contrasts traditional and milestone-driven pitch logic at a conceptual level, decision makers must still translate this logic into context-specific reframing. Table 6 provides illustrative translational examples that map dominant entry-stage uncertainty to decision-relevant reframing

logic, showing how milestone discipline can be operationalized without standardizing content across programs. Notably, platform delivery exemplars illustrate that evaluability fails not because of weak science, but because platform ambition amplifies uncertainty unless anchored to a single, decision-governing experiment with explicit downgrade or termination criteria.

Table 6. Illustrative Exemplar Translational Contexts, Dominant Risks, and Decision-Relevant Reframing

Translational Context	Dominant Uncertainty at Entry	Common Pitch Design Failure	Decision-Relevant Reframing Logic
Neurological therapeutic program	Biological validity and translational relevance	Market-first framing prior to decisive biological validation	Can tie milestones to decisive preclinical experiments with explicit discontinuation thresholds
Gene-based programs with staged population expansion	Delivery feasibility, durability, and regulatory acceptance	Risk stacking across vector, delivery, durability, and market scope	Can propose orphan-first sequencing with milestones focused on durable expression before expansion
Implantable medical device	Procurement dynamics and buyer power	Assumption that clinical enthusiasm ensures adoption	Can align milestones with purchasing approval gates and facility-level economics
Gene-based programs targeting chronic indications	Safety, durability, and payer acceptance	Premature partnership or licensing narratives	Can define early biological kill criteria as a proper stage-gate prior to formal development commitment
Drug–device combination adjunct therapies in procedure-based care	Buyer identity, reimbursement plausibility, and decision authority	Treated workflow fit as sufficient; under-specified who pays, who decides, and what de-risks the partnership.	Can define milestones as gates that validate payer/buyer logic and partner decision gates; link funding tranches to explicit adoption-economic and partnering thresholds.
Platform-stage intracellular drug delivery technology	Biological validity and translational relevance of a defined payload–indication pairing	Platform extensibility and downstream market breadth were emphasized before specifying a single anchor payload and explicit biological kill criteria.	Can define a single anchor payload–indication pair with explicit *in vivo* efficacy and safety thresholds as a key gate, then can link funding tranches to experiments that validate or downgrade the platform as additional gates before expanding the program's scope.

4.5 SYNTHESIS AND IMPLICATION

The central insight emerging from this synthesis is not that early-stage life science ventures lack compelling science or ambition. Rather, they systematically mis-specify the function of the pitch. Existing failure modes map cleanly to the four investability domains: problem reality, solution differentiation, de-risking path, and value capture logic. When pitch artifacts operate as promotional narratives, they obscure decision logic and increase perceived risk. When reframed as milestone-driven governance tools, they improve evaluability, capital efficiency, and alignment with staged investment and partnering decisions.

This insight directly motivates the framework introduced in the subsequent section: a milestone-driven pitching model designed to make uncertainty reduction, value inflection points, and kill or continue decisions explicit. In this sense, milestone-driven pitching extends formal stage-gate logic upstream into pre-contractual governance artifacts, allowing ventures to simulate institutional gate discipline before formal control rights or portfolio review structures exist.

5. Discussion

Early-stage, preclinical life science ventures systematically misalign how they present opportunities with how investors and pharmaceutical business development teams allocate capital under extreme uncertainty. Translational medicine and venture finance literatures independently emphasize high attrition, staged commitment, and real options logic.[1,5,6,8–10] However, these governance principles rarely shape the design of pitch decks and business plans. Instead, early-stage scientific pitches often adopt narrative conventions drawn from later-stage venture contexts, privileging ambition, scale, and platform extensibility over disciplined uncertainty resolution. This misalignment does not merely weaken rhetoric; it impairs evaluators' ability to determine whether continued capital deployment or partnership engagement is justified.

5.1 PITCHING AS PRE-CONTRACTUAL GOVERNANCE

The cross-exemplar synthesis reveals a consistent structural pattern: ventures obscure which uncertainty governs the present stage. Founders frequently assume that persuasive storytelling, leadership credibility, or long-term market potential can offset unresolved translational risk. Therapeutic programs emphasize downstream expansion before decisive biological validation. Device ventures assume clinical enthusiasm will overcome procurement friction. Platform technologies highlight extensibility before anchor validation. Despite modality differences, the underlying failure remains constant: founders stack uncertainty rather than operationalize it as a decision variable.

This paper reframes the pitch deck as a pre-contractual governance artifact. At the preclinical stage, the pitch constitutes the primary mechanism through which capital allocators evaluate whether scientific uncertainty can be converted into interpretable evidence. Before formal contracts, tranching, or board oversight exist, the pitch mediates how uncertainty is framed and how staged capital deployment is justified. When artifacts minimize dominant risk or omit continuation thresholds, evaluators interpret the omission as weak capital discipline rather than confidence.

The investability framework developed in this paper clarifies this governance function. It frames evaluation around four decision domains—problem reality, solution differentiation, de-risking path, and value capture logic. This framework shifts attention from narrative coherence to decision readiness. It compels ventures to demonstrate not only scientific plausibility but also a credible pathway from uncertainty to proof. In doing so, it aligns pitch structure with how venture investors and business development teams reason under high attrition.[5,6,8]

5.2 RISK SEQUENCING AND DECISION THRESHOLDS

A central insight emerging from the synthesis concerns risk sequencing. Early-stage ventures frequently stack multiple high-uncertainty elements—novel biology, delivery feasibility, safety assumptions, regulatory pathways, and commercialization logic—without clarifying which uncertainty dominates. Stacked risk obscures accountability and increases perceived governance ambiguity. When programs fail, evaluators cannot determine whether failure reflects biological invalidity, execution error, or premature scaling.

Milestone-driven pitching enforces risk hierarchy. It requires founders to identify a single dominant uncertainty, articulate a decisive experiment, and define predefined thresholds that govern continuation, narrowing, or termination. This discipline mirrors staged investment and stage-gate governance logic.[8,14–17] Real options reasoning further clarifies that early capital purchases information, not scale.[9,10] This logic aligns with March's[31] distinction between exploration and exploitation, in which early investment functions as structured exploration designed to generate interpretable learning before scaled commitment. By making continuation criteria explicit, ventures signal that capital deployment aims to resolve a defined uncertainty rather than extend speculative activity.

Explicit decision thresholds function as markers of governance sophistication. Founders often hesitate to articulate termination criteria, fearing that doing so signals weakness. Evaluators interpret the opposite. Predefined stopping rules demonstrate probabilistic reasoning and alignment with portfolio-level decision-making. In pharmaceutical R&D, timely termination preserves portfolio value; escalation of commitment erodes it.[9,10] Extensive research demonstrates that decision makers escalate commitment to failing courses of action when termination thresholds remain ambiguous.[32,33] Predefined stopping rules counteract this bias by structuring a disciplined exit. When pitch artifacts embed explicit thresholds, they reduce perceived governance risk even when biological uncertainty remains unchanged.

Through the investability framework, these principles become operational. The "de-risking path" domain requires ventures to specify which milestone materially alters belief, what evidence suffices for continuation, and what outcome triggers redirection. This structure transforms milestones from narrative progress markers into decision gates.

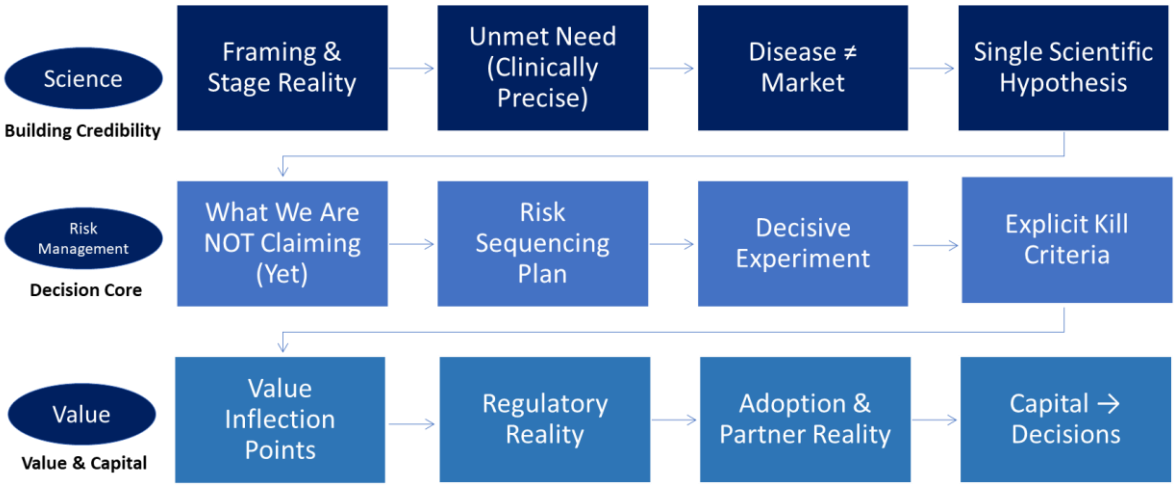
5.3 THE 12-SLIDE ROADMAP AS GOVERNANCE ARTIFACT

The 12-slide milestone-driven roadmap translates governance logic into artifact design. Rather than prescribing aesthetics, the roadmap assigns each slide a decision function. It begins with unmet need

and mechanistic rationale, advances through dominant risk articulation and decisive experiment design, and introduces commercial logic only after scientific uncertainty reaches interpretable thresholds. Each slide answers a diligence question investors already pose implicitly: What uncertainty governs this stage? What evidence resolves it? What happens if the results are negative?

Figure 1 depicts the roadmap as a decision flow. In this configuration, the pitch deck becomes governance infrastructure. Capital is framed not as fuel for growth but as a mechanism for purchasing answers to defined questions. By sequencing content according to uncertainty reduction rather than narrative persuasion, the roadmap operationalizes stage-gate discipline upstream of formal contracting.[8,14–17] This upstream simulation of gate discipline mirrors how scientific portfolio committees evaluate programs internally before contractual tranching occurs.[18]

Figure 1 The New Scientific Pitch: A Preclinical 12-Slide Milestone-Driven Pitch "Road Map" (Investor, Business Development Lens) as a Decision Flow Process Involving Science, Risk Management, and Value Development



This figure depicts: a linear, decision-oriented pitch structure for preclinical ventures. The roadmap begins with stage realism and unmet need, progresses through hypothesis articulation, dominant risk identification, decisive experiment design, and explicit kill criteria, and culminates in value inflection points tied to regulatory and partnering decisions. The framework positions capital as a mechanism for uncertainty resolution rather than growth acceleration.

Importantly, the roadmap does not guarantee biological success. It enhances decision clarity. By aligning artifact structure with staged capital allocation norms, the framework improves evaluability across modalities. Therapeutic, device, and platform ventures differ in dominant risk, but all benefit from explicit sequencing and threshold-based logic. The roadmap thus complements the investability framework: the former structures the artifact; the latter structures evaluation.

5.4 IMPLICATIONS AND BOUNDARY CONDITIONS

This reorganization yields three primary contributions. First, the paper explains why early-stage life science pitch artifacts systematically misalign with governance logic, shifting attention from venture outcomes to decision artifacts. Second, it reframes pitching as pre-contractual governance rather than persuasion, integrating translational risk, venture governance, and real options reasoning. Third, it provides two operational tools—the investability framework and the 12-slide milestone-driven roadmap—that translate theory into practice.

For founders, the framework replaces inevitability narratives with experimental discipline. For investors and business development teams, it standardizes early-stage assessment around risk sequencing and threshold clarity. For educators and translational funders, it offers a decision-aligned alternative to persuasion-centered pitch training.

The framework operates within defined boundaries. It applies primarily to preclinical and early translational life science ventures, where biological feasibility, safety, and regulatory pathways remain unresolved and where the early-stage ventures use capital funds for information generation rather than scaling. It does not extend mechanically to digital startups, consumer ventures, or later-stage biomedical firms with established clinical proof-of-concept. Contextual adaptation remains necessary.

Future research should empirically examine whether ventures that encode predefined gate thresholds within pitch artifacts achieve more efficient staged capital allocation and clearer continuation or termination decisions. Comparative and longitudinal studies could assess how milestone-driven pitching interacts with different capital providers and institutional settings. Such research would not test whether governance discipline increases biological success rates, but whether it improves decision quality and capital stewardship in high-attrition biomedical entrepreneurship.

6. Conclusion

Early-stage biomedical ventures frequently misalign how they communicate opportunity with how capital is actually allocated under extreme uncertainty. Conventional pitch logic emphasizes ambition, market size, and long-term scale, yet under-specifies dominant scientific, regulatory, and translational risks. In high-attrition life science environments, this narrative orientation obscures decision-relevant uncertainty and weakens evaluability, even when the underlying science is strong. Milestone-driven pitching reframes the pitch deck as a governance artifact rather than a promotional narrative. By explicitly identifying the dominant uncertainty, defining a decisive experiment, and specifying continuation, narrowing, or termination thresholds, the pitch becomes a mechanism for staged decision-making. Capital is positioned not as fuel for growth, but as a tool for purchasing answers to defined scientific and developmental questions.

This paper conceptually integrates translational risk, venture governance, stage-gate reasoning, and real options logic to reposition early-stage pitching as pre-contractual governance. It introduces a practical 12-slide milestone-driven roadmap that operationalizes disciplined uncertainty reduction and aligns entrepreneurial communication with how investors and business development teams allocate capital. The framework does not promise higher biological success rates in an inherently uncertain domain. Instead, it improves decision clarity, strengthens capital discipline, and reduces governance ambiguity. Future empirical research should examine whether ventures that encode predefined gate thresholds within pitch artifacts achieve more efficient staged capital allocation, clearer continuation or termination decisions, and improved capital stewardship across translational innovation settings.

Conflict of Interest Statement:

None.

Funding Statement:

None.

Acknowledgements:

None.

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